GREENHOUSE GAS EMISSIONS IN ESTONIA 1990-2012

NATIONAL INVENTORY REPORT
under the UNFCCC and the Kyoto Protocol

Submission to the UNFCCC secretariat

Common Reporting Formats (CRF)
1990–2012

Tallinn 2014

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 2012 emissions and exemptions to the previous inventories. A summarizing table of the emissions data for the years 1990–2012 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 Merilyn Möls and Mr Tanel Laasma) and Estonian Environment Agency (Ms Kaie Kriiska and Mr Veiko Adermann) 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 Ingrid Võrno) 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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EXECUTIVE SUMMARY

ES1. Background information on greenhouse gas inventories, climate change and supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

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 not to be as extreme as in many other countries in the European Union (notably in southern Europe) and around the world, and some effects can be considered positive.

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 was 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 2012 the total emissions of GHGs, measured as CO_2 equivalents, were 17 237.25 Gg, and without LULUCF 19 188.43 Gg. From 1990 to 2012 the emissions decreased by 52.75%. Table ES.1. shows the trend in total emissions during the period 1990–2012. Figure ES.1. shows greenhouse gas emissions trends in CO_2 equivalents.

In 2012, the most important GHG in Estonia was carbon dioxide (CO_2), contributing 89.01% to total national GHG emissions expressed in CO_2 equivalents, followed by nitrous oxide (N_2O), 5.26%, and methane (CH_4), 4.85%. Fluorocarbons (so-called 'F-gases') account for about 0.88% of total emissions. The energy sector accounted for 87.94% of total GHG emissions, followed by agriculture (6.91%), industrial processes (3.45%), waste (1.60%) and solvent and other product use (0.10%).

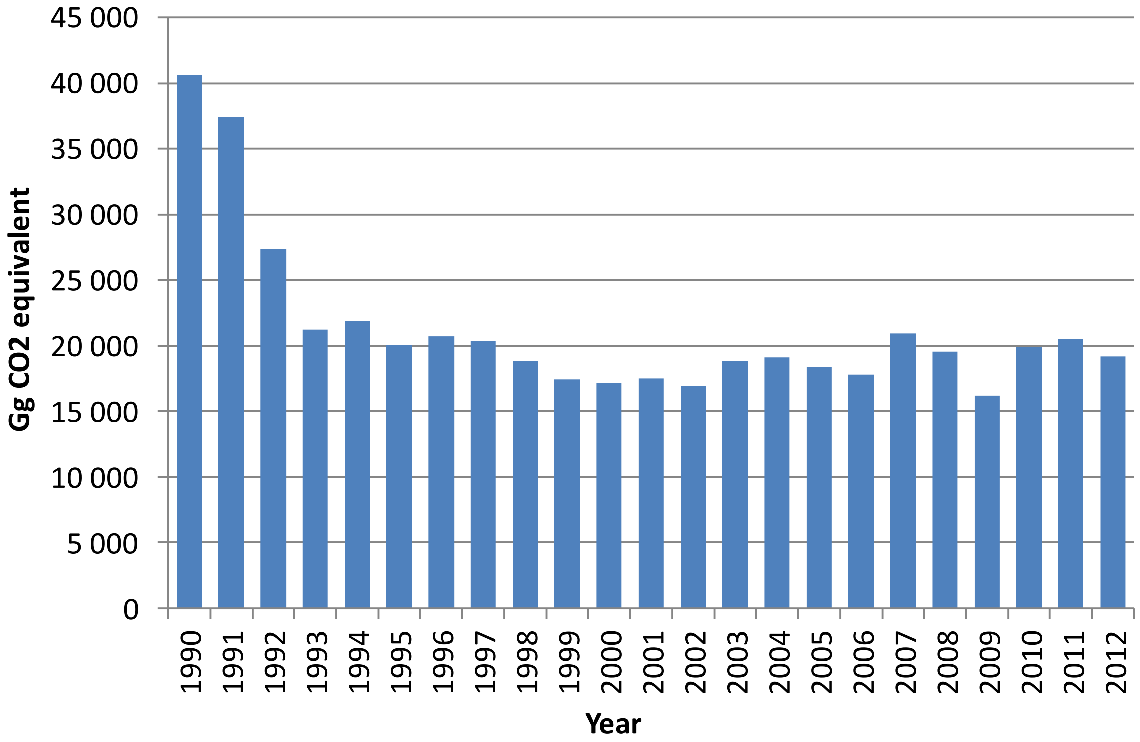


Figure ES.1. Overall development of greenhouse gases in Estonia, in CO_2 equivalents (without net CO_2 from LULUCF)

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

GREENHOUSE GAS EMISSIONS	Base year (1990)	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
CO_2 emissions including net CO_2 from LULUCF	27 878.76	7 480.70	16 952.00	11 428.58	8 998.74	11 244.73	10 208.36	8 111.63	13 217.51	15 536.91	15 121.06
CO_2 emissions excluding net CO_2 from LULUCF	36 700.83	17 997.83	15 149.09	16 421.74	15 843.05	18 873.46	17 365.55	14 157.98	17 803.32	18 427.19	17 079.28
CH_4 emissions including CH_4 from LULUCF	1 670.00	980.19	1 025.00	1 011.58	1 014.79	1 011.77	1 013.46	946.37	966.84	923.47	930.69
CH_4 emissions excluding CH_4 from LULUCF	1 669.60	979.78	1 023.32	1 011.28	1 006.52	1 011.48	1 012.15	946.18	966.71	923.35	930.62
N_2O emissions including N_2O from LULUCF	2 245.61	1 059.72	914.06	871.78	856.46	918.49	1 041.28	950.91	974.10	978.66	1 016.18
N_2O emissions excluding N_2O from LULUCF	2 244.10	1 058.18	912.28	868.79	851.05	913.62	1 035.35	944.60	967.47	971.85	1 009.21
HFCs	NA,NE,NO	25.37	69.54	118.33	135.48	149.15	131.48	138.31	153.04	159.72	167.36
PFCs	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	NA,NE,NO
SF_6	NA,NE,NO	3.22	2.73	1.08	1.15	0.97	1.35	1.44	1.81	1.85	1.96
Total (including LULUCF)	**31 794.37**	**9 549.20**	**18 963.34**	**13 431.35**	**11 006.70**	**13 325.16**	**12 395.97**	**10 148.66**	**15 313.30**	**17 600.61**	**17 237.25**
Total (excluding LULUCF)	**40 614.54**	**20 064.37**	**17 156.96**	**18 421.21**	**17 837.32**	**20 948.75**	**19 545.92**	**16 188.50**	**19 892.34**	**20 483.96**	**19 188.43**
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**Base year (1990)**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
1. Energy	36 019.14	17 610.89	14 775.76	16 021.74	15 384.42	18 268.90	16 752.10	14 128.21	17 768.24	18 253.84	16 873.83
2. Industrial Processes	1 048.23	675.54	705.92	807.28	871.64	1 059.16	1 051.30	451.20	494.34	614.20	662.58
3. Solvent and Other Product Use	26.48	26.16	26.76	26.16	26.35	24.43	21.96	18.49	17.39	18.86	18.72
4. Agriculture	3 177.03	1 495.38	1 215.05	1 179.43	1 174.12	1 216.38	1 336.21	1 236.22	1 261.85	1 273.85	1 326.17
5. Land Use, Land-Use Change and Forestry	-8 820.17	-10 515.17	1 806.38	-4 989.86	-6 830.63	-7 623.59	-7 149.95	-6 039.84	-4 579.04	-2 883.35	-1 951.18
6. Waste	343.65	256.41	433.47	386.61	380.80	379.87	384.35	354.38	350.53	323.22	307.13

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

GHG EMISSIONS [CO2 equivalent (Gg)]	1990		1995		2000		2005		2010		2011		2012	
	[Gg]	[%]	[Gg]	[%]	[Gg]	[%]	[Gg]	[%]	[Gg]	[%]	[Gg]	[%]	[Gg]	[%]
CO_2 emissions excluding net CO_2 from LULUCF	36 700.83	90.36	17 997.83	89.70	15 149.09	88.30	16 421.74	89.15	17 803.32	89.50	18 427.19	89.96	17 079.28	89.01
CH_4 emissions excluding CH_4 from LULUCF	1 669.60	4.11	979.78	4.88	1 023.32	5.96	1 011.28	5.49	966.71	4.86	923.35	4.51	930.62	4.85
N_2O emissions excluding N_2O from LULUCF	2 244.10	5.53	1 058.18	5.27	912.28	5.32	868.79	4.72	967.47	4.86	971.85	4.74	1 009.21	5.26
HFCs	NA,NE,NO		25.37	0.13	69.54	0.41	118.33	0.64	153.04	0.77	159.72	0.78	167.36	0.87
PFCs	NA,NE,NO		NA,NE,NO		NA,NE,NO		NA,NE,NO		NA,NE,NO		NA,NE,NO		NA,NE,NO	
SF_6	NA,NE,NO		3.22	0.02	2.73	0.02	1.08	0.01	1.81	0.01	1.85	0.01	1.96	0.01
Total (excluding LULUCF)	**40 614.54**		**20 064.37**		**17 156.96**		**18 421.21**		**19 892.34**		**20 483.96**		**19 188.43**	

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 2012, net emissions from Article 3.3 activities were 306.59 Gg CO_2 eq. Uptake from afforestation and reforestation activities including emissions from biomass burning was estimated at -130.51 Gg CO_2 eq., whereas deforestation resulted in a net emission of 437.10 Gg CO_2 eq. Areas subject to AR and D were 29 165 ha and 20 805 ha, respectively by the end of 2012. Annual rates of afforestation and deforestation have declined continuously from 0.7 kha to 0.3 kha per year for AR and from 2.3 kha to 1.0 kha per year for D during the period 2008–2012.

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	2012	Total
A. Article 3.3 activities	**692.12**	**625.29**	**424.92**	**346.80**	**306.59**	**2 395.72**
A.1. Afforestation and Reforestation	-60.49	-81.29	-102.87	-119.69	-130.51	-494.85
A.1.1. Units of land not harvested since the beginning of the commitment period	-60.50	-81.31	-102.89	-119.71	-130.51	
A.1.1. Biomass burning	0.015	0.016	0.018	0.020	0.004	
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA	NA	
A.2. Deforestation	752.61	706.58	527.79	466.49	437.10	2 890.57
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.

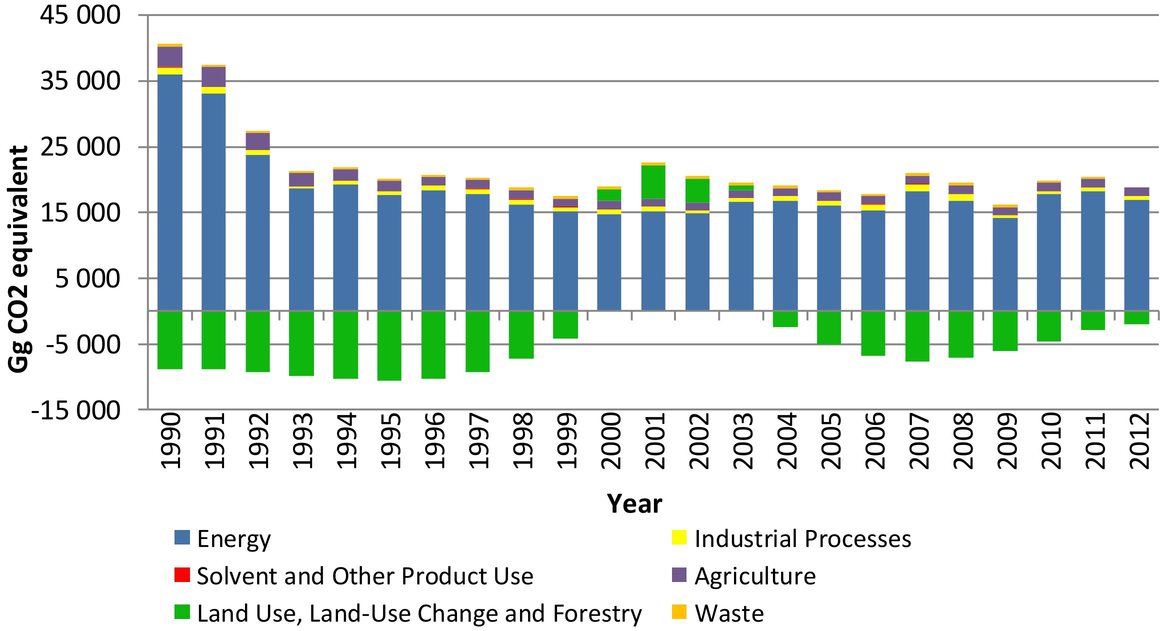


Figure ES.2. Greenhouse-gas emissions trends, by source groups, in CO_2 equivalents

The energy sector is the most significant source of greenhouse gas emissions in Estonia with 87.94% share of the total emissions in 2012. Since the base year, emissions have decreased by 53.15%. 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 2012 the agriculture sector contributed 6.91% of the total emissions. Since the base year emissions have decreased by 58.26%, mostly due to the decreasing livestock population and quantities of synthetic fertilizers and manure applied to agricultural fields.

In 2012 industrial processes greenhouse gas emissions contributed 3.45% of the total greenhouse gas emissions in Estonia. Emissions have decreased by 36.79% between 1990 and 2012. 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 a planned economy to a market economy after 1991 when Estonia became independent.

The waste sector contributed 1.60% of the total greenhouse gas emissions in 2012. The total emissions in CO_2 equivalents from the waste sector decreased by 10.63% compared to the base year, although the emissions from solid waste landfilled increased by 33.7% and emissions from waste composting processes increased from 1.20 Gg in 1990 to 26.2 Gg in 2012.

In 2012, the LULUCF sector acted as a CO_2 sink, totalling 1 951.18 Gg CO_2 equivalent. Since 1990, net removals have decreased by 77.88%. 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 306.59 Gg CO_2 eq. in 2012. Afforestation/reforestation amounted a net uptake of -130.51 Gg CO_2 eq. and deforestation a net emission of 437.10 Gg CO_2 eq. Areas of AR and D were 29 165 ha and 20 805 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

Air temperature has increased at a more rapid rate in Estonia in the second half of the 20th century than the global average. Climate warming was especially intense from 1966–2010. January characterises the highest increase in temperature. The annual average temperature has increased by 1.8 degrees. Statistically significant warming is also characteristic of April, July and August.

The monthly mean maximum and minimum temperatures have increased in parallel with average warming. It is interesting to note that the increase in the maximum temperature is higher from April to October (except June) while the same applies to the minimum temperature from December to February. The daily temperature range therefore indicates an increasing trend in the warm half-year, especially in April and May, while a decreasing trend can be noted in winter.

Precipitation constitutes the climate indicator with the biggest variability in time and space. Large fluctuations of precipitation can be observed between single days, weeks, months, seasons and even years. The difference in precipitation between locations situated close to one another may be significant, especially in summer. As the measuring methodology of precipitation has changed over time, it is quite difficult to ascertain trends in precipitation. However, the opinion that the amount of precipitation in winter will increase in Northern Europe as the climate becomes warmer is generally recognised.

In the period 1966–2010, it is apparent that the increase in annual precipitation is statistically significant in some Estonian meteorological stations and insignificant in others. A positive trend has above all been noted in January and June, and to a lesser extent in February, March and August. However, a decreasing trend in precipitation has been observed in April, May and September. In summary, it may be stated that precipitation has somewhat increased in winter and summer and decreased in spring and autumn.

It is understandable that changes in snow cover are closely related to changes in air temperature and precipitation. As the air temperature increases, the number of days with snow cover should decrease and the snow cover itself should become more erratic. However, an increase in winter precipitation may result in thicker snow cover.

The duration of snow cover has generally decreased in Estonia in the last few decades, but due to its high variability this trend is not statistically significant. While a number of mild winters with little snow were recorded in the late 1980s and early 1990s, such winters have become scarcer in the last few years and snowy winters have become more frequent.

It is extremely difficult to adequately assess long-term changes in wind speed as it largely depends on the obstacles to wind situated close to the measuring site. However, research has been conducted into changes in wind directions in the period from 1966–2008. This indicates that the proportion of westerly and south-westerly winds has significantly increased in winter while the proportion of south-easterly and easterly winds has decreased.

Extreme climate phenomena occur in Estonia from time to time. In summer, hot weather and unstable air stratification along with thunderstorms result in whirlwinds (tornadoes/ waterspouts) of destructive force. In winter, the most hazardous climate phenomena have been powerful snowstorms accompanying cyclones, resulting in the obstruction and even closure of road traffic.

Even though climate change is not likely to be as extreme in Estonia as in many other countries in the EU (notably in southern Europe) and around the world, and although some effects can be considered positive, we expect a continued rise in temperatures and a resulting decrease in ice and snow cover; more frequent heat waves and droughts in summer; more health problems and forest fires caused by longer heat waves; more storms and power failures; more floods; changes in vegetation, species and habitats; invasions of alien species (incl. new plant pests and infectious agents); and other adverse effects (Estonia's Sixth National Communication, 2013).

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 2008–2013 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 2014 inventory is produced in collaboration between the MoE, Estonian Environment Agency (EtEA)[1] 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 2012. 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 3.7.3). The methodology used in

[1] The Estonian Environment Agency was formed in 2013 as a result of the merger of the Estonian Meteorological and Hydrological Institute and the Estonian Environment Information Centre and is the legal successor to both.

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 2012. Chapters 3–8 give information of GHG emission trends from the base year 1990 to year 2012 for the following sectors: energy, industrial processes, solvent and other product use, agriculture, land use, land-use change and forestry, and 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 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.

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.

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 and EtEA.

The MoE is responsible for:

- coordinating the inventory preparation process as a whole;
- 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;
- entering into formal agreements with inventory compilers (EERC);
- coordinating cooperation between the inventory compilers and UNFCCC Secretariat;
- informing the inventory compilers of 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 of new or revised guidelines; and
- coordinating the UNFCCC inventory reviews and communication with the expert review team, including responses to the review findings.

The EERC, as the inventory coordinator, is responsible for:

- compiling the National Inventory Report according to the parts submitted by the inventory compilers;
- coordinating the implementation of the QA/QC plan;
- coordinating the inventory process; and
- the overall archiving system.

The EERC is responsible for preparing the estimates for the energy, industrial processes, solvents and other product use, agriculture and waste sectors. The Forest Monitoring Department of the Estonian Environment Agency is responsible for LULUCF and KP LULUCF estimates. All experts collect activity data, estimate emissions and/or removals, implement QC procedures, fill in sectoral data to the CRF Reporter and prepare the sectoral parts of the NIR. Experts are also responsible for archiving activity data, estimates and all other relevant information according to the archiving system.

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 Statutes of the Ministry of the Environment (RT I 2009, 63, 412), the MoE 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 Statutes 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.

The Estonian Environment Agency (EtEA) is a state authority administered by MoE, which was formed as a result of the merger of the Estonian Meteorological and Hydrological Institute (EMHI) and the Estonian Environment Information Centre (EEIC) in 2013. In accordance with §9 section 12 of the Statute of the EtEA, the tasks of the Forest Monitoring Department are to plan, organize and perform forest monitoring and applied research, statistical forest inventory, land-use and land use change and carbon cycle monitoring, and to control, process and analyse monitoring data, comply national and international reporting obligations.

The Estonian Environmental Research Centre (EERC) is a joint stock company, all of the shares in which are held by 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.

A three-year contract agreement (for the 2011, 2012 and 2013 submissions) was entered into with the EERC for inventory compilation in the industrial processes, solvent and other product use and waste sectors. A one-year contract agreement (for the 2013 submission) was entered into with the EERC for inventory preparation in the energy and agriculture sectors and for inventory coordination.

A new contract agreement with the EERC for inventory compilation in the energy, industrial processes, solvent and other product use, agriculture and waste sectors and for inventory coordination was entered into in 2013 for three years (for the 2014, 2015 and 2016 submissions). The MoE plans to use the three-year contract approach in the coming years to ensure the continuity of inventory preparation.

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

All three institutions are in close contact with one another. Several cooperation meetings are held annually to discuss and agree on methodological issues, problems that have arisen and improvements that need to be implemented. As Estonia is a small country and only two institutions are preparing the inventory estimates there is close contact between inventory experts (EERC and EtEA) 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.

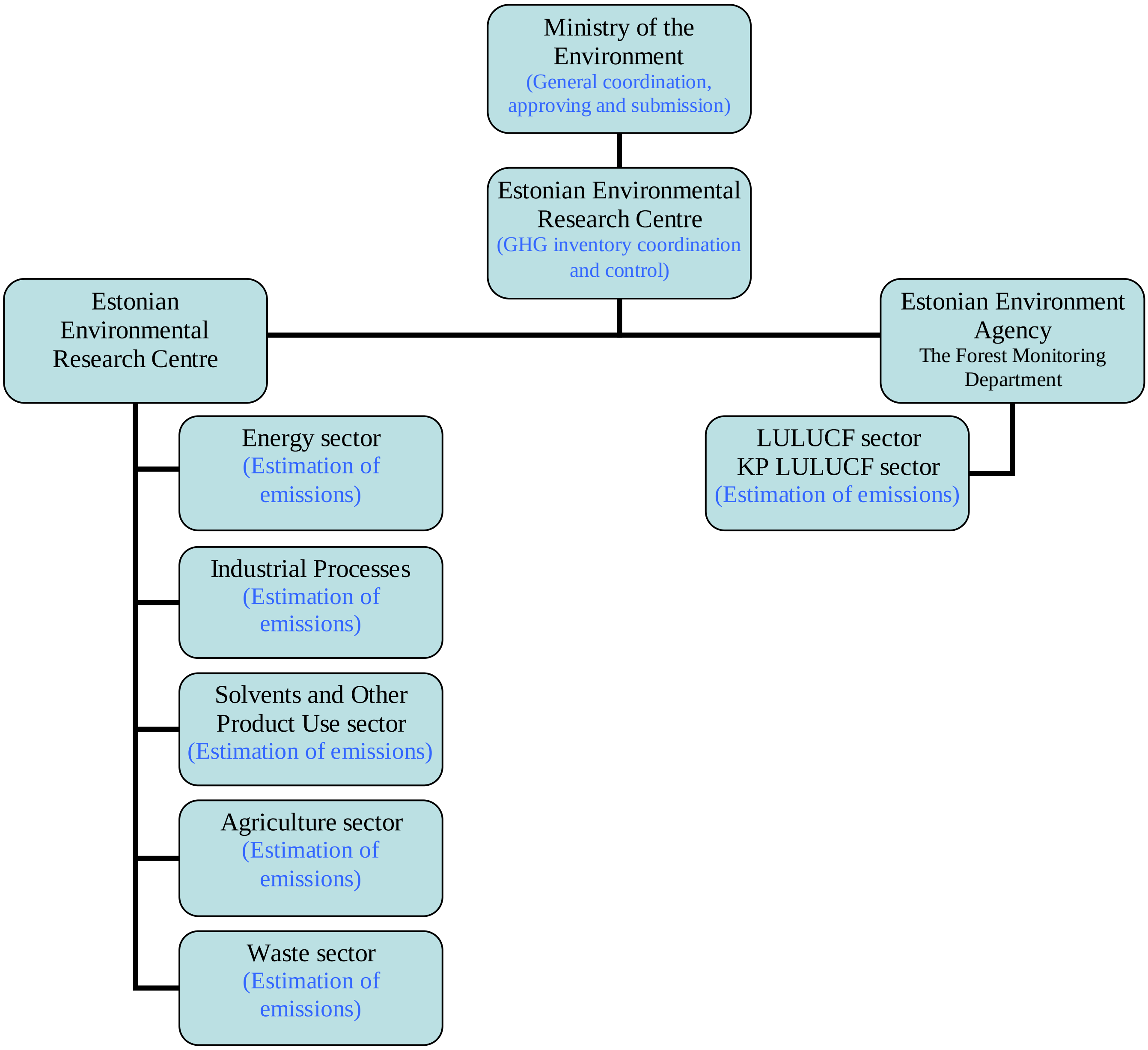


Figure 1.1. National System for GHG inventory in Estonia
Source: National Greenhouse Gas Inventory System in Estonia

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.

The EERC and the MoE have developed an inventory production plan that sets out the schedule for inventory preparation. The schedule, which is annually reviewed, forms part of Estonia's QA/QC plan and must be followed by all core institutions (MoE, EERC and EtEA). 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, EtEA	Dec. 1
Sectoral experts send the necessary data for uncertainty analysis to EERC and MoE	EERC, EtEA	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, EtEA	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, EtEA	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, EtEA	Febr. 22
Annual meeting: The independent experts will meet with the sectoral experts in order to discuss the results of the QA checks	*EERC, EtEA*	*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 European Union (EU) greenhouse gas monitoring mechanism require Estonia to submit annually a NIR and CRF tables. The annual submission contains emission estimates for the years between 1990 and the year before last year. So the 2014 submission contains estimates for the years 1990–2012.

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 and EtEA.

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 inventory cycle starts with an examination of previous years and an analysis of the available datasets in order to improve the inventory through new knowledge and the activity data developed.

The sectoral experts from EERC and EtEA are collecting data and preparing 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. Aditionally, 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.

EtEA – GHG emission estimations from civil aviation and road transport sector. EtEA 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.

EtEA – activity data on combustible waste amounts.

EtEA – 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.

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 EtEA. 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 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, including afforestation/reforestation and deforestation

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

Activity data of wildfires is obtained from Estonian Rescue Service. In 2013, the Estonian Environment Agency (the former Estonian Environment Information Centre) performed fieldwork on recorded wildfire locations in 2012, determining the precise area and biomass burned.

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

Storm damaged forest area is obtained from Statistics Estonia and Estonian Environment Agency (NFI).

Waste

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

The data on methane recovery is obtained from EtEA 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 EtEA 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 EtEA.

Activity data on biogas burnt in a flare is derived from EtEA 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 and EtEA) 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 and EtEA. EERC as the quality coordinator has an overall responsibility for coordinating and implementing the QA/QC plan. EERC checks the QC reports of EERC and EtEA 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), Estonian Environment Agency (EtEA)
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 EtEA
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	D, CS, PS	National Energy Balances and Annual Yearbooks and the statistical data base of Statistics Estonia; data on waste fuels from EtEA
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

IPCC category	Methodology	Emission factor	Activity data
			transport fuels and corresponding GHG emission estimations from EtEA
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 Agency; national companies
A. Paint Application	T_1	D	Estonian Environment Agency
B. Degreasing and Dry Cleaning	T_1	D	Estonian Environment Agency
C. Chemical Products, Manufacture and Processing	T_1	D	Estonian Environment Agency
D. Other	T_1, T_2	D, CS	Estonian Environment Agency; national companies
4. Agriculture	Revised 1996 IPCC, IPCC 2000	Revised 1996 IPCC, IPCC 2000	Statistics Estonia; IPCC default parameters

IPCC category	Methodology	Emission factor	Activity data
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 (Estonian Environment Agency); Statistics Estonia; Estonian Rescue Service; Ministry of Agriculture
A. Forest land	T_1, T_2	D, OTH	National Forest Inventory; Estonian Rescue Service
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
D. Wetlands Peatland	T_2	CS	National Forest Inventory; Estonian Rescue Service
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 Agency; Statistics Estonia
A. Solid Waste Disposal on Land	T_2 (the FOD method)	D	Estonian Environment Agency; Statistics Estonia
B. Wastewater Handling	T_1	D	Estonian Environment Agency; Statistics Estonia
C. Waste Incineration	T_1	D	Estonian Environment Agency
D. Other	T_1	D	Estonian Environment Agency

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 the 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 1990–2012. Land-use matrix was developed by adding and subtracting the transition areas to and from land-use category areas.

Area and the volume of growing stock and dead wood of ARD activities is obtained from the NFI. 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 are estimated assuming that the volume of growing stock on deforested area is the same as under the 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 2012), the trend of emissions (change between 1990 and 2012) 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, 2012), Trend	Level (1990, 2012), Trend
1.A.1.a	Energy Industries/ Electricity and Heat Production - Liquid Fuels	CO_2	yes	Level (1990), Trend	Level (1990), Trend
1.A.1.a	Energy Industries/ Electricity and Heat Production - Gaseous Fuels	CO_2	yes	Level (2012)	Level (2012)
1.A.1.a	Energy Industries/ Electricity and Heat Production - Biomass	N_2O	yes	Trend	
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CO_2	yes	Level (2012), Trend	Level (2012), Trend
1.A.2	Manufacturing Industries and Constructions - Other Fuels	CO_2	yes	Level (2012), Trend	Level (2012), 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, 2012)	Level (1990, 2012), Trend
1.A.3.b	Road Transport - Liquid Fuels	CO_2	yes	Level (2012), Trend	Level (2012), 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 (2012), Trend	Level (2012), Trend
1.A.4.b	Other Sectors/Residential - Biomass	N_2O	yes	Trend	Trend
2.A.1	Cement Production	CO_2	yes	Trend	
2.B.1	Ammonia Production	CO_2	yes	Trend	Trend
2.F.1.2	Commercial Refrigeration	HFCs	yes	Trend	
4.A	Enteric Fermentation - Dairy Cattle	CH_4	yes	Level (1990, 2012)	Level (1990, 2012), Trend
4.A	Enteric Fermentation - Non-Dairy Cattle	CH_4	yes	Level (1990, 2012), Trend	Level (1990, 2012), Trend
4.B	Manure Management - Solid Storage and Dry Lot	N_2O	yes	Level (1990, 2012), Trend	Level (1990, 2012), Trend
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N_2O	yes	Level (1990, 2012)	Level (1990, 2012), Trend
4.D.1.2	Direct Soil Emissions - Animal Manure Applied to Soils	N_2O	yes	Level (1990, 2012)	Level (1990, 2012), Trend
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N_2O	yes	Level (1990, 2012), Trend	Level (1990), Trend
4.D.1.5	Direct Soil Emissions - Cultivation of Histosols	N_2O	yes	Level (1990, 2012), Trend	Level (2012), Trend
4.D.2	Pasture, Range and Paddock Manure	N_2O	yes	Level (1990, 2012), Trend	Level (1990, 2012), Trend
4.D.3.1	Indirect Emissions - Atmospheric Deposition	N_2O	yes	Level (1990, 2012)	Level (2012)
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	yes	Level (1990, 2012), Trend	Level (1990, 2012), Trend

	IPCC Source Category	Gas	Key category	Criteria for identification (without LULUCF)	Criteria for identification (with LULUCF)
5.A.1	Forest Land remaining Forest Land - living biomass	CO_2	yes		Level (1990, 2012), Trend
5.A.1	Forest Land remaining Forest Land - mineral soils	CO_2	yes		Level (1990, 2012), Trend
5.A.1	Forest Land remaining Forest Land - organic soils	CO_2	yes		Level (1990, 2012), Trend
5.A.1	Forest Land remaining Forest Land - dead wood	CO_2	yes		Level (2012), Trend
5.A.2.1	Cropland converted to Forest Land - mineral soil	CO_2	yes		Trend
5.A.2.2	Grassland converted to Forest Land - living biomass	CO_2	yes		Level (2012), Trend
5.B.1	Cropland remaining Cropland - organic soils	CO_2	yes		Level (1990, 2012), Trend
5.B.1	Cropland remaining Cropland - mineral soils	CO_2	yes		Level (1990, 2012), Trend
5.B.2.2	Grassland converted to Cropland - mineral soils	CO_2	yes		Trend
5.B.2.2	Grassland converted to Cropland - organic soils	CO_2	yes		Trend
5.C.1	Grassland remaining Grassland - living biomass	CO_2	yes		Level (2012), Trend
5.C.1	Grassland remaining Grassland - organic soils	CO_2	yes		Level (2012), Trend
5.C.2	Land converted to Grassland - mineral soils	CO_2	yes		Level (2012), Trend
5.D.1	Wetlands remaining Wetlands\Peatland - organic soils managed for peat extraction	CO_2	yes		Level (2012), Trend
5.D.2.1	Forest Land converted to Wetlands - living biomass	CO_2	yes		Level (2012), Trend
5.E.2	Land converted to Settlements - living biomass	CO_2	yes		Level (2012), Trend
5.E.2	Land converted to Settlements - soils	CO_2	yes		Level (2012), Trend
6.A	Solid Waste Disposal on Land	CH_4	yes	Level (1990, 2012), Trend	Level (1990, 2012), Trend
6.B.1	Industrial Wastewater	CH_4	yes	Level (1990), Trend	Level (1990), Trend
6.B.2.2	Domestic and Commercial Wastewater - human sewage	N_2O	yes	Level (2012), Trend	Level (2012)
6.D	Biological Treatment	CH_4	yes	Trend	
6.D	Biological Treatment	N_2O	yes	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 the 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 and EtEA) 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 and EtEA. 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 and EtEA. 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 and EtEA.

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 in accomplishing a high-quality GHG inventory is consideration of expectations and inventory requirements. The quality requirements set for annual inventories are continuous improvement, transparency, consistency, comparability, completeness, accuracy and timeliness. The setting of concrete annual quality objectives is based on these requirements. The next step is development 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, 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 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 data, identification of errors and deficiencies, documentation and archiving of inventory data and quality control actions. Once the experts have implemented the QC procedures, they complete the QA/QC checklist for each source/sink category, which provides a record of the procedures performed. The QA/QC checklists are part of Estonia's QA/QC plan. Also assessment of completeness is evaluated.

In addition, the QA/QC of Member States' submissions conducted under the European Union GHG monitoring mechanism (e.g. completeness checks, consistency checks and comparison across Member States) 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 the European Union GHG monitoring mechanism, that are, 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 who have not been involved in preparing the inventory. These reviewers should preferably be independent experts from other agencies or national experts or groups not closely connected to national inventory compilation.

Estonia's GHG inventory is checked annually by one or more independent experts. 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 the 2013 submission and the 2014 submission the inventory was reviewed in parts by the EERC, TUT and other national experts.

A public review is also carried out. The draft NIR is uploaded to the MoE website www.envir.ee where all interested parties have the 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 EtEA. 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 annually sent to Statistics Estonia for quality checking.

UNFCCC reviews are part of QA. The reviews are performed by a team of experts (sectoral experts and generalist) from other countries. They examine the data and methods that Estonia is using and check 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 in which 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 were and the materials used in the 2014 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 2012[2]. The results indicated that share of verified ETS emissions in stationary combustion (includes emissions of

[2] EU ETS data has been used for verification purposes of the 2014 inventory as a recommendation of the UNFCCC review team (ARR 2012, para 31).

1.A.1, 1.A.2 and 1.A.4) was about 79.8% in 2012. Share of verified ETS emissions in CRF category 2.A mineral products was about 100.0% in 2012.

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 2014 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 sectors: energy, industrial processes, solvent and other product use, agriculture, LULUCF and waste sector.

Estonia revised the EF uncertainty of public electricity and heat production – solid fuels for the 2014 submission as a recommendation of the UNFCCC review team (ARR 2012, para 21 and 23). Previous uncertainty estimate was overestimated and based on an outdated study. Revision of this uncertainty had significant impact on Estonia's total inventory uncertainty (combined uncertainty of total national emissions in year t without LULUCF – 24.93% in the 2013 submission and 5.65% in the 2014 submission).

Table 1.4 shows the estimated uncertainties for total greenhouse gas emissions in 2012 and the trend.

Table 1.4. Inventory uncertainties in 2012

	Combined as % of total national emissions in 2012	Introduced into the trend in total national emissions
	Uncertainty [%]	
Without LULUCF	5.65	1.98
With LULUCF	9.45	4.57

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 all required carbon pools: above- and below-ground biomass, litter, dead wood, mineral and organic soils and biomass burning (CH_4, N_2O) for ARD activites. Dead wood estimates were provided for the first time under AR in current submission.

Estonia does not separate gains and losses (a net change is reported) for living biomass estimates, since it is not feasible due to the stock-change method used.

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 1990–2012.

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[3].

Total emissions of the six greenhouse gases in Estonia (excl. net emissions from the LULUCF) decreased steadily from 40 614.54 Gg CO_2 equivalent in 1990 to 19 188.43 Gg CO_2 equivalent in 2012 (Figure 2.1). From 1990 to 2012 the GHG emissions decreased by 52.75%. This decrease was mainly caused by the transition from a planned economy to a market economy and the successful implementation of the necessary reforms.

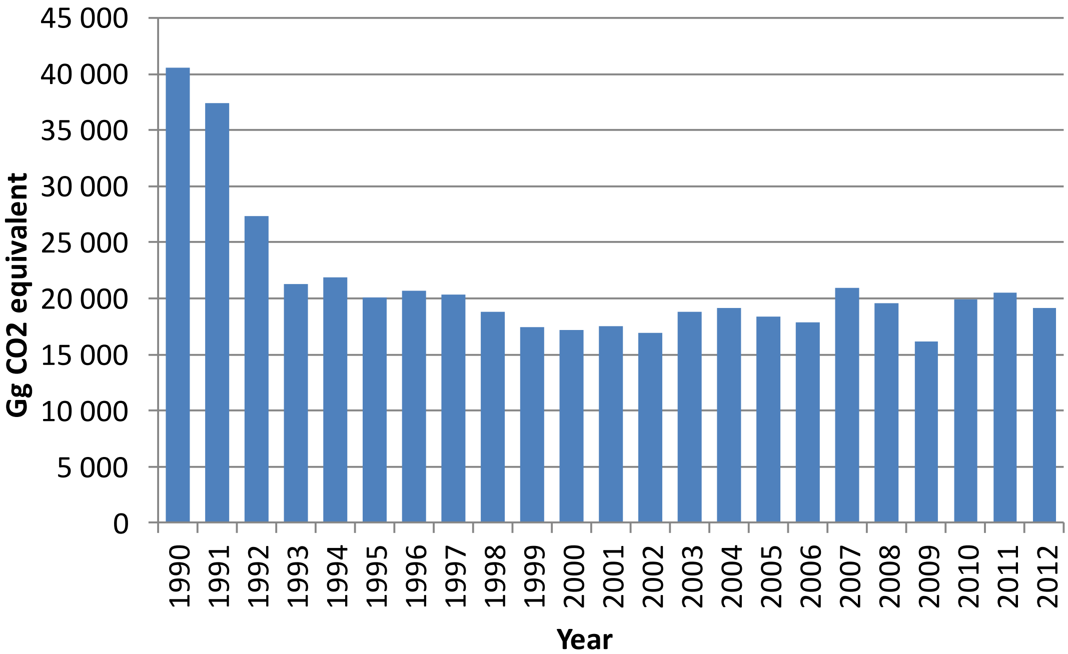


Figure 2.1. Overall development of greenhouse gases in Estonia, in CO_2 equivalents (without CO_2 from LULUCF)

[3] Estonia's base year for F-gases under the Kyoto Protocol is 1995.

2.2. Description and interpretation of emission trends by gas

In 2012, the main GHG in Estonia was carbon dioxide (CO_2), accounting for 89.01% of the total GHG emissions (excl. LULUCF) expressed in CO_2 equivalent, followed by nitrous oxide (N_2O) on 5.26% and methane (CH_4) on 4.85%. Fluorinated gases (the so-called 'F-gases') collectively accounted for 0.88% of overall GHG emissions (Figure 2.2).

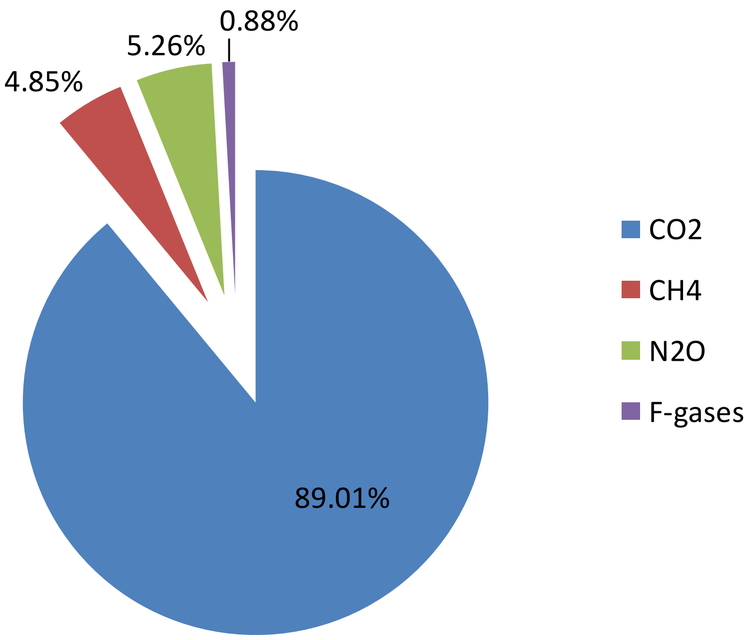


Figure 2.2. GHG emissions by gas in 2012, %

Figure 2.3 shows GHG emission trends in 1990 to 2012. Emissions of CO_2 decreased by 53.46% from 36 700.83 Gg in 1990 to 17 079.28 Gg in 2012, 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 55.03% from 2 244.10 Gg CO_2 equivalent in 1990 to 1 009.21 Gg CO_2 equivalent in 2012, 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 44.26% from 1 669.60 Gg CO_2 equivalent in 1990 to 930.62 Gg CO_2 equivalent in 2012, 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 169.32 Gg CO_2 equivalent in 2012, 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).

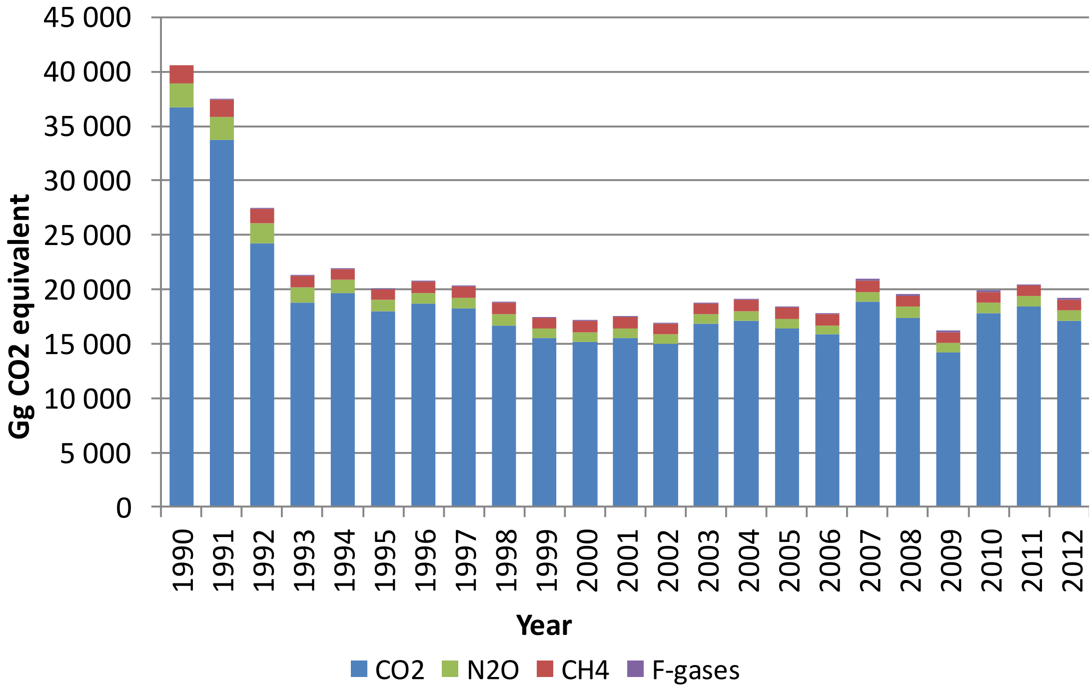


Figure 2.3. Greenhouse gas emission trends (CO_2 equivalent) in 1990 to 2012

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 energy sector, which in 2012 contributes 87.94% of total greenhouse gas emissions (excl. LULUCF). The second largest sector is agriculture, which accounted for 6.91% of the total emissions in 2012. Emissions from industrial processes, waste and solvent and other product use sectors accounted 3.45%, 1.60% and 0.10%, respectively of total emissions in 2012. Emissions of indirect gases are discussed in section 2.4.

Over the period 1990–2012, emissions from energy sector decreased by 53.15%, emissions from the industrial processes, agriculture and solvent and other product use sectors decreased by 36.79%, 58.26% and 29.31%, respectively. Emissions from waste sector decreased by 10.63%. Reported net CO_2 removals on land use, land use change and forestry sector decreased by 77.88% between 1990 and 2012. See Figure 2.4. Greenhouse gas emission trends, by source groups, in CO_2 equivalents.

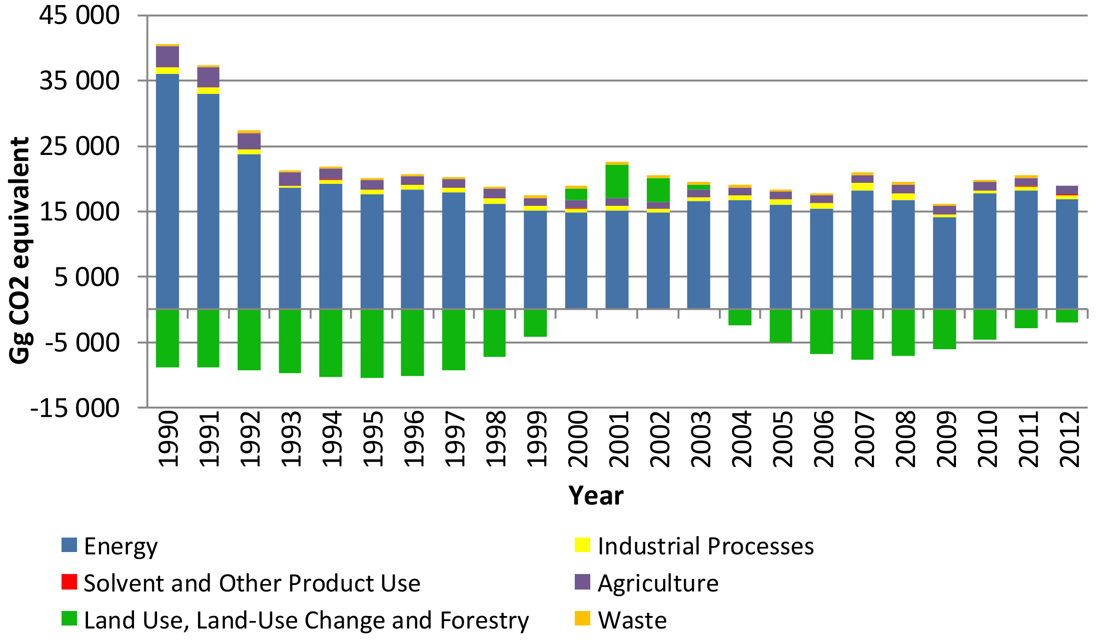


Figure 2.4. Greenhouse gas emission trends, by source groups, in CO_2 equivalents

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 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.

The energy sector is the main source of GHG emissions in Estonia. In 2012 the sector contributed 87.94% of all emissions, totalling 16 873.83 Gg CO_2 eq. 99.5% of emissions in the sector originated from fuel combustion – just 0.5% were from fugitive emissions.

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

Emissions from the energy sector decreased by 53.15% compared to 1990 (incl. energy industries – 54.64%; manufacturing industries and construction – 69.13%; transport – 7.36%; other sector – 67.95%; other – 47.96% and fugitive emissions from fuels – 56.87%). This major decrease was caused by 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 factories), agriculture (reorganisation and dissolution of collective farms), transport (the proportion of new and environmentally friendly cars has increased and the number of agricultural machines has decreased), households (energy saving) etc. The overall progression of GHG emissions in the energy sector in CO_2 equivalent is presented in Figure 2.5.

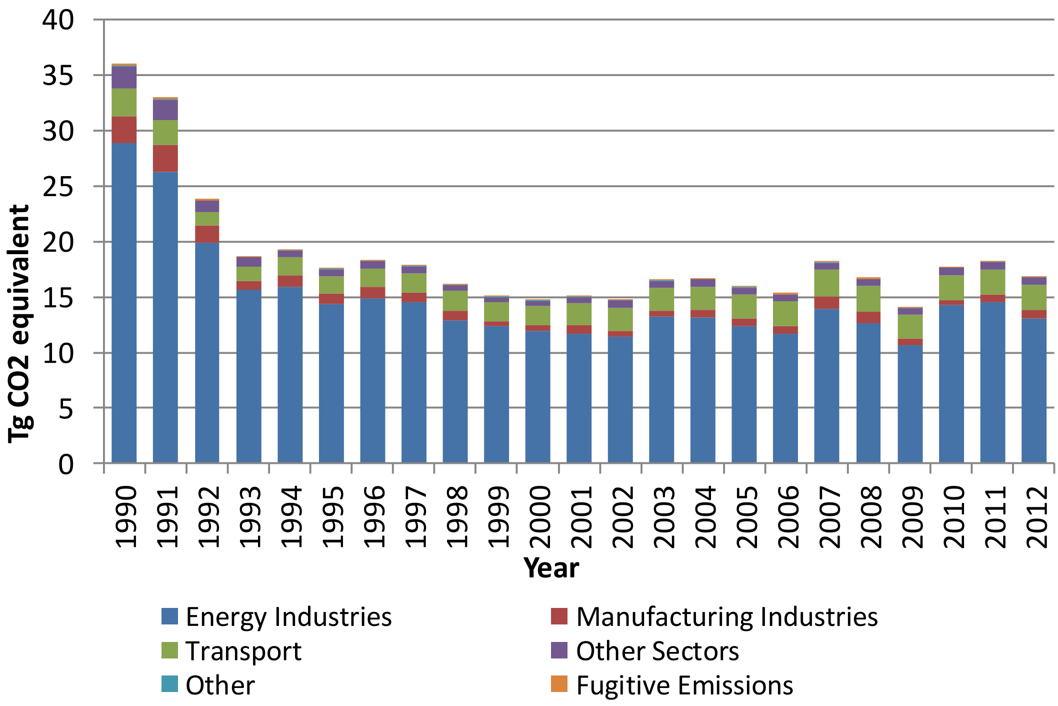


Figure 2.5. Trend in emissions from energy sector, 1990–2012

2.3.2. Trends in Industrial Processes (CRF 2)

Estonia's emissions from the industrial processes sector are divided into the following categories: mineral products; chemical industry; consumption of halocarbons and SF_6; and other production. Under mineral products, emissions from cement, lime, glass, bricks and tiles production as well as those from lightweight gravel production and soda ash use are reported. Also NMVOC emissions from road paving with asphalt are reported in this category. Emissions from ammonia production are reported under chemical industry. Consumption of halocarbons and SF_6 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 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 2012 the industrial processes sector contributed 3.45% of all GHG emissions in Estonia, totalling 662.58 Gg CO_2 equivalent. The most significant emission sources were CO_2 emissions from cement and lime production at 2.12% and 0.25% respectively, and HFC emissions from refrigeration and air-conditioning equipment at 0.82% of total GHG emissions. F-gas emissions as a whole comprised 0.88% of total GHG emissions.

Industrial CO_2 emissions have fluctuated strongly since 1990, reaching their lowest level in 1993. The decrease in emissions during the early 1990s was caused by the transition from a planned economy to a market economy after 1991 when Estonia regained its independence. This led to lower 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 increased. The decrease in emissions in

2002 and 2003 was caused by the reduction in ammonia production, as the only ammonia factory in the country was being reconstructed. The sudden increase in emissions in 2007 was mainly caused by an increase in cement production, as the only cement factory renovated its third kiln. In 2009 the industrial processes sector was affected by the recession. Decline in production was mainly due to insufficient demand on both the domestic and external markets. Increase in 2011 emissions was caused by increase of cement production. The overall progression of GHG emissions in the industrial processes sector in CO_2 equivalent is presented in Figure 2.6.

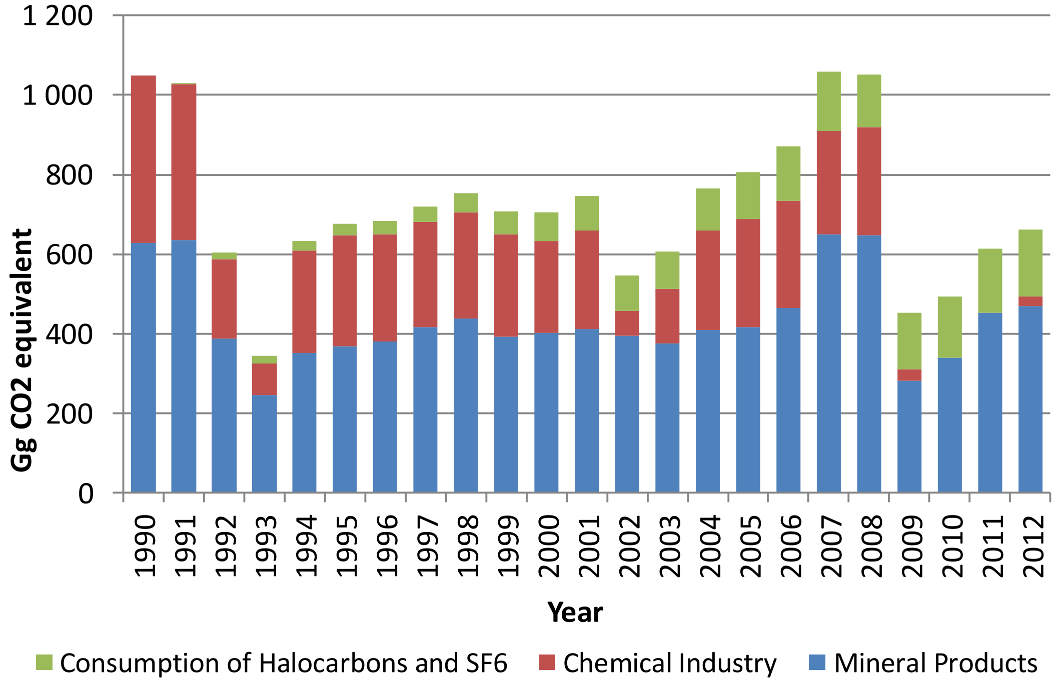


Figure 2.6. Trend in emissions from industrial processes sector, 1990–2012

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

Estonia's emissions from the solvent and other product use sector are divided into the following categories: paint application; degreasing and dry cleaning; chemical products, manufacture and processing; and other (CRF 3.D). 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 2012, the solvent and other product use sector contributed 0.10% of all GHG emissions in Estonia, totalling 18.72 Gg CO_2 equivalent. Indirect CO_2 emissions from paint application and other (CRF 3.D.5) contributed the main share of total emissions from the sector – 28.64% and 31.93% respectively.

Emissions from the solvent and other product use sector have decreased by 29.31% compared to 1990. Two major categories where a decrease in NMVOC emissions and, consequently, a decrease in indirect CO_2 emissions have occurred in more recent years are paint application and other product use. The fluctuation of NMVOC emissions in the period 1990–2012 has mostly occurred due to the welfare of the economic state of the country. The overall progression of GHG emissions in the solvent and other product use sector is presented in Figure 2.7.

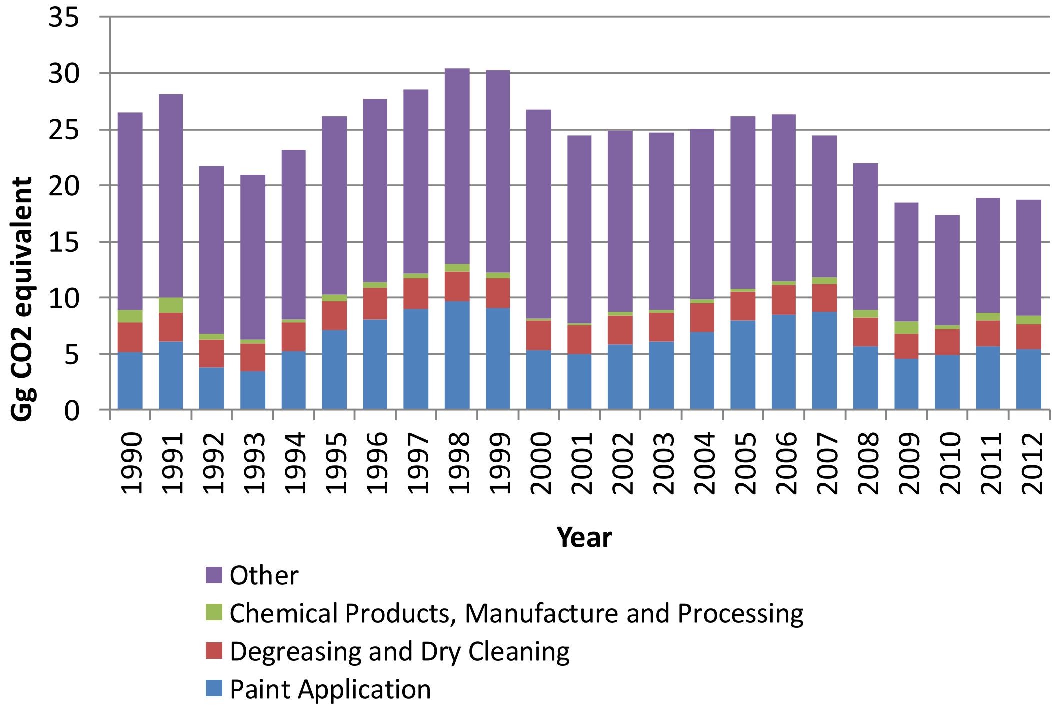


Figure 2.7. Trend in emissions from solvent and other product use sector, 1990–2012

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 and direct and indirect N_2O emissions from agricultural soils. Direct N_2O emissions include emissions from synthetic fertilizers, animal manure and sewage sludge applied to agricultural soils, emission occurring from crops-growing (i.e., N-fixing crops and crop residues) and due to the cultivation of histosols. Indirect N_2O emissions include emissions due to atmospheric deposition and nitrogen leaching and run-off. The trend in emissions in CO_2 eq. by category is presented in Figure 2.8.

In 2012 the agriculture sector contributed 6.91% of total GHG emissions in Estonia, totalling 1 326.17 Gg CO_2 eq. Emissions from enteric fermentation of livestock and direct emissions from agricultural soils were the major contributors to the total emissions recorded in the sector – 31.94% and 31.88% respectively.

Emissions from the agricultural sector declined by 58.26% by 2012 compared with the base year (1990), mostly due to the decrease in the livestock population and quantities of synthetic fertilizers and manure applied to agricultural fields. The overall progression of GHG emissions in the agriculture sector is presented in Figure 2.8.

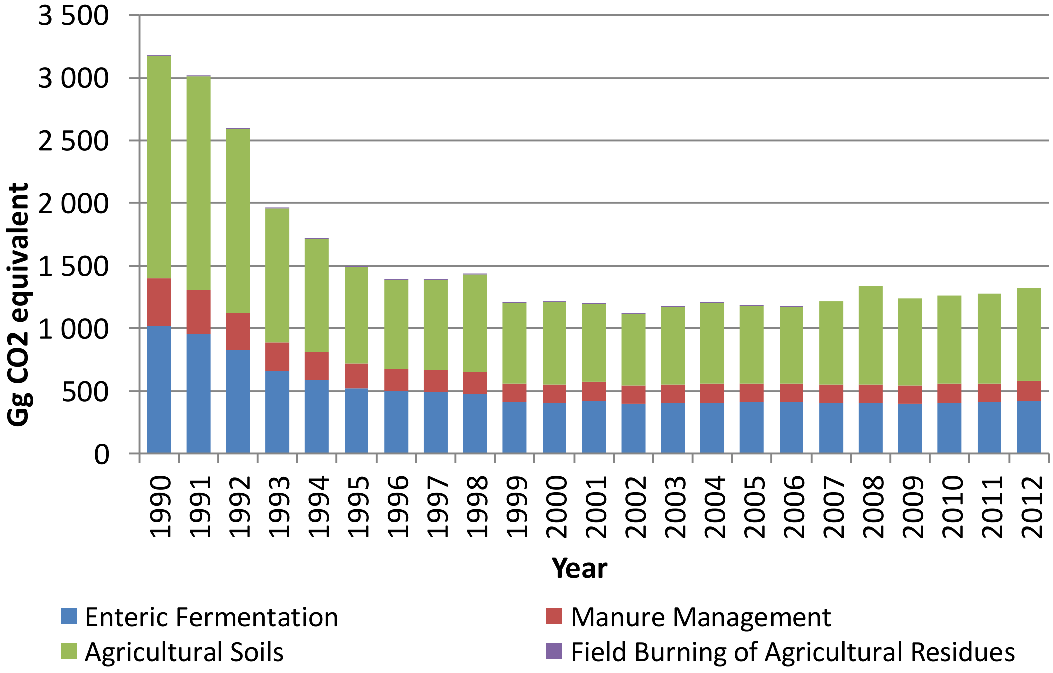


Figure 2.8. Trend in emissions from agriculture sector, 1990–2012

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

The 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 1990–2012 is presented in Figure 2.9. In 2012 the LULUCF sector acted as a CO_2 sink, totalling uptake of 1 951.18 Gg CO_2 equivalent. Compared to the base year (1990), uptake of CO_2 has decreased by 77.9% and compared to the previous year (2011), 32.3%. The main driver behind the decreasing sink is increasing harvest rates and expanding settlements area and emissions from organic soils. 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, the 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.

The majority CO_2 removals in the LULUCF sector come from the biomass increment in forest land remaining forest land and land converted to forest land subcategories. In 2012, forest land was the only net sink category.

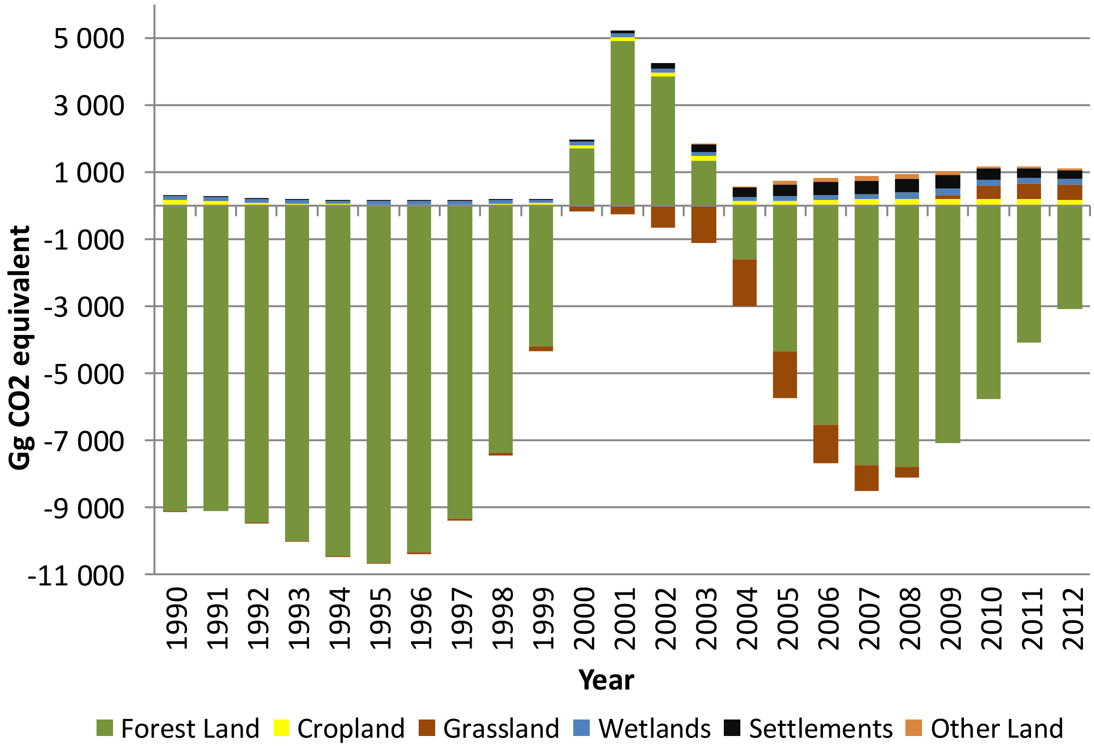


Figure 2.9. Trend in emissions from land use, land-use change and forestry sector, 1990–2012

2.3.6. Trends in Waste (CRF 6)

In the waste sector, Estonia's GHG inventory covers CH_4 emissions from solid waste disposal sites including solid municipal and industrial waste and domestic and industrial sludge. The waste sector also covers GHG emissions from waste incineration (incl. biogas burned 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 2012, the waste sector contributed 1.60% of all GHG emissions, totalling 307.13 Gg CO_2 equivalent. Solid waste disposal on land contributed the most to total emissions in the waste sector in Estonia.

The total CO_2 equivalent emission from the waste sector in 2012 decreased by 10.63% compared to the base year, although the emission from solid waste landfilled increased 33.7% and emission from waste composting processes increased from 1.20 Gg to 26.2 Gg in 2012. As seen from the Figure 2.10, the lowest value of GHG emissions from waste management occurred in 1995, mainly due to decreased CH_4 emissions from paper and sludge disposal on land. The highest CO_2 equivalent emission in 2001 is related to significant increase in emissions also from solid waste disposal. Emissions from waste incineration have been marginal during the whole period compared to other activities involved. The total CO_2 equivalent in 2012 decreased significantly compared to previous years, mainly because of the change in the national currency, which raised prices in the country and therefore reduced consumption habits and waste generation. The overall progression of GHGs in the waste sector in CO_2 equivalent is presented in Figure 2.10.

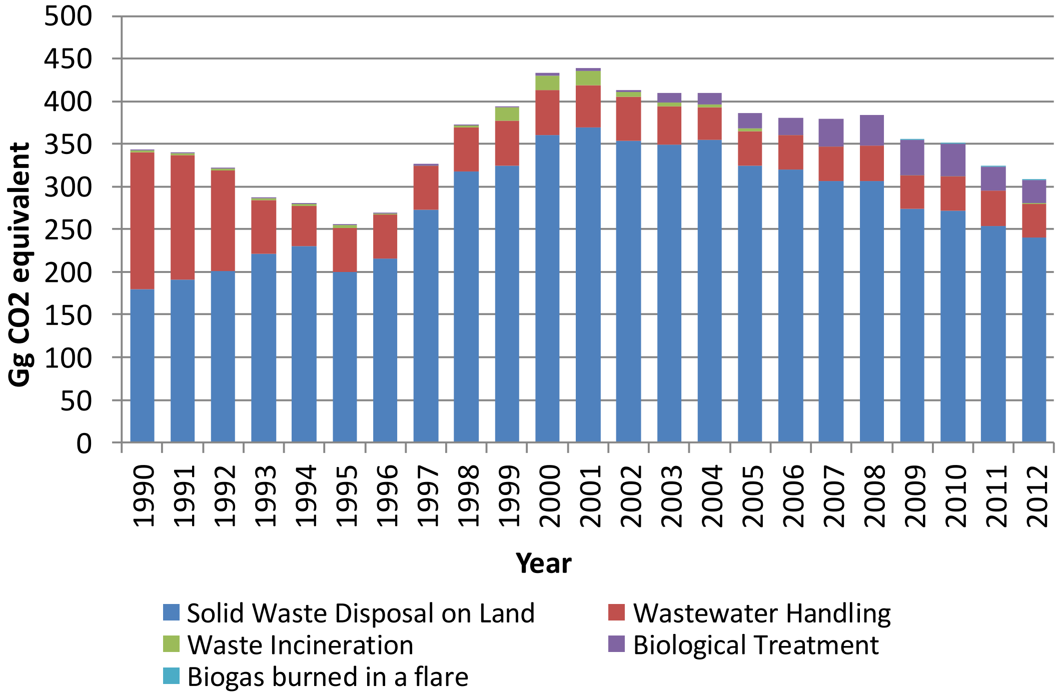


Figure 2.10. Trend in emissions from waste sector, 1990–2012

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 2012 are presented in Figure 2.11. Total NOx emissions decreased by 58.78% from 77.20 Gg in 1990 to 31.82 Gg in 2012. Total CO emissions decreased by 26.06% from 189.98 Gg in 1990 to 140.48 Gg in 2012. Total NMVOC emissions decreased by 42.18% from 53.80 Gg in 1990 to 31.11 Gg in 2012. Total SO_2 emissions decreased by 62.03% from 184.26 Gg in 1990 to 69.96 Gg in 2012.

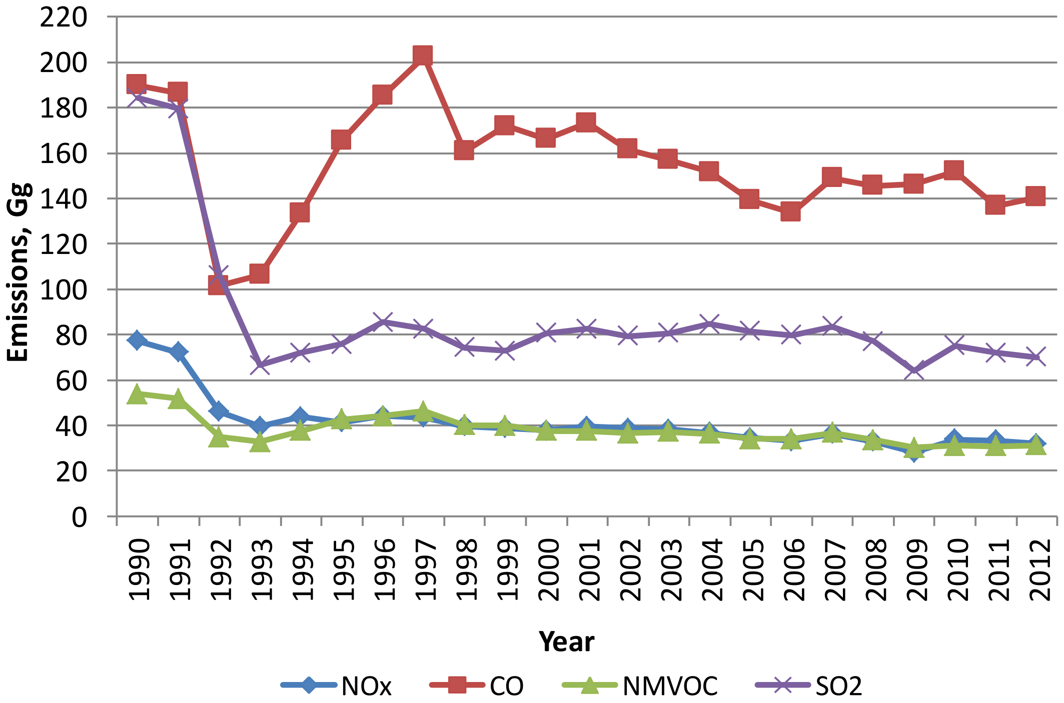


Figure 2.11. Emissions of NOx, CO, NMVOC and SO_2 1990–2012, Gg

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

In 2012, Article 3.3 activities were a net source in Estonia. The total net emissions were estimated at 306.59 Gg CO_2 eq. Afforestation and reforestation resulted in a net removal of -130.51 Gg CO_2 eq. and deforestation a net emission of 437.10 Gg CO_2 eq. (Table ES.3). Areas subject to AR and D were 29 165 and 20 805 ha, respectively by the end of 2012.

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 the 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. KP-LULUCF areas (ha) and emissions by gas (Gg)

Afforestation/reforestation					
	2008	**2009**	**2010**	**2011**	**2012**
Area, ha	27 595	28 120	28 512	28 843	29 165
CO_2, Gg	-60.50	-81.31	-102.89	-119.71	-130.51
AR Biomass burning					
Area, ha	4.73	4.82	4.88	4.94	5.00
CH_4,, Gg	5.9 E-04	6.5 E-04	7.3 E-04	8.1 E-04	1.6 E-04
N_2O, Gg	7.2 E-06	8.0 E-06	8.9 E-06	9.9 E-06	2.0 E-06

AR total CO_2 eq., Gg	-60.49	-81.29	-102.87	-119.69	-130.51
Deforestation					
Area, ha	15 218	17 297	18 686	19 816	20 805
D total CO_2 eq., Gg	752.61	706.58	527.79	466.49	437.10
ARD TOTAL CO_2 Gg	**692.12**	**625.29**	**424.92**	**346.80**	**306.59**

3. ENERGY (CRF 1)

3.1. Overview of sector

Energy sector is the main source of greenhouse gas emissions in Estonia. In 2012, the energy sector contributed about 88% of total emissions, totalling 16 873.8 Gg of CO_2 equivalent (see Figure 3.1). Compared to the base year 1990, the emissions were about 53.2% below that level (36 019.14 Gg CO_2). Most of the energy sector emissions – 99.5% originate from fuel combustion and only 0.5% 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.

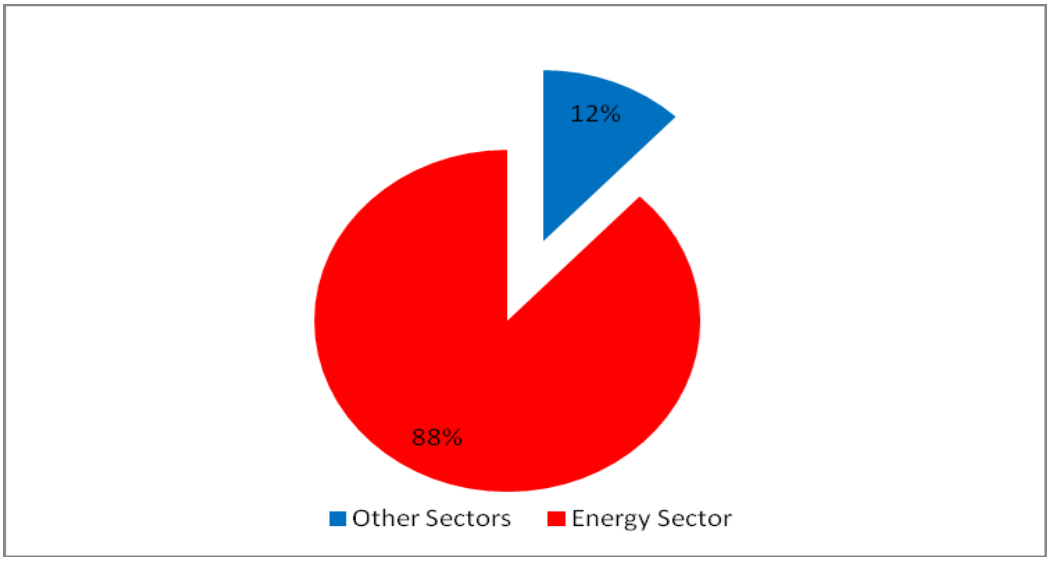


Figure 3.1. Emissions from the energy sector compared to the total emissions in 2012

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.

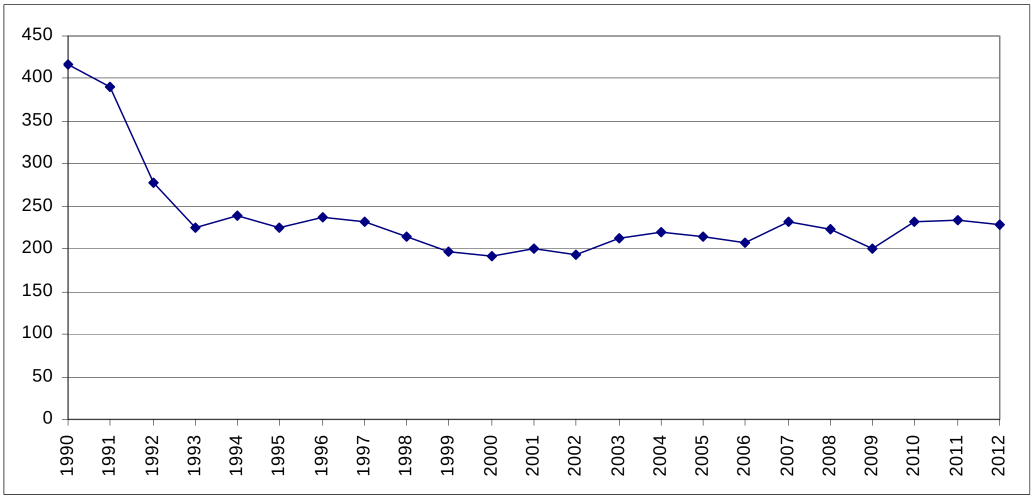
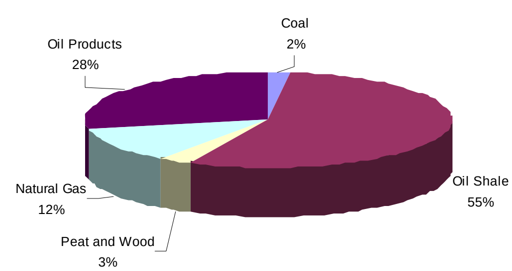


Figure 3.2. Development of Total Primary Energy Supply in Estonia in 1990–2012, PJ (Source: Statistics Estonia)

In 2012 the supply of primary energy was 229.3 PJ, of which oil shale formed 64%, and peat and wood together – 15%. The share of renewable energy sources amounted to approximately 14%, of which wood fuels comprised the main portion and other sources 0.1%. About 48% of the primary fuel energy was used for electricity and 17% for heat generation. The total primary energy supply stayed in the same level in 2012 compared with the previous year (see Figure 3.2).

The structure of primary energy supply in 1990 and 2012 accordingly is presented in Figure 3.3.

1990



2012

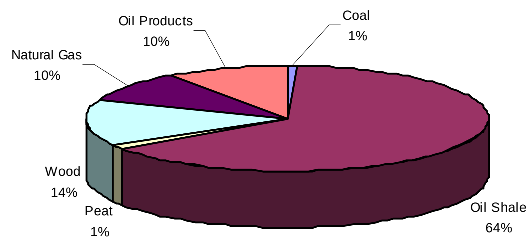


Figure 3.3. Structure of primary energy supply in Estonia in 1990 and 2012

The economic situation in 2012 was quite similar to 2011. Final consumption of energy decreased about 4.3% compared to 2011.

Domestic fuels have a large share in Estonia's total energy resources and in the balance of primary energy – mainly based on oil shale. In 2012, 18.8 million tons of oil shale was produced, which is 0.3% more than in 2011. 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 80% of the production was exported – 11% more than in 2011. More than a third (34%) of this amount was exported to the Netherlands, followed by Belgium and Denmark. The production of peat fuels decreased significantly in 2012 due to bad weather conditions. Compared to 2011, there was almost a twofold decrease in the production of both milled peat and peat briquettes (Figure 3.3).

Emissions from the energy sector by subcategory in 1990–2012 are presented on the Figure 3.4.

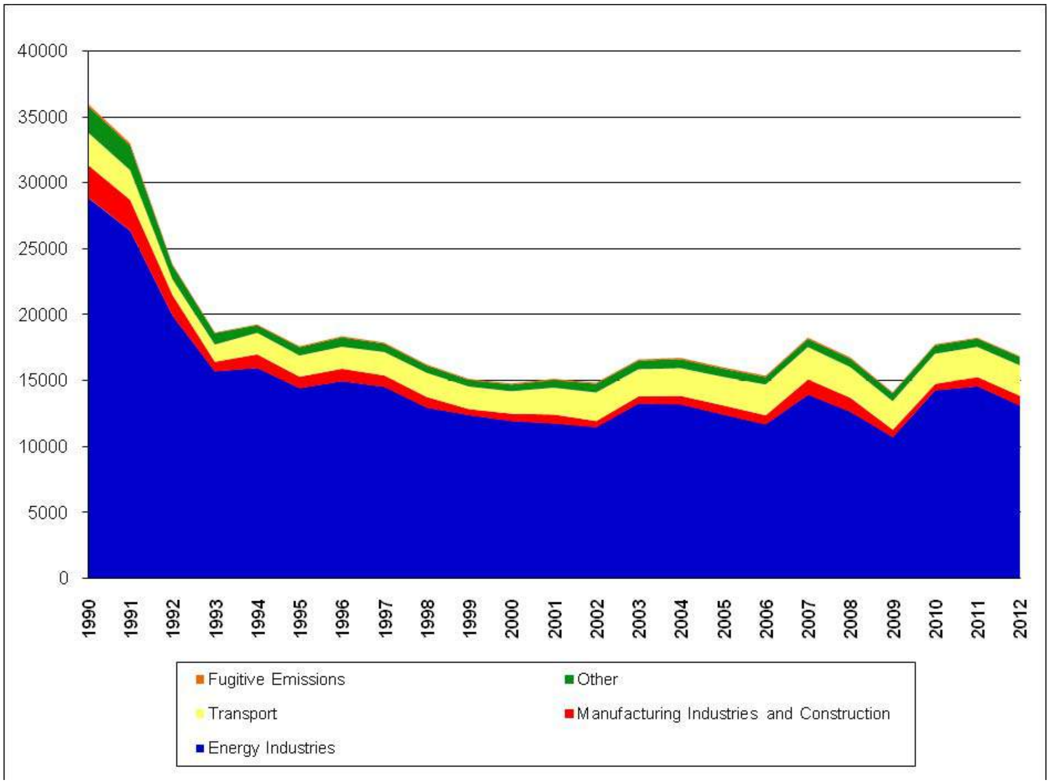


Figure 3.4. Emissions from the energy sector by subcategory in 1990–2012 (Gg CO_2 equivalent)

Trend of fuel consumption in Energy sector in 1990–2012 is presented on the Figure 3.5.

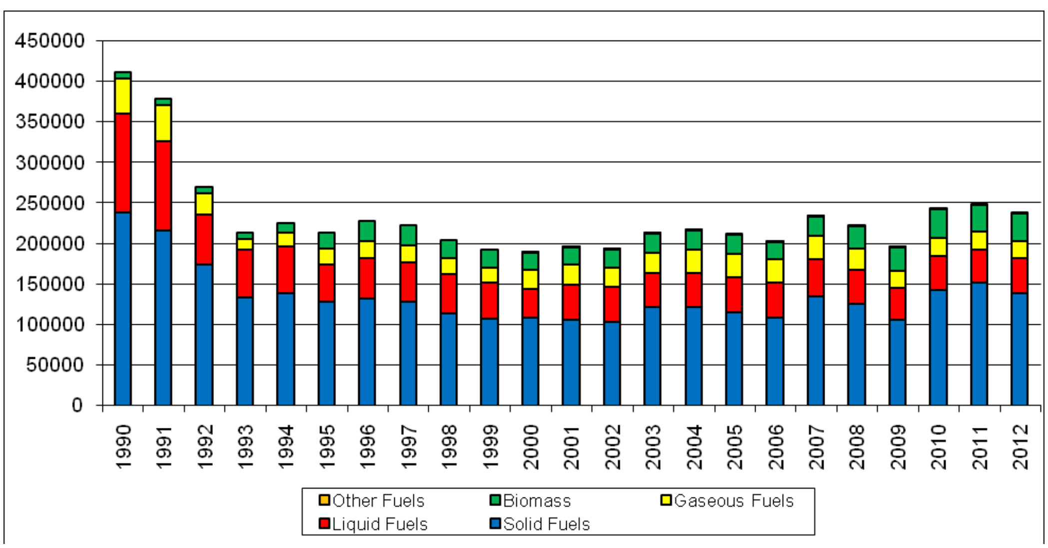


Figure 3.5. Fuel consumption in 1990–2012, TJ

Table 3.1. Emissions from the energy sector in 1990–2012 by sub-category and greenhouse gas (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Energy Total, CO_2 eq	36 019.14	33 025.73	23 842.13	18 632.80	19 249.11	17 610.89	18 359.41	17 872.07	16 220.80	15 115.87	14 775.76
1.A Fuel Combustion Total, CO_2 eq	35 841.60	32 847.68	23 738.13	18 581.20	19 175.00	17 526.38	18 266.21	17 781.50	16 134.84	15 032.19	14 679.57
1.A Fuel Combustion, CO_2	35 631.75	32 646.59	23 604.03	18 459.59	19 037.30	17 330.28	18 037.55	17 551.27	15 946.01	14 851.00	14 496.36
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	177.54	178.05	104.01	51.61	74.11	84.51	93.20	90.56	85.95	83.67	96.19

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1. Energy Total, CO_2 eq	15 133.24	14 828.77	16 596.51	16 723.10	16 021.74	15 384.42	18 268.90	16 752.10	14 128.21	17 768.24	18 253.84	16 873.83
1.A Fuel Combustion Total, CO_2 eq	15 029.96	14 742.26	16 501.18	16 610.62	15 905.71	15 266.96	18 152.07	16 640.14	14 052.16	17 686.62	18 180.25	16 797.26
1.A Fuel Combustion, CO_2	14 826.56	14 533.22	16 305.63	16 406.33	15 713.87	15 087.12	17 944.71	16 430.05	13 832.48	17 451.25	17 960.61	16 571.66
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	5.72	5.95
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	0.32
1.B Fugitive Emissions, CO_2 eq	103.28	86.51	95.33	112.48	116.02	117.46	116.83	111.97	76.04	81.62	73.59	76.57

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 1990–2012 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

CRF	Source	Emissions reported
	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 (16 571.66 Gg) accounted for 98.21% of the energy sector's total emissions and 86.36% of total greenhouse gas emissions in 2012.

The share of CH_4 emissions from fuel combustion (125.0 Gg CO_2 eq.) was 0.74% in 2012, mainly due to the incomplete combustion of wood fuels (small combustion). N_2O emissions from fuel combustion are relativly small (100.6 Gg CO_2 eq.) accounting for about 0.60%. N_2O emissions are emitted mainly from energy industries and transport sectors (Table 3.8 and Table 3.21).

Table 3.3. Emissions from fuel combustion in Estonia in 1990–2012 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A Fuel Combustion total, CO_2 eq	35 841.60	32 847.68	23 738.13	18 581.20	19 175.00	17 526.38	18 266.21	17 781.50	16 134.84	15 032.19	14 679.57
1.A.1 Energy Industries, CO_2 eq	28 848.60	26 330.53	19 902.91	15 674.08	15 932.39	14 406.37	14 929.54	14 504.76	12 931.33	12 358.65	11 916.66
1.A.2 Manufacturing Industries and Construction, CO_2 eq	2 487.99	2 347.68	1 577.97	746.18	1 050.97	884.32	962.89	881.94	827.48	477.50	575.46
1.A.3 Transport, CO_2 eq	2 459.92	2 239.55	1 155.31	1 278.89	1 605.52	1 574.93	1 639.99	1 747.03	1 798.50	1 679.05	1 667.20
1.A.4 Other Sectors, CO_2 eq	2 000.83	1 875.71	1 067.18	871.06	574.96	631.45	717.22	633.84	560.01	499.49	503.07
1.A.5 Other, CO_2 eq	44.25	54.22	34.75	10.99	11.16	29.31	16.57	13.94	17.52	17.51	17.18

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1.A Fuel Combustion total, CO_2 eq	15 029.96	14 742.26	16 501.18	16 610.62	15 905.71	15 266.96	18 152.07	16 640.14	14 052.16	17 686.62	18 180.25	16 797.26
1.A.1 Energy Industries, CO_2 eq	11 731.91	11 453.00	13 250.74	13 173.95	12 396.34	11 660.55	13 905.48	12 609.13	10 692.12	14 239.63	14 538.99	13 085.95
1.A.2 Manufacturing Industries and Construction, CO_2 eq	700.70	485.99	555.62	664.35	719.41	714.41	1 182.58	1 083.53	590.13	510.76	721.16	768.02
1.A.3 Transport, CO_2 eq	1 996.13	2 124.86	2 019.11	2 065.82	2 136.95	2 295.77	2 420.45	2 303.69	2 126.08	2 248.10	2 259.60	2 278.97
1.A.4 Other Sectors, CO_2 eq	582.39	663.47	656.39	678.29	617.65	564.12	612.46	632.84	614.24	646.58	640.36	641.28
1.A.5 Other, CO_2 eq	18.84	14.95	19.32	28.21	35.37	32.13	31.11	10.95	29.60	41.56	20.14	23.03

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 2012 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 2012, Level Assessment (without LULUCF) (quantitative method used: Tier 2)

IPCC code	IPCC source category	GHG	2012 Gg CO_2 equivalent
1.A.1.a	Energy Industries/Electricity and Heat Production – Solid Fuels	CO_2	11 396.09
1.A.1.a	Energy Industries/Electricity and Heat Production – Liquid Fuels	CO_2	339.94
1.A.1.a	Energy Industries/Electricity and Heat Production – Gaseous Fuels	CO_2	908.83
1.A.1.c	Energy Industries/Other Energy Industries – Solid Fuels	CO_2	396.91
1.A.2	Manufacturing Industries and Constructions – Other Fuels	CO_2	115.35
1.A.2.c	Manufacturing Industries and Constructions/Chemicals – Solid Fuels	CO_2	NO
1.A.2.f	Manufacturing Industries and Constructions/Other – Solid Fuels	CO_2	352.89
1.A.3.b	Road Transport – Liquid Fuels	CO_2	2 148.00
1.A.4.b	Other Sectors/Residential – Solid Fuels	CO_2	38.56
1.A.4.b	Other Sectors/Residential – Biomass	CH_4	102.14

Table 3.5. Key sources in the Energy sector in 2012, Trend Assessment (without LULUCF) (quantitative method used: Tier 2)

IPCC code	IPCC source category	GHG	1990 Gg CO_2 equivalent.	2012 Gg CO_2 equivalent
1.A.1.a	Energy Industries/Electricity and Heat Production – Solid Fuels	CO_2	21 886.83	11 396.09
1.A.1.a	Energy Industries/Electricity and Heat Production – Liquid Fuels	CO_2	4 900.29	339.94
1.A.1.a	Energy Industries/Electricity and Heat Production – Biomass	N_2O	3.03	21.66
1.A.1.c	Energy Industries/Other Energy Industries – Solid Fuels	CO_2	65.20	396.91
1.A.2	Manufacturing Industries and Constructions – Other Fuels	CO_2	NO	115.35

IPCC code	IPCC source category	GHG	1990 Gg CO_2 equivalent.	2012 Gg CO_2 equivalent
1.A.2.c	Manufacturing Industries and Constructions/Chemicals – Solid Fuels	CO_2	620.74	NO
1.A.3.b	Road Transport – Liquid Fuels	CO_2	2 236.11	2 148.00
1.A.4.b	Other Sectors/Residential – Solid Fuels	CO_2	667.08	38.56
1.A.4.b	Other Sectors/Residential – Biomass	CH_4	33.67	102.14
1.A.4.b	Other Sectors/Residential – Biomass	N_2O	6.63	20.10

Table 3.6. Key sources in the Energy sector in 2012, Level Assessment (with LULUCF) (quantitative method used: Tier 2)

IPCC code	IPCC source category	GHG	2012 Gg CO_2 equivalent
1.A.1.a	Energy Industries/Electricity and Heat Production – Solid Fuels	CO_2	11 396.09
1.A.1.a	Energy Industries/Electricity and Heat Production – Liquid Fuels	CO_2	339.94
1.A.1.a	Energy Industries/Electricity and Heat Production – Gaseous Fuels	CO_2	908.83
1.A.1.c	Energy Industries/Other Energy Industries – Solid Fuels	CO_2	396.91
1.A.2	Manufacturing industries and Constructions – Other Fuels	CO_2	118.07
1.A.2.c	Manufacturing Industries and Constructions/Chemicals – Solid Fuels	CO_2	NO
1.A.2.f	Manufacturing Industries and Constructions/Other – Solid Fuels	CO_2	352.89
1.A.3.b	Road Transport – Liquid Fuels	CO_2	2 148.00
1.A.4.b	Other Sectors/Residential – Solid Fuels	CO_2	38.56
1.A.4.b	Other Sectors/Residential – Biomass	CH_4	102.14

Table 3.7. Key sources in the Energy sector in 2012, Trend Assessment (with LULUCF) (quantitative method used: Tier 2)

IPCC code	IPCC source category	GHG	1990 Gg CO_2 equivalent.	2012 Gg CO_2 equivalent
1.A.1.a	Energy Industries/Electricity and Heat Production – Solid Fuels	CO_2	21 886.83	11 396.09
1.A.1.a	Energy Industries/Electricity and Heat Production – Liquid Fuels	CO_2	4 900.29	339.94
1.A.1.c	Energy Industries/Other Energy Industries – Solid Fuels	CO_2	65.20	396.91
1.A.2	Manufacturing Industries and Constructions – Other Fuels	CO_2	NO	115.35
1.A.2.c	Manufacturing Industries and Constructions/Chemicals – Solid Fuels	CO_2	620.74	NO
1.A.2.f	Manufacturing Industries and Constructions/Other – Solid Fuels	CO_2	796.77	355.24

IPCC code	IPCC source category	GHG	1990 Gg CO_2 equivalent.	2012 Gg CO_2 equivalent
1.A.3.b	Road Transport – Liquid Fuels	CO_2	2 236.11	2 148.00
1.A.4.b	Other Sectors/Residential – Solid Fuels	CO_2	667.08	38.56
1.A.4.b	Other Sectors/Residential – Biomass	CH_4	33.67	102.14
1.A.4.b	Other Sectors/Residential – Biomass	N_2O	6.63	20.10

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 2014 inventory submission, the difference of CO_2 emissions between RA and Sectoral Approach (SA) was 6.43%.

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 2012, GHG emissions from international bunkering were 658.77 Gg CO_2 equivalent including marine bunkers 543.40 Gg equivalent and aviation bunkers 115.37 Gg of CO_2 equivalent.

GHG emissions from international navigation increased throughout the period of 2005–2008. After 2008 the emissions have been declining. In 2012, the emissions decreased about 6% compared to 2011.

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 9% compared to previous year. Emissions from aviation bunkering increased about 10% in 2012 compared to 2011.

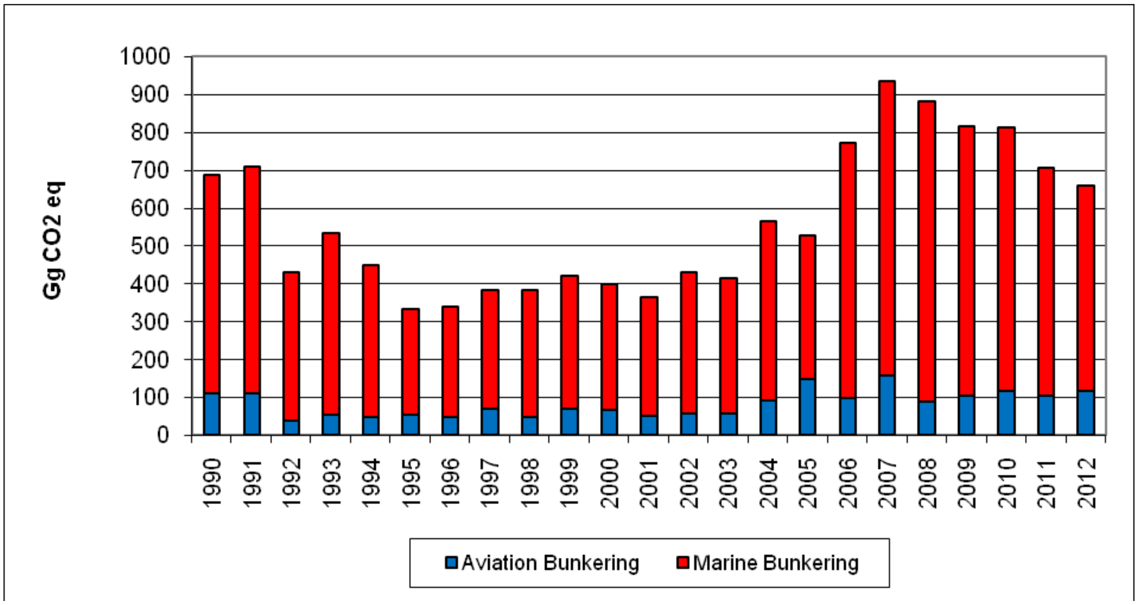


Figure 3.6. Emissions from international bunkers in 1990–2012, Gg CO_2 equivalent

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

1) The activity data of fuel consumption in Aviation Bunkering has been revised:

	Jet Kerosene, TJ	
	2013 submission	2014 submission
1993	735.3	747.7
1996	633.6	647.9
2007	2 096.1	2 097.1
2010	1 549.3	1 549.7
2011	1 412.8	1 412.6

2) The CEF of LTO cycle in aviation bunkering has been revised:

	tC/TJ	
	2013 submission	2014 submission
CEF of LTO cycle	74.8	73.3

3) The CH_4 and N_2O emissions have been corrected in Aviation Bunkering:

GHG	Year	Emissions in 2013 submission	Emissions in 2014 submission
CH_4	1990	0.000801	0.000804
CH_4	1991	0.000780	0.000804
CH_4	1992	0.000809	0.000273
CH_4	1993	0.000573	0.000291
CH_4	1994	0.000696	0.000288
CH_4	1995	0.000971	0.000456
CH_4	1996	0.001344	0.000585
CH_4	1997	0.000895	0.000549
CH_4	1998	0.001375	0.000598
CH_4	1999	0.000921	0.000568
CH_4	2000	0.001457	0.000539
CH_4	2001	0.001511	0.000534
CH_4	2002	0.001361	0.000522
CH_4	2003	0.001316	0.000621
CH_4	2004	0.000995	0.000846
CH_4	2005	0.000792	0.001135
CH_4	2006	0.000991	0.001128
CH_4	2007	0.000645	0.001345
CH_4	2008	0.001429	0.001584
CH_4	2009	0.000746	0.001070
CH_4	2010	0.000720	0.001034
N_2O	1990	0.002346	0.003420
N_2O	1991	0.002283	0.003420
N_2O	1992	0.002323	0.001140
N_2O	1993	0.002349	0.001710
N_2O	1994	0.002373	0.001425
N_2O	1995	0.002520	0.001710
N_2O	1996	0.002403	0.001520
N_2O	1997	0.002416	0.002141
N_2O	1998	0.002411	0.001497
N_2O	1999	0.002383	0.002120
N_2O	2000	0.002383	0.002058
N_2O	2001	0.002414	0.001543
N_2O	2002	0.002375	0.001773
N_2O	2003	0.002414	0.001762
N_2O	2004	0.002448	0.002829
N_2O	2005	0.002372	0.004656
N_2O	2006	0.002421	0.003096
N_2O	2007	0.002390	0.004876
N_2O	2008	0.002472	0.002710
N_2O	2009	0.002396	0.003204
N_2O	2010	0.002400	0.003603

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 2012 the ammonia production factory was reopened. In 2010 and 2011 it was temporarily closed down due to low ammonia price in the Word market.

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) The following activity data of fuel consumption has been revised:

		Fuel Consumption, TJ	
Fuel	Year	2013 submission	2014 submission
Lubricants	2011	160.8	129.3
Bitumen	2003	1 205.7	2 049.7
Bitumen	2004	1 768.4	2 652.5
Bitumen	2005	1 647.8	3 657.3
Bitumen	2006	2 170.3	4 220.0
Bitumen	2007	1 406.7	4 099.4
Bitumen	2008	1 527.2	3 697.5
Bitumen	2009	1 348.1	3 416.2
Bitumen	2010	1 559.8	3 054.4
Bitumen	2011	1 571.4	2 692.7
Oil Shale	1990	5 457.9	5 462.4
Oil Shale	1991	4 857.0	4 861.4
Oil Shale	1992	4 371.1	4 375.5
Oil Shale	1993	5 341.1	5 345.6
Oil Shale	1994	3 414.7	3 419.0
Oil Shale	1995	5 079.6	5 084.1
Oil Shale	1996	4 756.8	4 761.3
Oil Shale	1997	5 125.2	5 129.7
Oil Shale	1998	4 154.8	4 158.5

		Fuel Consumption, TJ	
Fuel	Year	2013 submission	2014 submission
Oil Shale	1999	2 027.6	2 028.1
Oil Shale	2000	3 688.0	3 692.7
Oil Shale	2001	4 923.7	4 928.3
Oil Shale	2002	4 065.3	4 070.0
Oil Shale	2003	4 137.6	4 142.4
Oil Shale	2004	4 013.1	4 017.3
Oil Shale	2005	4 134.4	4 138.4
Oil Shale	2006	3 625.2	3 629.4
Oil Shale	2007	3 363.2	3 367.8
Oil Shale	2008	3 135.7	3 140.3
Oil Shale	2009	3 146.0	3 150.6
Oil Shale	2010	3 811.6	3 841.7
Oil Shale	2011	4 064.4	4 090.7

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 2012, the category Energy Industries (1.A.1) contributed 77.55% of energy sector emissions, totalling 13 085.95 Gg of CO_2 equivalent (see Table 3.3) and about 68.2% of total GHG emissions. Compared to the base year 1990, the emissions were about 54.6% lower (28 848.60 Gg CO_2 eq.).

The emissions from energy industries by relevant subcategories and gases in 1990–2012 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 2012.

In general, the trend of GHG emissions in Energy Industries follows the trend of fuel consumption (Figure 3.5). In 2012, the emissions of Energy Industries decreased by 54.6% compared to 1990. The decrease of GHG emissions in electricity and heat production sub-sector was 55.9%. 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.

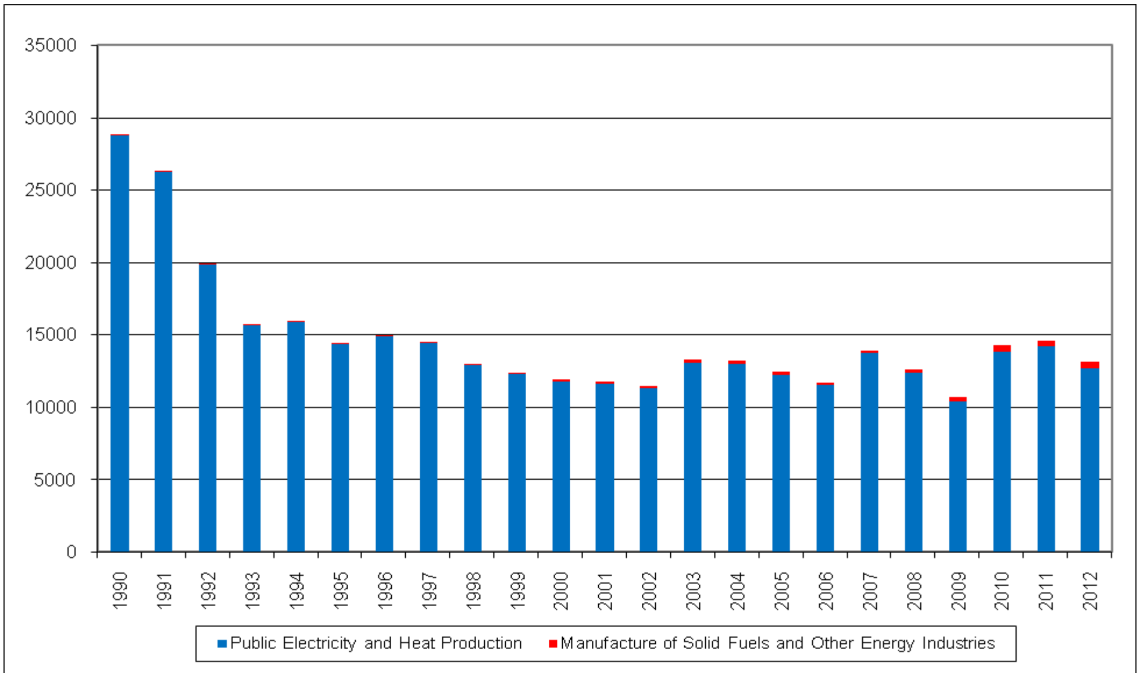


Figure 3.7. Trend of GHG emissions from Energy Industries by relevant subcategories in 1990–2012 (Gg CO_2 equivalent)

In 2012, the gross production of electricity was 11,966 GWh – about 7% lower compared to 2011 (12,893 GWh). The main reasons for decreased production were a foll in exports and the possibility to import electricity from the Nordic countries. Import from Finland represented 60% of total energy imports in 2012 and was more than three times higher than the year before. Although Estonia still exports a great volume of electricity, exports fell nearly 6% compared to 2011.

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. The introduction of renewable energy sources has slightly reduced the importance of waste-intensive oil shale in electricity production. In 2012, the procution of both wind and hydro energy increased about 20% compared to 2011. The installed capacity of wind parks increased about 47% in 2012 compared to 2011.

In 2012 heat production increased about 5% compared to 2011. This increase was caused by the general economic upturn and lower ambient temperature compared to 2011. About 60% of heat was produced by heating plants and their total heat production was more than 3% bigger than in 2011. About 40% of heat was produced by power plants and heat production by power plants increased more than 7% compared to 2011. More than a half (56%) of the total heat produced by heating plants was generated from natural gas, about a third (29%) from wood fuels and a tenth from shale oil. The production of heat from natural gas grew 13% compared to 2011, while production of heat from wood fuels decreased 7%.

In 2012, natural gas, liquid fuels, coal and coke were imported for domestic consumption. Imports of natural gas increased nearly 5% compared to 2011 due to increased consumption by the chemical industry and households. The imports of motor gasoline decreased 3.4%

while imports of diesel oil increased 6% compared to 2011. The imports of other fuels were smaller and remained on the same level as in 2011.

In 2012, the category Manufacturing Industries and Construction (1.A.2) contributed 4.55% of energy sector emissions, totalling 768.02 Gg of CO_2 equivalents and about 4.0% of total GHG emissions.

The emissions from manufacturing industries and construction by relevant subcategories and greenhouse gases in 1990–2012 are presented in Table 3.9 and Figure 3.9. Compared to 1990, the emissions of Manufacturing Industries and Construction decreased by 69.1% in 2012. 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 2012 are presented in the Figure 3.8.

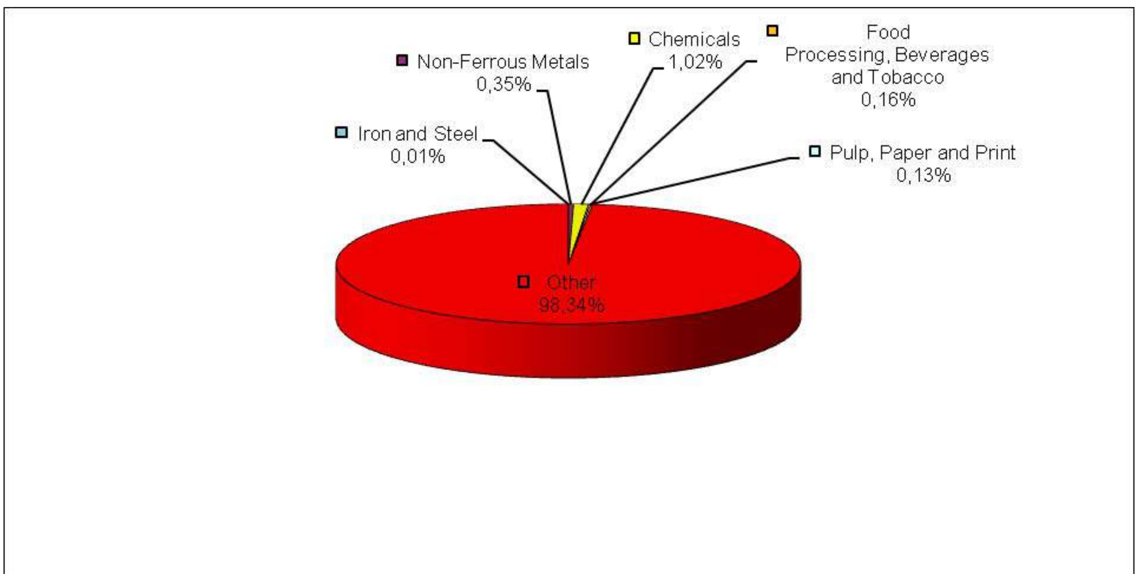


Figure 3.8. The share of GHG emissions from manufacturing industries and construction by relevant subcategories in 2012, %

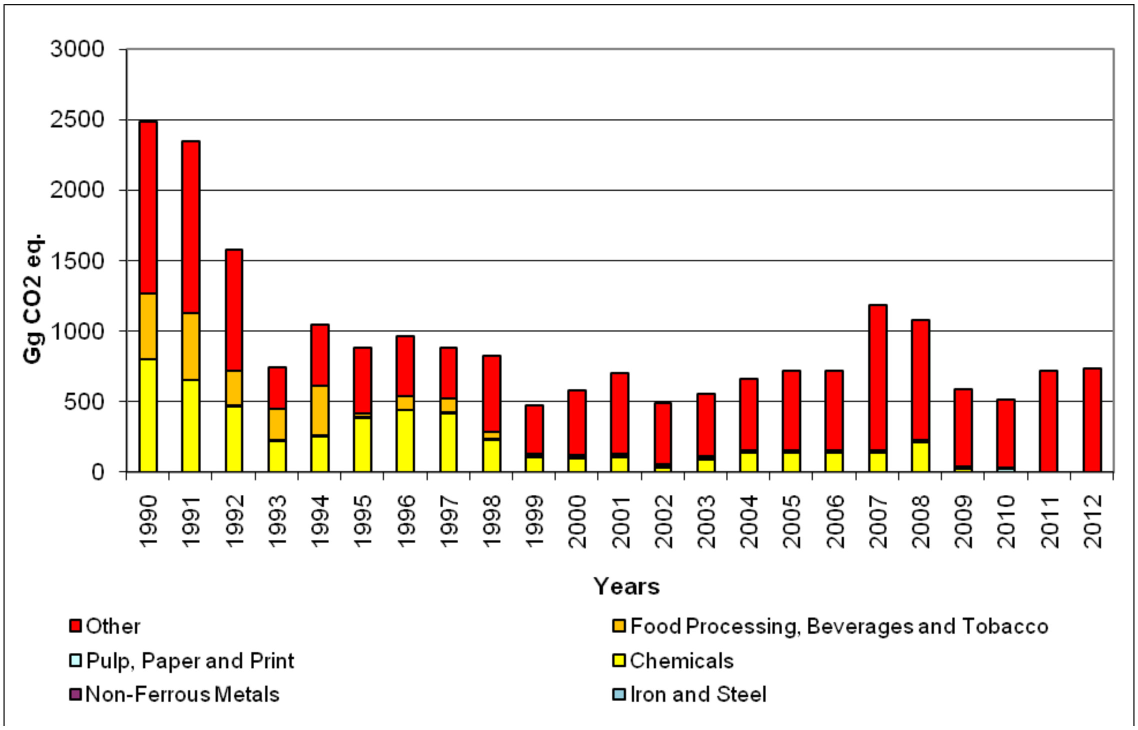


Figure 3.9. Trend of emissions GHG from manufacturing industries and construction by relevant subcategories in 1990–2012, Gg CO_2 equivalent

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 2012 (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. In 2012, the emissions stayed on the same level as in 2011.

The trend of GHG emissions of the CRF source category 1.A.2.a Iron and Steel in 1990–2012 is presented in Figure 3.10.

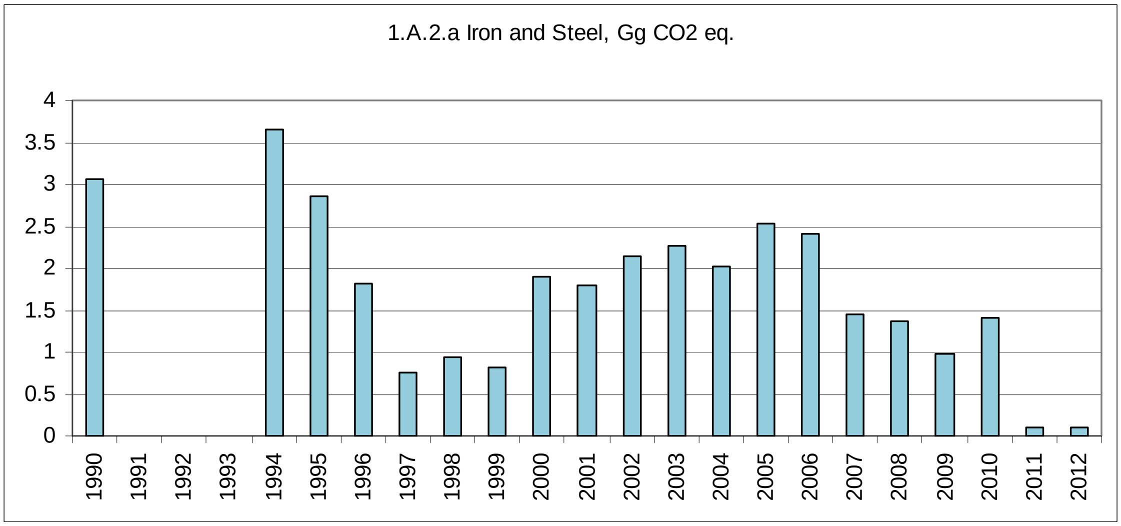


Figure 3.10. Trend of GHG emissions of the sub-sector Iron and Steel in 1990–2012, Gg CO_2 eq

The trend of GHG emissions of the CRF source category 1.A.2.b Non-Ferrous Metals in 1990–2012 is presented in Figure 3.11.

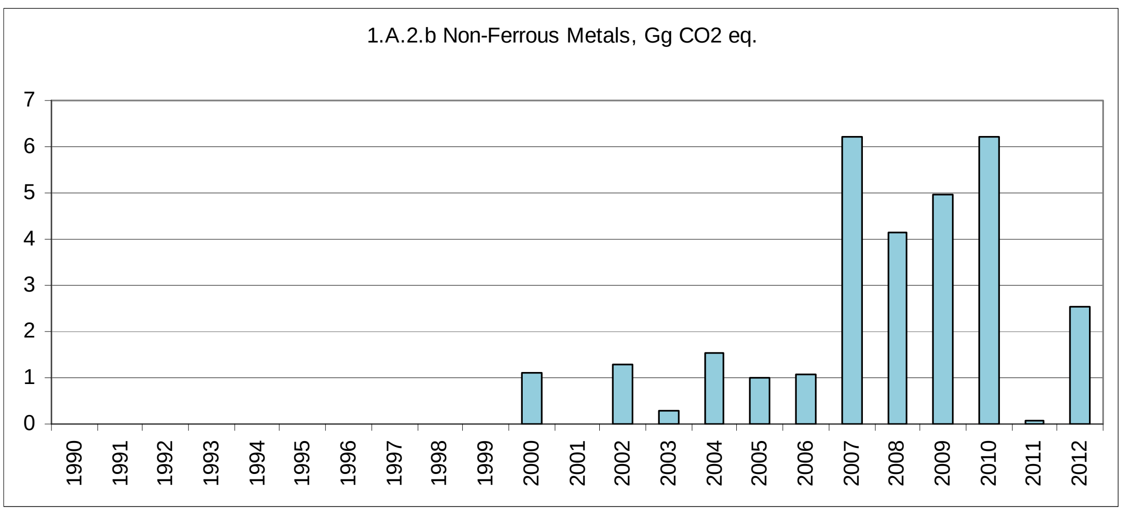


Figure 3.11. Trend of GHG emissions of the sub-sector Non-Ferrous Metals in 1990–2012, Gg CO_2 eq

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 0.35% of the manufacturing industries GHG emissions in 2012 (see Figure 3.8). In

2012 the emissions from Non-Ferrous Metals were only 2.53 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 1990–2012 is presented in the Figure 3.12.

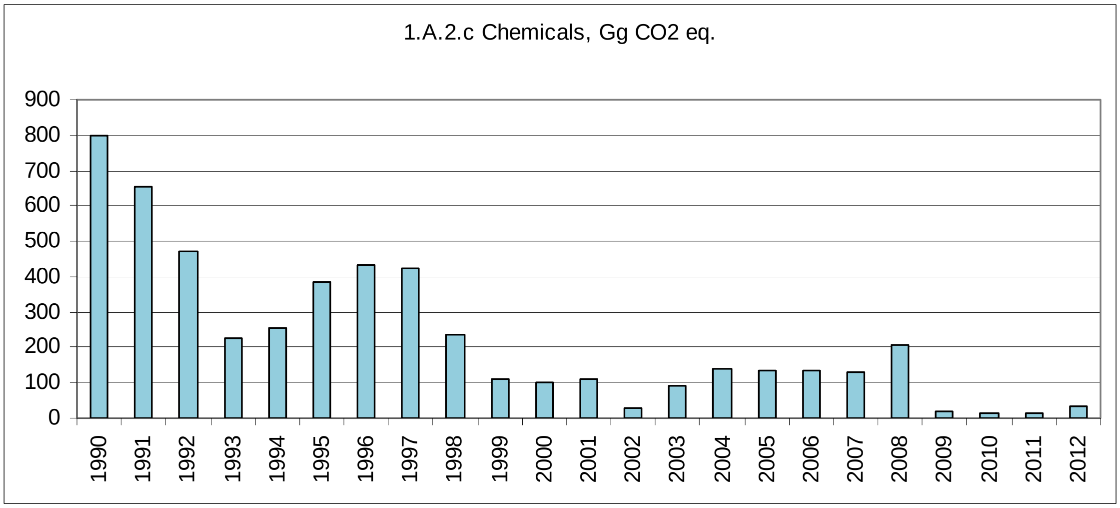


Figure 3.12. Trend of GHG emissions of the sub-sector Chemicals in 1990–2012, Gg CO_2 eq

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 1.02% of the manufacturing industries GHG emissions in 2012 (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. In 2012, the ammonia production factory Nitrofert was reopened. 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 1990–2012 is presented.

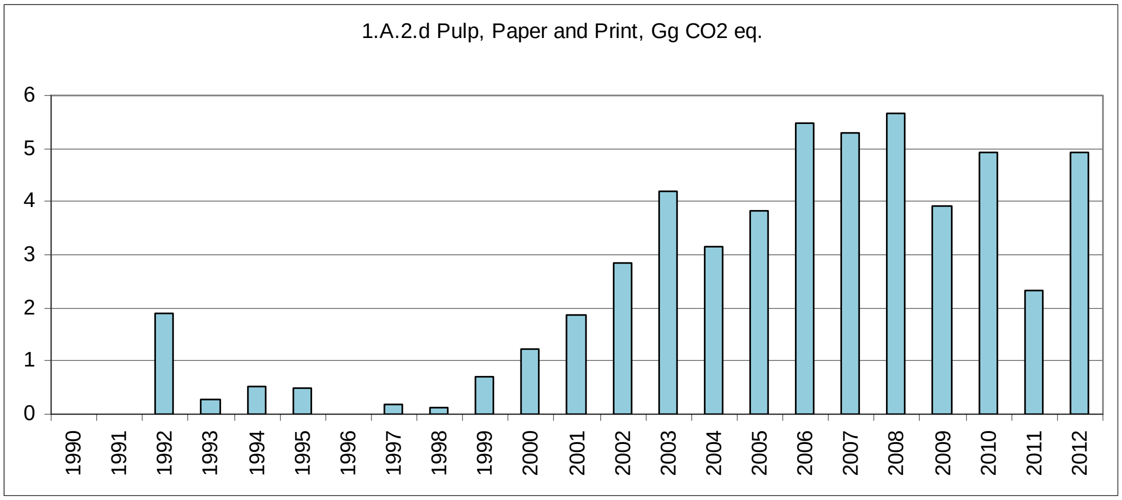


Figure 3.13. Trend of GHG emissions from the sub-sector Pulp, Paper and Print in 1990–2012, Gg CO_2 eq

The share of the CRF sub-category 1.A.2.d Pulp, Paper and Print is small, forming about 0.13% of the manufacturing industries GHG emissions in 2012 (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 and the increase of emissions in 2012 compared to 2011 are 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 1990–2012 is presented in the Figure 3.14.

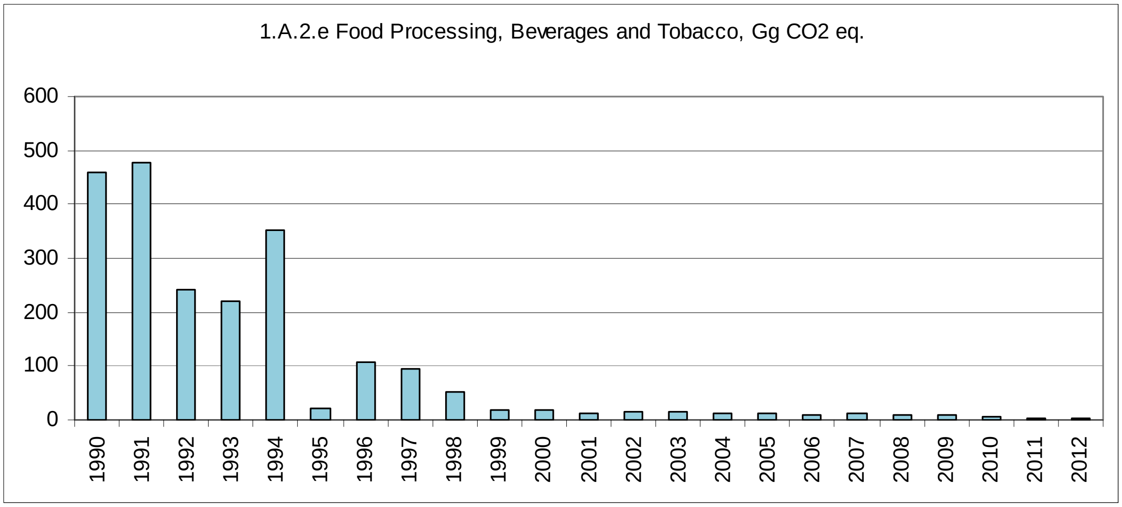


Figure 3.14. Trend of GHG emissions of the sub-sector Food Processing, Beverages and Tobacco in 1990–2012, Gg CO_2 eq

The share of the CRF sub-category 1.A.2.e Food Processing, Beverage and Tobacco is small forming about 0.16% of the manufacturing industries GHG emissions in 2012 (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 1990–2012 is presented in the Figure 3.15.

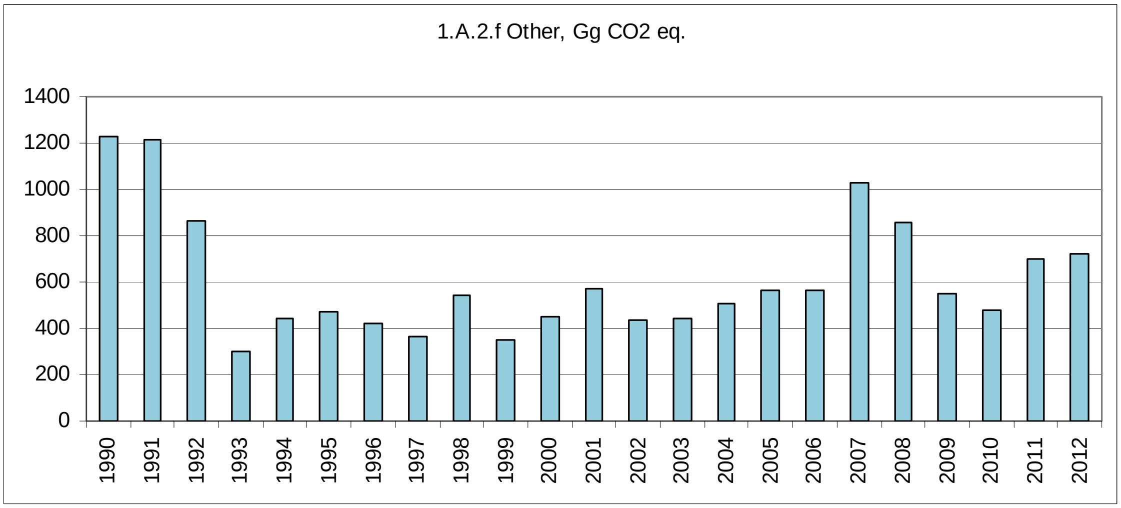


Figure 3.15. Trend of GHG emissions of the sub-sector Other in 1990–2012, Gg CO_2 eq

The share of the CRF sub-category 1.A.2.f Other is the biggest forming about 98.34% of the manufacturing industries GHG emissions in 2012 (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). In 2012, the emissions increased about 2.8% compared to 2011. The increase was caused by increased consumption of natural gas and liquid fuels.

The values of CO_2 IEFs of liquid fuels in the Manufacturing Industries and Construction are between 72.71 t/TJ (in 2012) and 75.58 t/TJ (in 1995) and the values of CO_2 IEF of solid fuels are between 97.57 t/TJ (in 2009) and 127.27 t/TJ (in 1994). The trends are fluctuating due to changes in the contribution of different solid and liquid fuels over time.

The emissions from Energy Industries are presented in Table 3.8 and the emissions from Manufacturing Industries and Construction are presented in Table 3.9.

Table 3.8. The emissions from Energy Industries by relevant subcategories and gases in 1990–2012 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.1 Energy Industries Total, CO_2 eq	28 848.60	26 330.53	19 902.91	15 674.08	15 932.39	14 406.37	14 929.54	14 504.76	12 931.33	12 358.65	11 916.66
1.A.1 Energy Industries, CO_2	28 821.06	26 305.80	19 885.20	15 657.41	15 913.37	14 386.14	14 906.19	14 482.81	12 909.64	12 337.05	11 896.77
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	28 755.85	26 269.60	19 848.83	15 611.14	15 827.35	14 306.16	14 835.94	14 399.51	12 837.65	12 254.11	11 751.38
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	2012
1.A.1 Energy Industries Total, CO_2 eq	11 731.91	11 453.00	13 250.74	13 173.95	12 396.34	11 660.55	13 905.48	12 609.13	10 692.12	14 239.63	14 538.99	13 085.95
1.A.1 Energy Industries, CO_2	11 708.77	11 429.15	13 226.94	13 145.80	12 362.32	11 630.37	13 876.65	12 577.20	10 657.88	14 195.43	14 492.47	13 041.76
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	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	0.10
1.A.1.a Public Electricity and Heat Production, CO_2	11 572.09	11 275.20	13 043.48	12 970.53	12 171.89	11 475.56	13 730.45	12 355.23	10 348.78	13 777.18	14 101.62	12 644.85
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	390.85	396.91

Table 3.9. The emissions from Manufacturing Industries and Construction by relevant subcategories in 1990–2012 (Gg, CO_2 equivalent)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.2 Manufacturing Industries and Construction Total	2 487.99	2 347.68	1 577.97	746.18	1 050.97	884.32	962.89	881.94	827.48	477.50	575.46
1.A.2.a Iron and Steel	3.06	NO	NO	NO	3.65	2.87	1.82	0.75	0.94	0.82	1.89
1.A.2.b Non-Ferrous Metals	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1.10
1.A.2.c Chemicals	800.23	653.54	472.29	224.79	254.02	387.08	434.78	424.37	235.19	111.38	101.98
1.A.2.d Pulp, Paper and Print	NO	NO	1.89	0.28	0.53	0.48	NO	0.20	0.11	0.70	1.23
1.A.2.e Food Processing, Beverages and Tobacco	458.88	476.34	241.65	221.19	352.30	21.65	106.23	94.89	51.21	16.85	17.41
1.A.2.f Other	1225.82	1217.80	862.15	299.92	440.48	472.24	420.06	361.73	540.03	347.75	451.84

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1.A.2 Manufacturing Industries and Construction Total	700.70	485.99	555.62	664.35	719.41	714.41	1 182.58	1 083.53	590.13	510.76	721.16	768.02
1.A.2.a Iron and Steel	1.79	2.14	2.26	2.02	2.54	2.41	1.45	1.36	0.98	1.40	0.11	0.10
1.A.2.b Non-Ferrous Metals	NO	1.29	0.27	1.54	0.99	1.06	6.21	4.14	4.96	7.07	0.07	2.53
1.A.2.c Chemicals	109.08	29.93	90.92	137.18	136.40	135.28	131.26	206.37	17.53	12.80	12.62	33.16
1.A.2.d Pulp, Paper and Print	1.87	2.84	4.19	3.14	3.83	5.48	5.28	5.67	3.91	4.94	2.32	4.92
1.A.2.e Food Processing, Beverages and Tobacco	13.18	16.43	15.43	13.38	12.69	9.45	11.53	9.36	9.55	7.00	3.19	4.55
1.A.2.f Other	574.77	433.37	442.54	507.08	562.95	560.73	1026.85	856.62	553.21	477.54	702.84	722.76

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. The semi-coke is landfilled and the corresponding carbon is stored. 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 used for drying and pre-heating of raw oil shale in dryer and then are completely emitted into atmosphere. Dust is delivered to ash fields but partly back to the reactor.

Therefore, in 2012, 46.48 PJ of oil shale was consumed for shale oil production in total but only processing of 21.44 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**
2012	15.13	6.00	0.31	21.44	21.18	3.86	25.04	**46.48**

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**

Year	Solid Heat Carrier			Total	Gas generators		Total	Total
	Narva	VKG	Kiviõli	in SHC	VKG	Kiviõli	in gas generators	Oil shale gas
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**
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**
2012	2.99	1.08	0.06	4.13	2.81	0.51	3.32	**7.45**

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 3.12 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 3.12. CO_2 emission factors, oxidation factors and net caloric values by fuel

Fuels	NCV average	Unit	CEF tC/TJ	Oxidation factor	Source of emission factor
Liquid fuels					
LPG	45.5	GJ/t	17.59	1	CS (Estonia)
Gasoline (for non-road transport)	44.00	GJ/t	19.61	1	CS (Estonia)
Light Fuel Oil	42.5	GJ/t	20.21	1	CS (Estonia)
Shale Oil (heavy fraction)	39.2	GJ/t	21.1	0.99	CS, MoE 2006
Shale Oil (light fraction)	42.2	GJ/t	20.2	0.99	CS (Estonia)
Diesel Oil	42.3	GJ/t	19.97	1	CS (Estonia)
Residual Fuel Oil (heavy fuel oil)	40.15	GJ/t	21.18	1	CS (Estonia)
Recycled Waste Oil	20.18	GJ/t	20.2	1	PS, Kunda Nordic Cement

Fuels	NCV average	Unit	CEF tC/TJ	Oxidation factor	Source of emission factor
Solid fuels					
Coal	27.14	GJ/t	26.08	1	CS (Estonia)
Coke Oven Coke	28.5	GJ/t	29.02	1	CS (Estonia)
Oil Shale$_{CFB}$ (Fludised Bed Combustion)	8.9	GJ/t	26.94	0.98	CS, MoE 2006
Oil Shale$_{PC}$ (Pulverised Combustion)	8.9	GJ/t	27.85	0.98	CS, MoE 2006
Milled Peat	9.7	GJ/t	28.9	0.99/0.97*	CS, FI (Finland) = D, IPCC 1996, Vol. 2, Table 1-2
Sod Peat	12.0	GJ/t	27.82	0.99/0.97*	CS, FI (Finland)
Peat Briquette	16.0	GJ/t	26.45	0.97	CS, FI (Finland)
Oil Shale semi-coke gas (SHC technology, Narva plant)	45.90	GJ/1000 m^3	18.79	0.995	PS (Estonia)
Oil Shale semi-coke gas (VKG plant)	41.971	GJ/1000 m^3	18.66	0.995	PS (Estonia)
Oil Shale generators gas (VKG)	3.41	GJ/1000 m^3	45.29	0.995	PS (Estonia)
Oil Shale semi-coke gas (Kiviõli plant)	31.98	GJ/1000 m^3	18.47	0.995	PS (Estonia)
Oil Shale generator gas (Kiviõli plant)	2.423	GJ/1000 m^3	45.15	0.995	PS (Estonia)
Gas Gasoline	44.0	GJ/t	19.9	0.99	PS (Estonia)
Waste Oils	16.0	GJ/t	20.1818	1	PS, Kunda Nordic Cement
Other Fossil based Solid Waste (MSW)	19.0	GJ/t	21.8182	1	PS, Kunda Nordic Cement
Plastic Waste	21.0	GJ/t	20.4545	1	PS, Kunda Nordic Cement
Gaseous fuels					
Natural Gas	33.6	GJ/1000 m^3	15.07	0.995	CS (Estonia)
Biomass fuels					
Solid Biomass (solid, includes e.g. firewood, wood chips, sawdust pellets, briquettes, etc.)	6.9 – 16.9	GJ/m^3s	29.9	0.98	D, IPCC 1996, Vol. 2, Table 1-2
Black Liquor	13.4	GJ/t	29.9	0.98	D, IPCC 1996, Vol. 2, Table 1-2
MSW biomass fraction	19.0	GJ/t	30.0	0.98	CS, Kunda
Biogas (landfill gas and biogas from wastewater treatment)	17.4	GJ/1000 m^3	14.89	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 factors have been implemented for Gasoline, LPG, Light Fuel Oil, Residual Fuel Oil, Diesel Oil, Coal and Coke. These country specific carbon emission factors are calculated using weighted average method using CEFs of countries, that Estonia imports thsee fuels 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 3.13 below.

Table 3.13. 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

Fuels	Energy Industry		Manufacturing Industry		Source
	CH_4	N_2O	CH_4	N_2O	
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 other industrial wood residues, pellets and briquettes)	30	4	30	4	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
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 3.14, Table 3.15 and Table 3.16).

Table 3.14. 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	

	Coal	*Natural Gas*	*Oil*	*Wood*	*Oil Shale**	*Peat/ Briquette*
Manufacturing and Construction	300	150	200	100	110	300

Table 3.15. 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 3.16. 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 1990–2012 (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 1990–2012 are presented in the Table 3.17 and on Figure 3.16 and Figure 3.17.

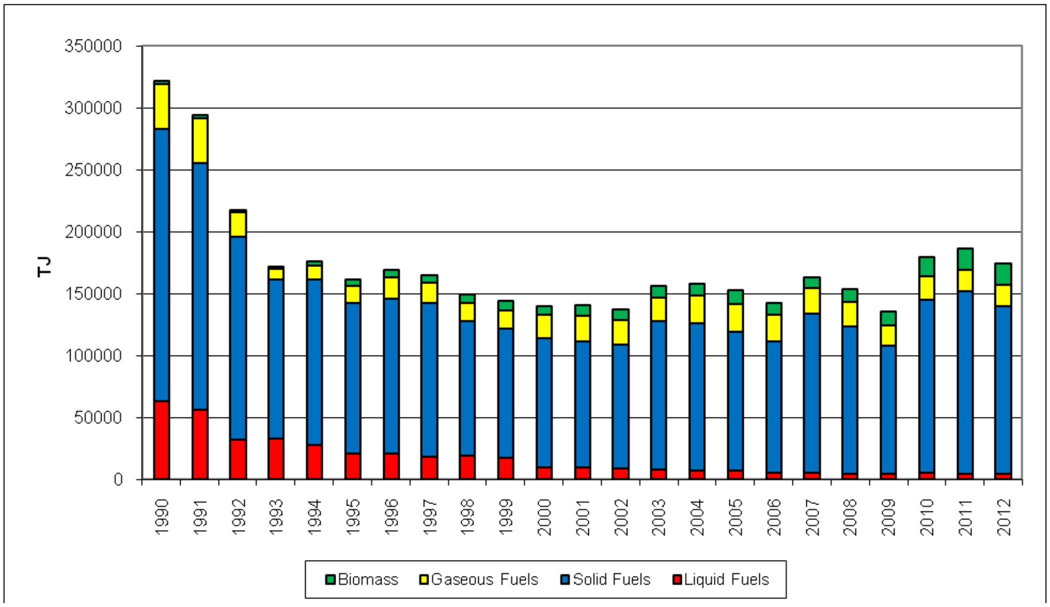


Figure 3.16. Trend of fuel consumption in Energy Industries, TJ

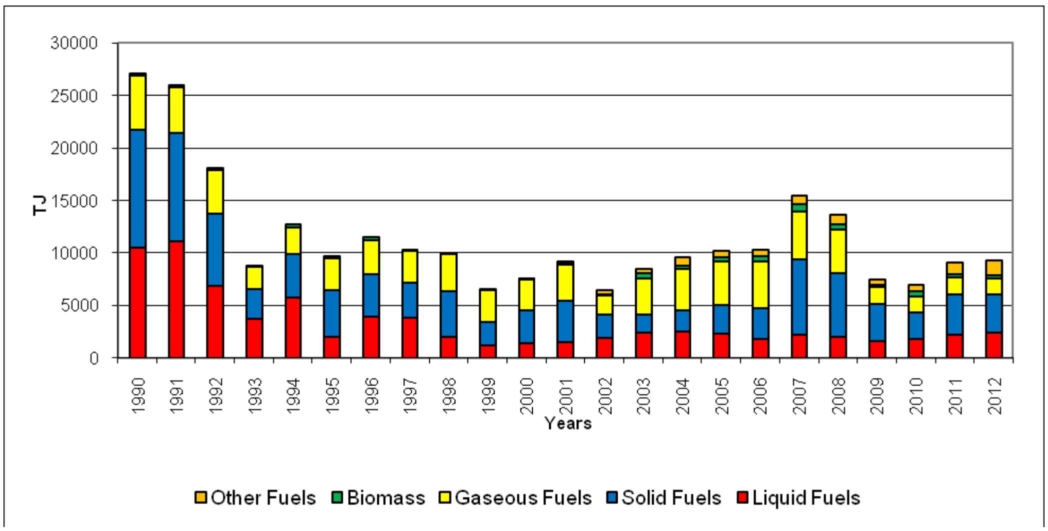


Figure 3.17. Trend of fuel consumption in Manufacturing Industries and Construction, TJ

Table 3.17. Fuel consumption in Energy Industries (CRF 1.A 1) and Manufacturing Industries and Construction (CRF 1.A 2) in 1990–2012 (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	2012
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	186 597	174 290
Liquid Fuels	9 823	8 638	8 116	7 408	7 167	5 648	5 421	4 714	4 557	5 001	4 518	4 526
Solid Fuels	101 869	100 366	119 473	119 010	112 259	105 670	128 098	118 978	103 040	140 259	147 584	135 644
Gaseous Fuels	20 141	19 719	19 470	21 646	21 914	21 991	21 240	19 771	16 351	18 273	16 624	16 530
Biomass	8 508	8 876	8 936	9 911	11 440	9 097	8 148	9 847	11 752	16 313	17 871	17 590

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.2.a 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	2012
1.A.2.a Manufacturing Industries and Construction Total	9 123	6 395	8 209	9 558	10 121	10 241	15 378	13 594	7 415	6 889	9 017	9 858
Liquid Fuels	1 426	1 836	2 165	2 450	2 227	1 801	2 212	1 983	1 595	1 717	2 131	2 352
Solid Fuels	3 986	2 225	1 769	1 995	2 747	2 911	7 183	6 038	3 487	2 556	3 866	3 611
Gaseous Fuels	3 424	1 824	3 401	4 027	4 206	4 474	4 525	4 134	1 609	1 553	1 663	2 186
Biomass	152	162	480	308	331	454	692	492	201	499	236	255
Other Fuels	135	348	394	778	610	601	766	947	523	564	1 121	1 454

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 2012: 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 2012 by using available estimates and the combination of available measured data;

Data has been obtained from database of SE.[4]

In estimation of uncertainty two main components has 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

[4] 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 3.18. The largest uncertainty contribution of 60% was caused by incomplete data of emission factor of other fuels (waste fuels).

Table 3.18. Estimated relative uncertainties of CO_2 emission due to fuel combustion in Estonia in 2012

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 / 2.39**	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 CRF category 1.A.1.a Energy Industries/Electricity and Heat Production emission factor uncertainty of 2.39% was used.

In estimation of uncertainties in greenhouse gases CH_4 and N_2O the IPCC[5] 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 3.19).

Table 3.19. 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

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

Source and Sink	GHG	Activity data uncertainty U_A	Emission factor uncertainty U_E	Reference U_A, U_E
	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*
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 6.

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 fuel consumption data in energy units (in TJ-s) are available in the statistical database on the website of SE (www.stat.ee). Year average net calorific values of fuels are received from SE by a special request. 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 to 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 2014 inventory submission Energy Sector CO_2 emissions and emission factors were compared against EF-s used by European Union Emission Trading System (EU ETS) enterprises (for the year 2012) and with the total EU ETS emissions. Some inconsistencies were identified due to the differences in methodologies. For example, the CEFs of oil shale gases are different. This is caused by the nature of very chemically uneven gases and differences in calculation methodologies resulting higher emissions in GHG inventory.

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 current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG and Coal have been implemented. The implementation of these CEFs resulted in following recalculations in the CRF source-category 1.A.1.a:

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
1990	CO_2	28 682.91	28 755.85
1991	CO_2	26 204.02	26 269.60
1992	CO_2	19 820.88	19 848.83
1993	CO_2	15 579.83	15 611.14
1994	CO_2	15 802.76	15 827.35
1995	CO_2	14 291.04	14 306.16
1996	CO_2	14 817.57	14 835.94
1997	CO_2	14 383.77	14 399.51

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
1998	CO_2	12 821.84	12 837.65
1999	CO_2	12 240.80	12 254.11
2000	CO_2	11 746.82	11 751.38
2001	CO_2	11 568.35	11 572.09
2002	CO_2	11 272.03	11 275.20
2003	CO_2	13 041.03	13 043.48
2004	CO_2	12 968.98	12 970.53
2005	CO_2	12 170.11	12 171.89
2006	CO_2	11 474.62	11 475.56
2007	CO_2	13 729.51	13 730.45
2008	CO_2	12 354.02	12 355.23
2009	CO_2	10 347.77	10 348.78
2010	CO_2	13 776.18	13 777.18
2011	CO_2	14 415.37	14 101.62

2) In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG, Coke and Coal have been implemented. The implementation of these CEFs resulted in following recalculations in the CRF source-category 1.A.2 (Total Manufacturing Industries and Construction):

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
1990	CO_2	2 477.72	2 477.54
1991	CO_2	2 366.91	2 336.80
1992	CO_2	1 570.70	1 570.67
1993	CO_2	742.87	742.86
1994	CO_2	1 044.60	1 044.59
1995	CO_2	880.24	880.23
1996	CO_2	958.12	958.08
1997	CO_2	878.03	877.99
1998	CO_2	822.89	822.86
1999	CO_2	474.62	474.60
2000	CO_2	572.38	572.30
2001	CO_2	696.81	696.83
2002	CO_2	482.06	482.09
2003	CO_2	565.06	551.21
2004	CO_2	659.30	659.35
2005	CO_2	714.30	714.29
2006	CO_2	709.73	709.72
2007	CO_2	1 175.12	1 175.10
2008	CO_2	1 070.40	1 070.42
2009	CO_2	586.85	586.82

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
2010	CO_2	506.00	506.10
2011	CO_2	784.00	716.30

3) The CEF of Narva semi-coke gas in 2011 is corrected:

	CEF, tC/TJ	
	2013 submission	2014 submission
Narva semi-coke gas	16.43	18.70

4) The following activity data has been revised in the CRF source-category 1.A.2.f:

	Year	2013 submission	2014 submission
Oil Shale, TJ	2011	2 201	3 046

3.2.5.6. Source-specific planned improvements

There are no source-specific planned improvments planned.

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 2011, the financial results of Estonian transport Enterprises improved in 2012.

3.2.6.1. Source category description

In 2012, the greenhouse gas emissions from transport sector amounted to 2 278.97 Gg CO_2 equivalent. The share of the transport sector of the energy sector was 13.51% and of the total greenhouse gas emissions approximately 11.88% in 2012.

Emissions from Transport (CRF 1.A 3) include all domestic transport sectors (Table 3.20):

- 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 3.20. 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	Farm and forest tractors are included in CRF 1.A.4.c

CRF source category	Description	Remarks
	engines: passengers cars, vans, buses, lorries, motorcycles and mopeds.	Agriculture/Forestry/Fishery. Fuel consumption and emissions from military vehicles are included in 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. In 2012, the emissions stayed about the same level as in 2011 (increase of 0.86%).

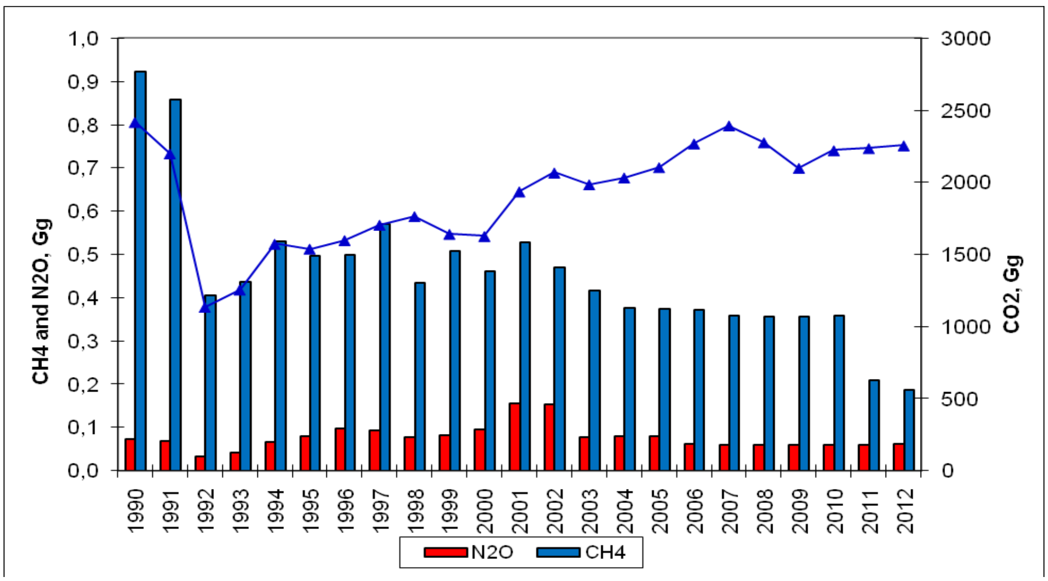


Figure 3.18. Emissions from transport sector by gas in 1990–2012, Gg CO_2 equivalent

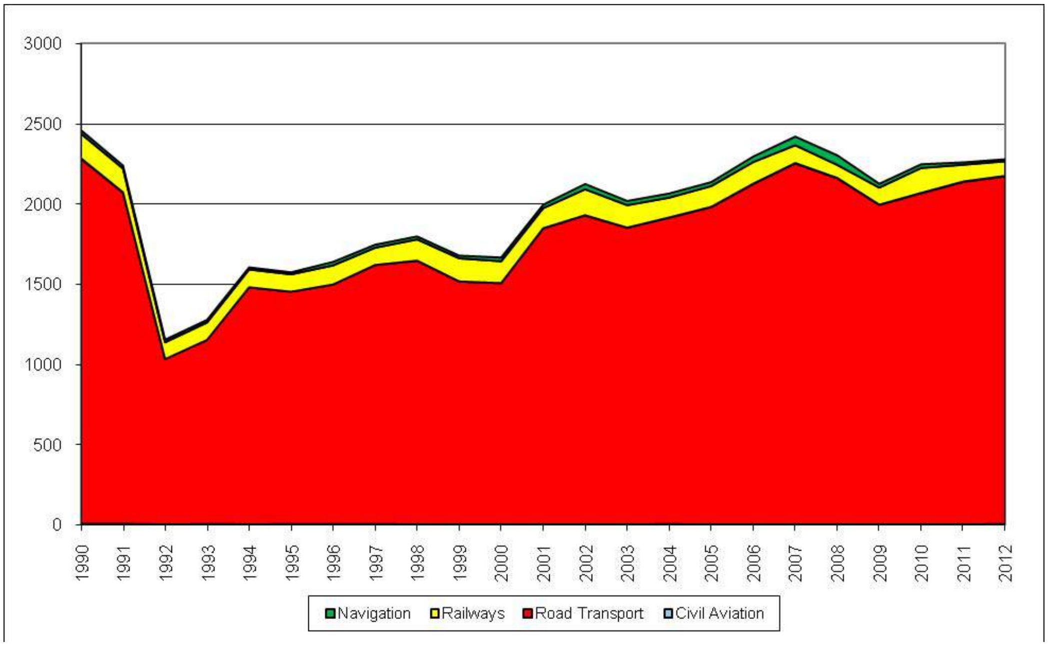


Figure 3.19. Emissions from transport by subcategory in 1990–2012, Gg CO_2 equivalent

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

Table 3.21. Emissions from the transport sector in 1990–2012 by sub-categories, (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.3 Transport Total, CO_2 eq	2 459.92	2 239.55	1 155.31	1 278.89	1 605.52	1 574.93	1 639.99	1 747.03	1 798.50	1 679.05	1 667.20
1.A.3.a Civil Aviation, CO_2	5.67	5.67	1.89	3.84	2.58	3.53	3.18	3.57	2.56	2.71	2.49
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	154.04	148.44	104.13	108.39	110.92	108.22	118.47	107.23	132.01	143.76	135.71
1.A.3.d Navigation, CO_2	21.80	18.69	15.57	15.72	12.46	12.32	21.87	18.86	18.49	16.65	23.18
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	2012
1.A.3 Transport Total, CO_2 eq	1 996.13	2 124.86	2 019.11	2 065.82	2 136.95	2 295.77	2 420.45	2 303.69	2 126.08	2 248.10	2 259.60	2 278.97
1.A.3.a Civil Aviation, CO_2	2.45	2.53	2.36	3.35	1.72	1.27	1.31	2.28	1.74	1.78	2.74	3.44
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	2 148.00
1.A.3.c Railways, CO_2	125.29	161.28	140.07	123.56	129.74	135.52	111.84	82.08	107.04	155.72	105.52	91.88
1.A.3.d Navigation, CO_2	21.82	32.94	25.92	25.97	24.94	34.01	54.17	59.75	23.56	23.38	14.71	12.67
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	0.19
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	0.06

Table 3.22. Fuel consumption in transportation sector in 1990–2012, 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	2012
1.A.3.a Civil Aviation												
Aviation Gasoline	33	34.49	32	44.88	23.68	17.38	17.93	30.904	23.693	24.258	37.453	46.913
1.A.3.b Road Transport												
Gasoline	14 148	12 981	12 438	11 995	12249	13 323	13 977	13 845	12 661	11745	11 144	10 691
Diesel Oil	10 697	12 726	12 488	13 797	14 795	15 974	17 091	15 843	14 612	16 302	17 868	18 842
LPG	9	18	11	8	8	4	2	5	4	5	6	5
1.A.3.c Railways												
Coal	8	1	NO	NO	NO	0	NO	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	1 255
1.A.3.d Domestic Navigation												
Diesel Oil	298	450	354	355	341	465	740	816	322	319	201	173

3.2.6.2. Civil Aviation

Similarly to 2011, a record number of passengers passed through airports in 2012. In 2012, the passenger traffic volume of Estonian airports was over 2.2 million persons, which is 15% more than in 2011. Nearly 2.2 million passengers were transported on international flights and over 53 800 passengers on domestic flights (13% less than in 2011). Compared to 2011, cargo and mail services through airports increased by 31% and 19% respectively, amounting to about 24 000 tonnes in total. Tallinn Airport was visited by 15% more passengers in 2012 than the year before.

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 3.21).

The share of the civil aviation from the transport sector was only 0.15% and the amount of emissions was 3.47 Gg of CO_2 equivalents in 2012. The corresponding figure was 5.73 Gg (CO_2 equivalent) in 1990. See the Figure 3.20 and Table 3.21.

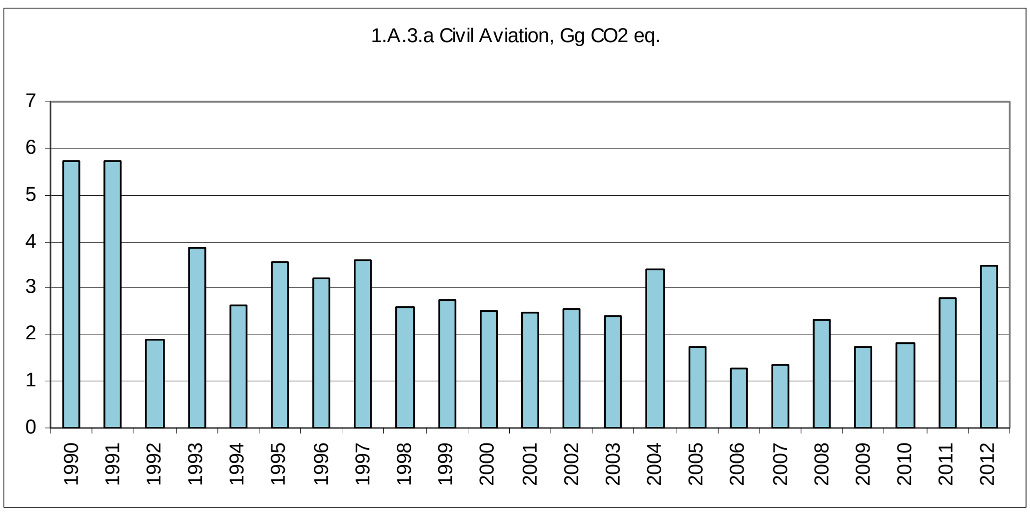


Figure 3.20. GHG emissions from civil aviation in 1990–2012, Gg CO_2 equivalent

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 3.22. 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 EtEA for the years 1992–2012. There has been done extrapolation for 1990 and 1991 (see Table 3.23).

Table 3.23. 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	2012
Domestic LTO	8 025	6 243	7 740	7 219	7 958	8 212	7 598	7 637	8 320	8692
International LTO	14 040	15 868	17 907	15 460	17 078	20 501	14 122	14 855	17 334	21811

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 3.24 is presented average emission factors for 2012 emission calculations.

Table 3.24. 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	3 150.0	0.5	0.1	6.0	103.3	5.1	0.9

**Table 3-3, p.18 (average fleet)*

Emission factors in kg per ton of aviation gasoline (Table 3.24) are converted to kg/TJ using net average calorific value of aviation gasoline (43 MJ/kg) (see Table 3.25).

Table 3.25. 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 2 170.53 Gg (CO_2 equivalent) in 2012, it is about 95.2% of total transport sector emissions, 12.86% of the Energy sector and 11.31% of the total Estonian GHG emissions. In 2012 the GHG emissions of the road transport sector were about 4.7% lower than in 1990 (2 277.62 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. Similarly, the emissions increased about 0.86% in 2012 compared to 2011.

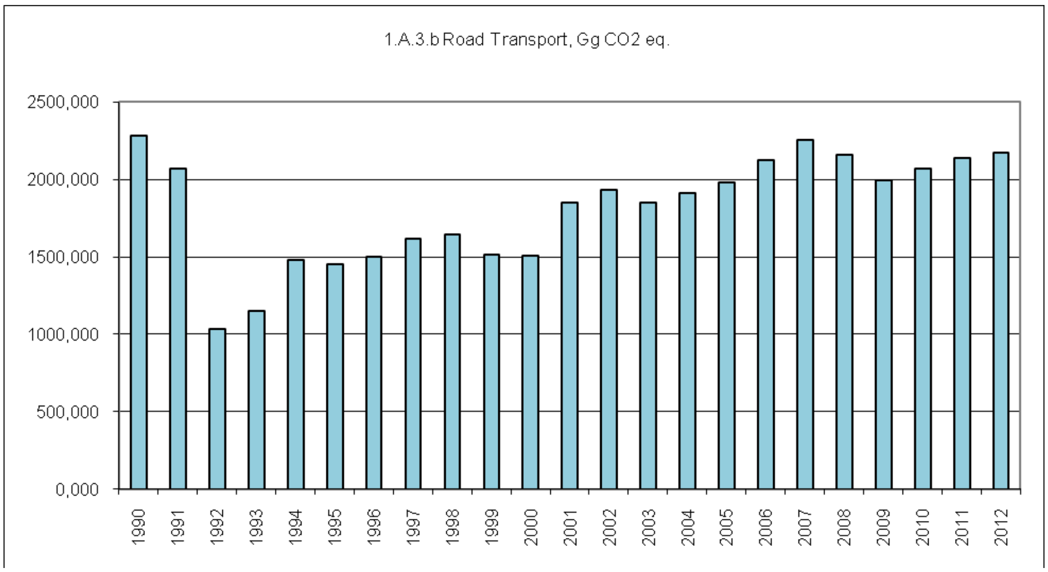


Figure 3.21. Emissions from the road transportation in 1990–2012, Gg CO_2 equivalent

Methods

Emission estimations from road transportation are made using the IPCC1996 Tier 2 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 2* 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[6]. 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.

[6] 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.

QA/QC on input data collection of COPERT model includes: vehicle data and annual mileage per vehicle are collected from the Estonian Road Administration. 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[7].

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 3.22. 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 Environmental Agency has concluded a contract to the Estonian Motor Vehicle Registration Centre.

In the Table 3.27 number of vehicles, in the Table 3.28 road traffic kilometrage and on the Figure 3.22 road traffic kilometrage per vehicle in 1990–2012 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 Agency. The biofuels consumption figures in PJ are reported in Table 3.22 and in tons in Table 3.26.

Table 3.26. Consumption of pure bioethanol and biodiesel in Estonia, 2005–2012

	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
2012	5.63	0

[7] *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 3.27. 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
2012	602	4	88	35	75	804

Source: Statistics Estonia.

Table 3.28. 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**

	Cars	Vans	Lorries	Buses	MC+Mopeds	Vehicles total
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**
2012	6 711	858	887	154	34	**8 644**

Source: Estonian Environmental Agency

The number of vehicles increased between 1991 and 1992 by 8.6% while the kilometers driven decreased by 52.8%. This increase in number of vehicles, but in the same time decrease in mileage is due to the fact, that Estonia regained its independence in 1991. Before that, only people with special permits could by a vehicle. In 1992, no permits were needed, therefore everyoune could by a vehicle. Still, there was a shortage of motor fuels and the prices were very high. Therefore there was a large decrease in the mileage of vehicles.

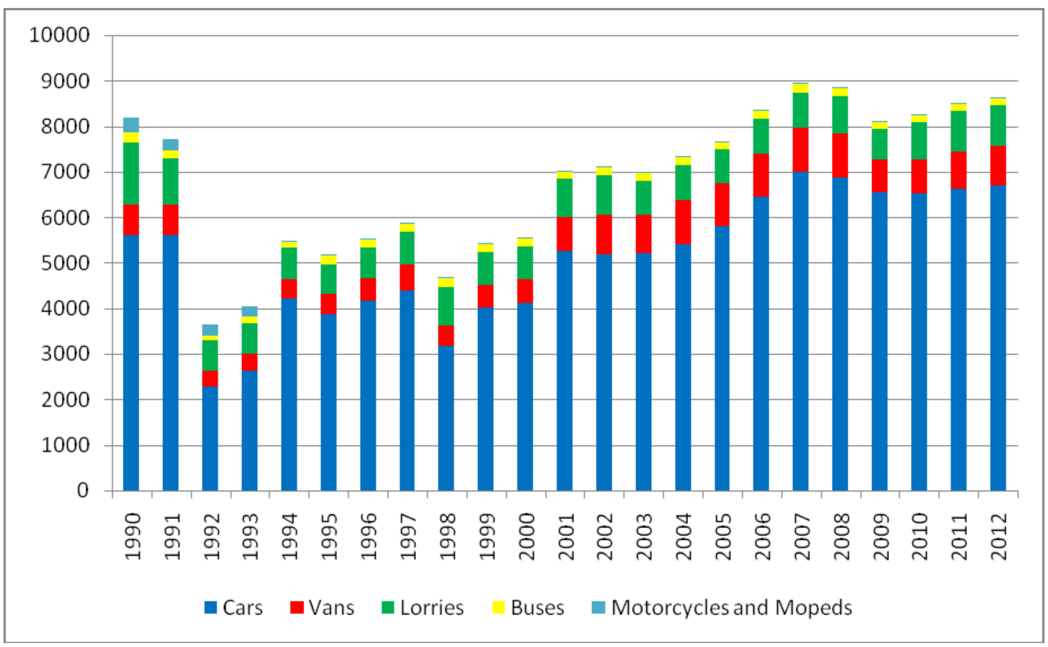


Figure 3.22. Road traffic kilometrage per vehicle in 1990–2012, Million km/y

Emission factors and other parameters

CO_2 emission factors of Gasoline, LPG and Diesel oil for road transportation are presented in Table 3.29. 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 3.29. 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
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**	**2012**
Gasoline	19.34	19.71	19.79	19.79	19.27	19.03	19.06	19.19	19.40	19.77	19.78	19.61
Diesel oil	19.97	19.96	19.97	19.95	19.95	19.94	19.94	19.95	19.91	19.89	19.92	19.96
LPG	17.03	17.06	17.10	17.05	17.03	17.03	17.04	17.29	17.30	17.30	17.21	17.29

The amounts of fuels imported in 2012 are presented in Table 3.30.

Table 3.30. Imported fuel amounts in 2012 by country

Gasoline (1000 l)		**Diesel (kg)**		**LPG (kg)**	
Belarus	94 669	**Belarus**	94 173 355	**Belarus**	101 980
Cuba	1 547	**Belgium**	4 830 660	**China**	66
Finland	180 488	**Denmark**	7 470	**European Union**	3 435 536
Germany	13 436	**European Union**	17 099 651	**Finland**	41
Great Britain	15 834	**Finland**	225 966 701	**France**	3 301
Italy	1 175	**Germany**	99 169	**Germany**	133 972
Lithuania	274 654	**Gibraltar**	12 900	**Great Britain**	2 676
Netherlands	1 169	**Italy**	100	**Greece**	31
Norway	10 455	**Latvia**	526 609	**Italy**	2 467
Poland	24 481	**Lithuania**	313 361 584	**Latvia**	940 134
Russia	20 051	**Norway**	1 196 082	**Lithuania**	2 651 353
Sweden	180 488	**Poland**	2 245 010	**Netherlands**	1 509
		Russia	17 473 858	**North Korea**	184
		Spain	415 000	**Norway**	150
		Sweden	11 705 347	**Russia**	9 983 377
		Switzerland	1 471	**South Korea**	416
		United States	39	**Spain**	85
				Sweden	7 715
				Turkey	337
				Undefined*	1 129 479

* For undefined countries, the CEF-s of European Union have been used.

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.

In 2011, compared to 2010, the CH_4 implied EF for diesel oil decreased from 5.01kg/TJ to 2.67kg/TJ. This decrease is related to the fact, that the increase on the number of newer EURO class vehicles was rather large (and in the same time, the decrease in number of old vehicles was also large).

3.2.6.4. Railway

There were 292 diesel locomotives, 23 electric railcars, 32 diesel railcars, 253 passenger wagons and 21 662 freight wagons registered in the Railway Traffic Register at the end of 2012.

Rail transport enterprises carried 44.7 million tonnes of goods, which was almost 8% less than in 2011. The amount of freight carried on public railways was 26.2 million tonnes. Refined oil products made up 15 million tonnes of this amount, but their transport fell by nearly a fifth in 2012.

Railway transportation in Estonia is a small emission source in transport sector. The emissions of railway transportation were 92.2 Gg of CO_2 equivalents in 2012. The share of GHG emissions from railway transport was about 4.0% of the total transport sector emissions. In 1990 the corresponding figure was 154.7 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.

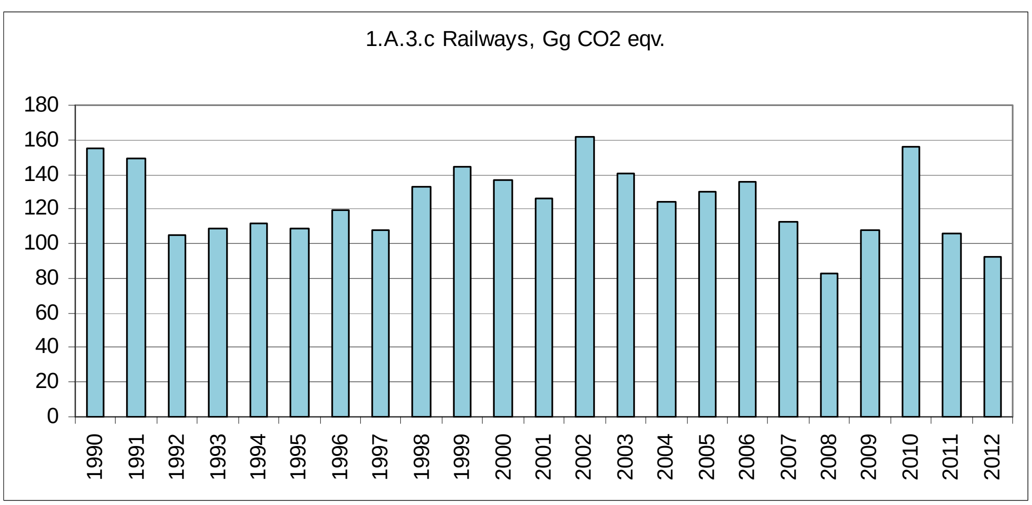


Figure 3.23. Emissions from the rail transportation in 1990–2012, Gg CO_2 equivalent

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. In 2012, almost 8% less goods was carried by rail transport enterprises then in 2011.

Methods

Emissions of railway transportation are calculated by multiplying the estimated fuel (diesel oil, coal) consumption with a country-specific emission factor (Tier 2).

Activity data

The activity data on fuel consumption used in railway transportation are obtained from the Statistics Estonia and presented in the Table 3.22.

Emission factors and other parameters

CO_2 emissions from railway transportation are calculated using the country-specific carbon emission factors of Coal and Diesel Oil. These emission factors are calculated using the weighted average method using CEFs of countries, that Estonia imports these fuels from. Emission factors of e 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 used EFs 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	Source
Diesel Oil	42.3	CO_2	19.97 tC/TJ	CS, EE
		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	27.14	CO_2	26.08 tC/TJ	CS, EE

Fuel	NCV average. GJ/t	GHG	EF	Source
		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 2012.

Domestic navigation in Estonia is also a small emission source in transport sector. The emissions of domestic navigation were 12.72 Gg of CO_2 equivalent in 2012 (0.56% of the total transport sector emissions). In 1990 the corresponding figure was 21.89 Gg CO_2 equivalent.

Emissions from deep sea fishing are not included in the reporting for national navigation.

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

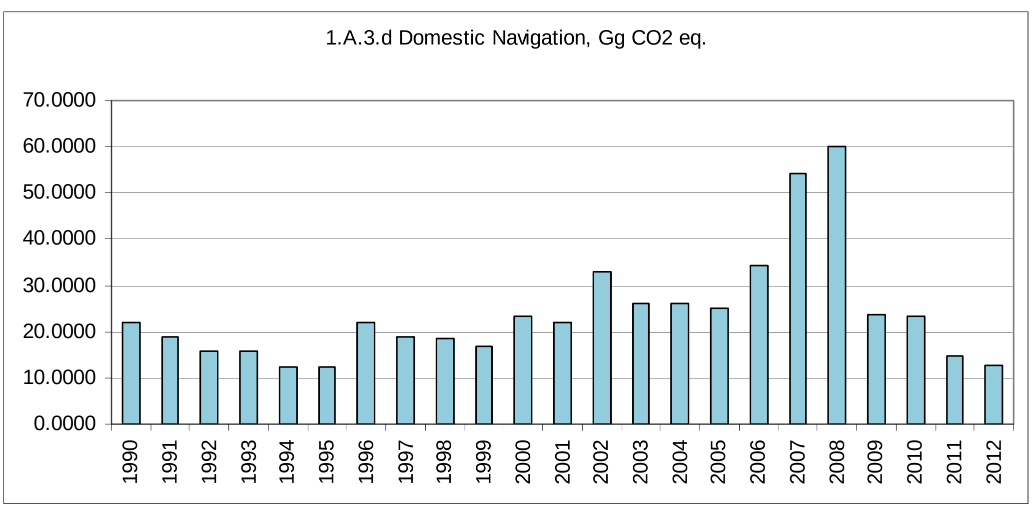


Figure 3.24. Emissions from the National Navigation in 1990–2012, Gg CO_2 equivalent

Methods

Emissions of domestic navigation are calculated by multiplying the estimated fuel (diesel oil) consumption with a country-specific emission factor (Tier 2).

Activity data

The activity data on fuel consumption used in domestic navigation are obtained from the Statistics Estonia and presented in the Table 3.22.

Emission factors and other parameters

CO_2 emissions from domestic navigation are calculated using the country-specific carbon emission factor Diesel Oil. This emission factor is calculated using the weighted average method using CEFs of countries, that Estonia imports this fuel from. 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**	**Source**
Diesel Oil	42.3	CO_2	19.97 tC/TJ	CS, EE
		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
		SO_2	141.2 kg/TJ	CS, EE

3.2.6.6. Source-specific recalculations

1) In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG and Coal have been implemented. The implementation of these CEFs resulted in following recalculations in the CRF source-category 1.A.3.c:

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
1990	CO_2	155.16	154.68
1991	CO_2	149.54	149.07
1992	CO_2	104.87	104.56
1993	CO_2	109.16	108.83

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
1994	CO_2	111.71	111.37
1995	CO_2	108.69	108.66
1996	CO_2	118.87	118.95
1997	CO_2	107.61	107.66
1998	CO_2	132.47	132.53
1999	CO_2	144.29	144.33
2000	CO_2	136.18	136.25
2001	CO_2	126.00	125.79
2002	CO_2	162.20	161.92
2003	CO_2	140.83	140.62
2004	CO_2	124.34	124.05
2005	CO_2	130.60	130.25
2006	CO_2	136.42	136.06
2007	CO_2	112.49	112.29
2008	CO_2	82.52	82.41
2009	CO_2	107.70	107.46
2010	CO_2	156.44	156.33
2011	CO_2	106.16	105.94

2) In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG and Coal have been implemented. The implementation of these CEFs resulted in following recalculations in the CRF source-category 1.A.3.d:

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
1990	CO_2	21.95	21.89
1991	CO_2	18.82	18.76
1992	CO_2	15.68	15.63
1993	CO_2	15.83	15.78
1994	CO_2	12.54	12.51
1995	CO_2	12.37	12.37
1996	CO_2	21.94	21.96
1997	CO_2	18.92	18.93
1998	CO_2	18.55	18.56
1999	CO_2	16.71	16.72
2000	CO_2	23.26	23.27
2001	CO_2	21.94	21.9
2002	CO_2	33.13	33.07
2003	CO_2	26.06	26.02
2004	CO_2	26.13	26.07
2005	CO_2	25.10	25.04

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
2006	CO_2	34.24	34.15
2007	CO_2	54.48	54.38
2008	CO_2	60.07	59.99
2009	CO_2	24.70	23.65
2010	CO_2	23.48	23.47
2011	CO_2	14.80	14.77

3) In current submission, the CO_2 emission factor of LTO cycles was corrected in the CRF source-category 1.A.3.a Civil Aviation

	CO2 EF, t/TJ	
	2013 submission	2014 submission
Aviation Gasoline	74.8	73.3

3.2.6.7. Source-specific planned improvements

There are currently no source-specific improvements planned.

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 2012, emissions of the CRF sub-category CRF 1.A.4 Other Sectors were 641.3 Gg in CO_2 equivalent, it is about 3.8% of the energy sector’s emissions and 3.34% of total GHG emissions in Estonia. Corresponding emissions were 2 000.8 Gg CO_2 equivalent in 1990 (see Figure 3.25 and Table 3.33).

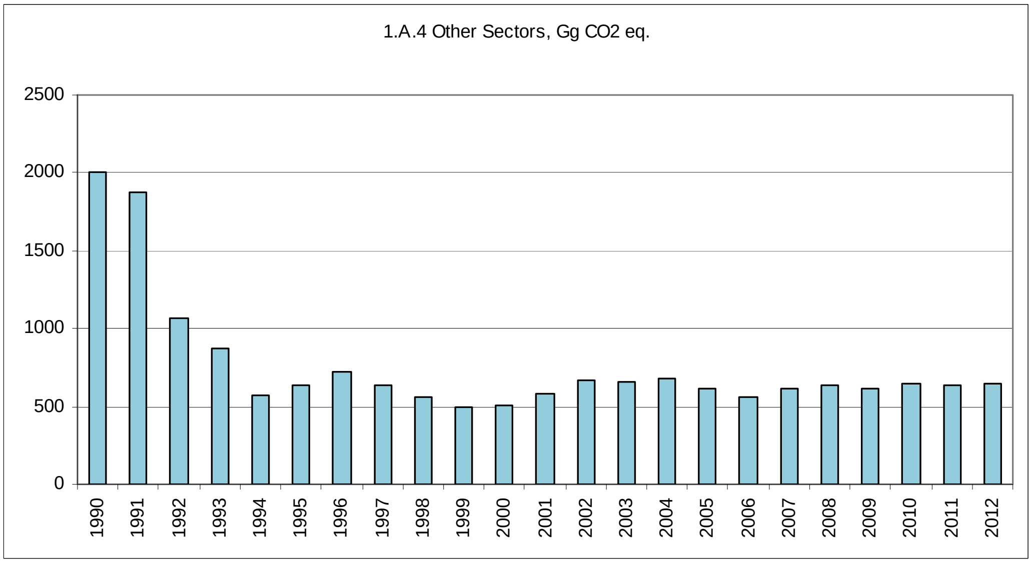


Figure 3.25. Trend of GHG **e**missions in the CRF category 1.A.4 Other Sectors, Gg CO_2 eq

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.

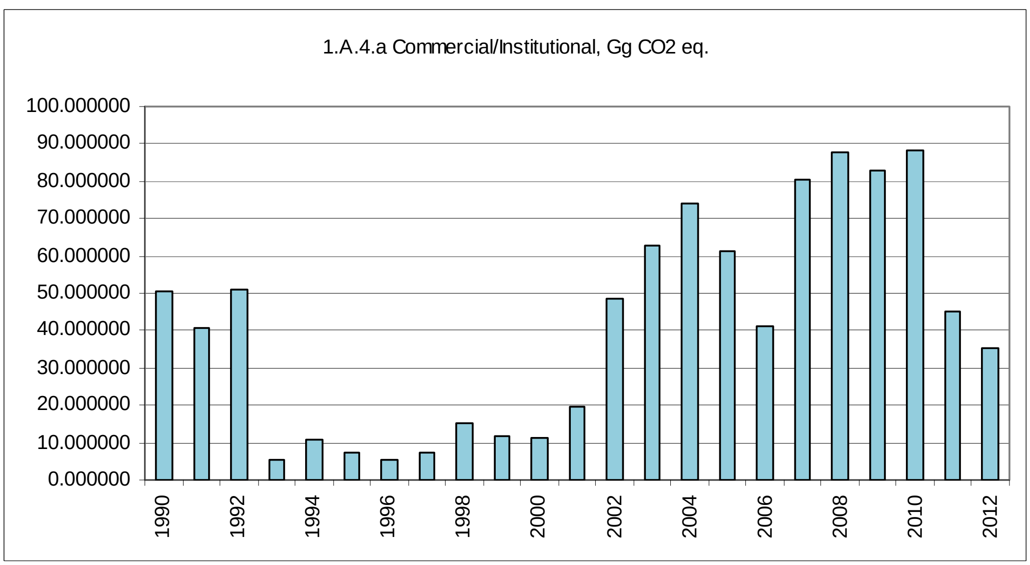


Figure 3.26. Trend of GHG emissions in the CRF category 1.A.4.a Commercial/Institutional, Gg CO_2 eq

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. Similarly in 2012, the emissions decreased about 22% compared to 2011 due to decreased consumption of natural gas.

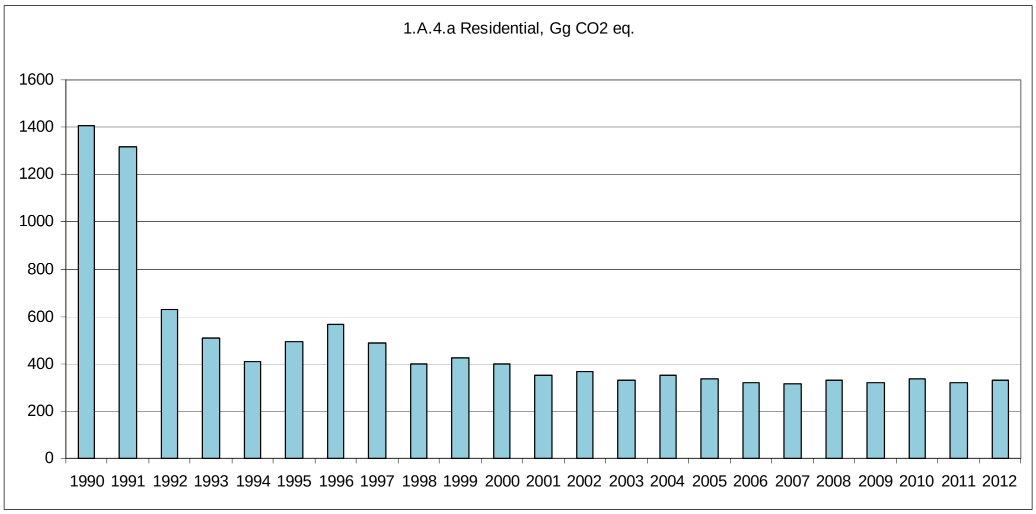


Figure 3.27. Trends of GHG emissions in the CRF categories 1.A.4.b Residential, Gg CO_2 eq

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).

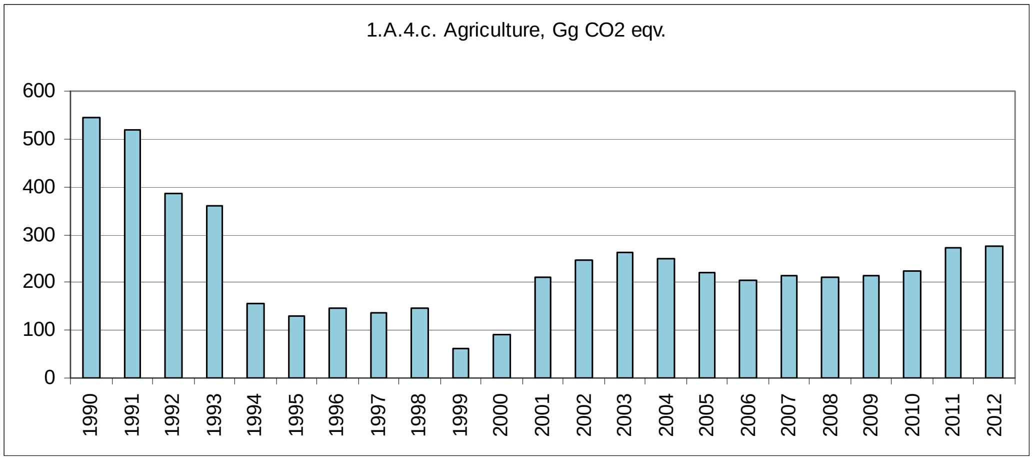


Figure 3.28. Trends of GHG emissions in the CRF categories 1.A.4.c Agriculture, Gg CO_2 eq

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. In 2012, the emissions stayed abuot the same level as in 2011.

The values of CO_2 IEFs of liquid fuels in the Other Sector are between 72.42 t/TJ (in 1997) and 73.40 t/TJ (in 1993) and the values of CO_2 IEF of solid fuels are between 94.58 t/TJ (in 1995) and 96.03 t/TJ (in 2008). 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 23.03 Gg CO_2 equivalent in 2012, it is about 0.14% of the energy sector's emissions and 0.12% of total GHG emissions in Estonia. Corresponding emissions were 44.25 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 IPCC 1996 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.A.4 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.

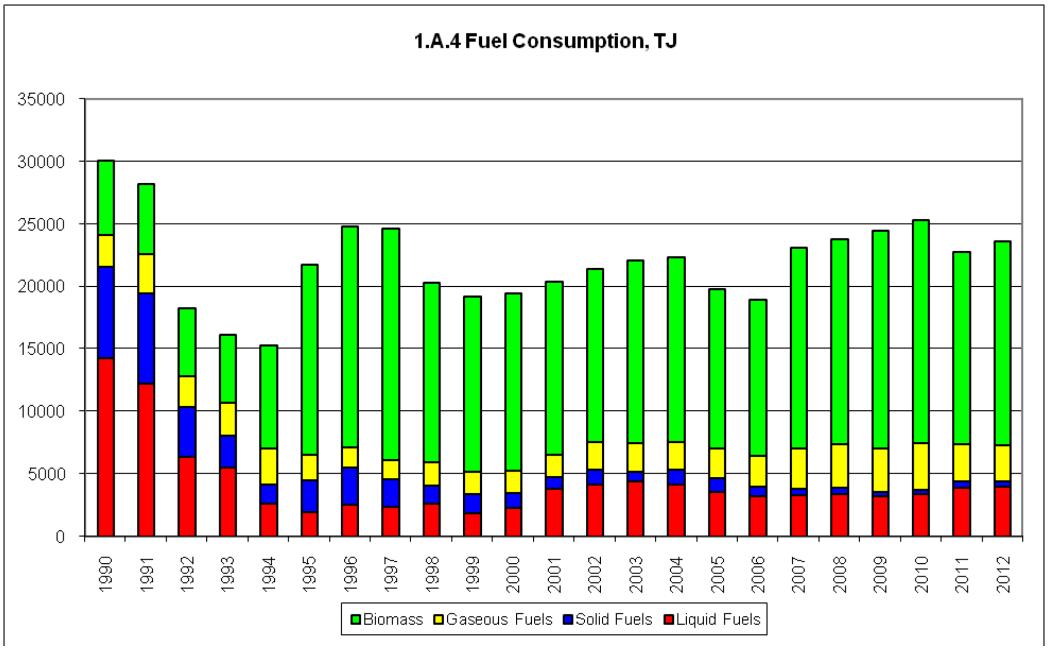


Figure 3.29. Fuel Consumption in the CRF category 1.A.4 Other Sectors, PJ

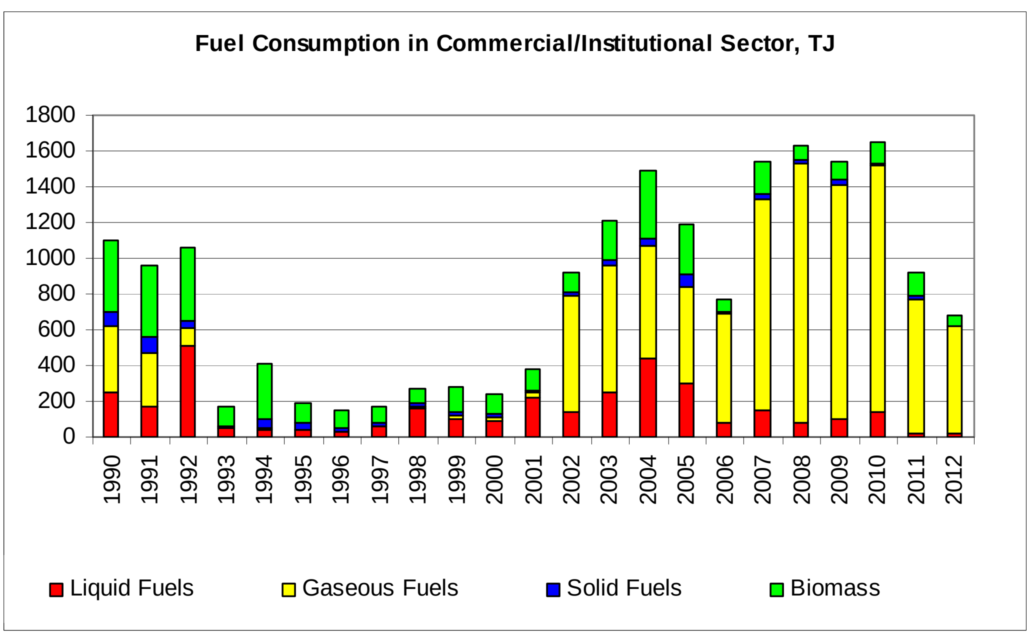


Figure 3.30. Fuel consumption by main fuel groups in Commercial/Institutional sector, PJ

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).

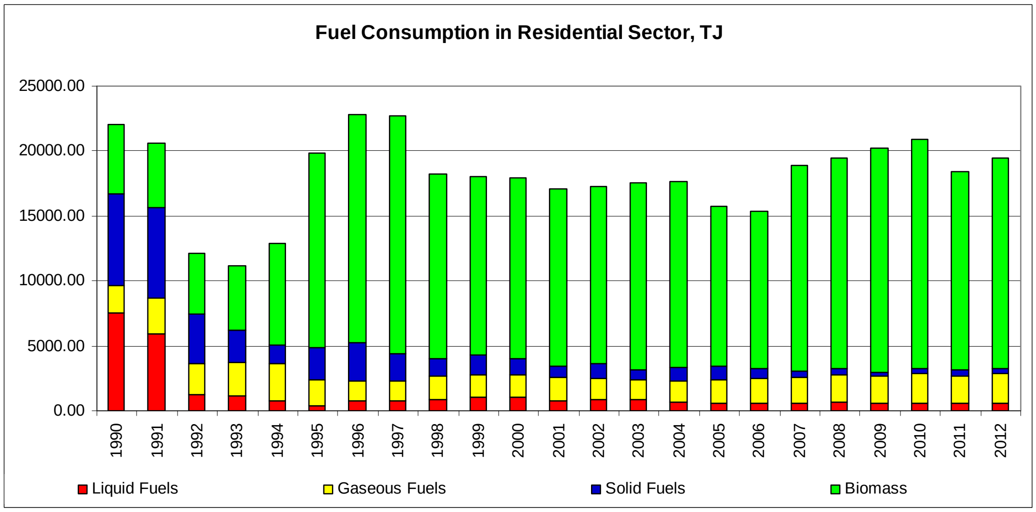


Figure 3.31. Fuel consumption by main fuel groups in Residential sector, PJ

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 compared to 2010. In 2012, the use of biomass in residential sector increased about 6.2% compared to the previous year.

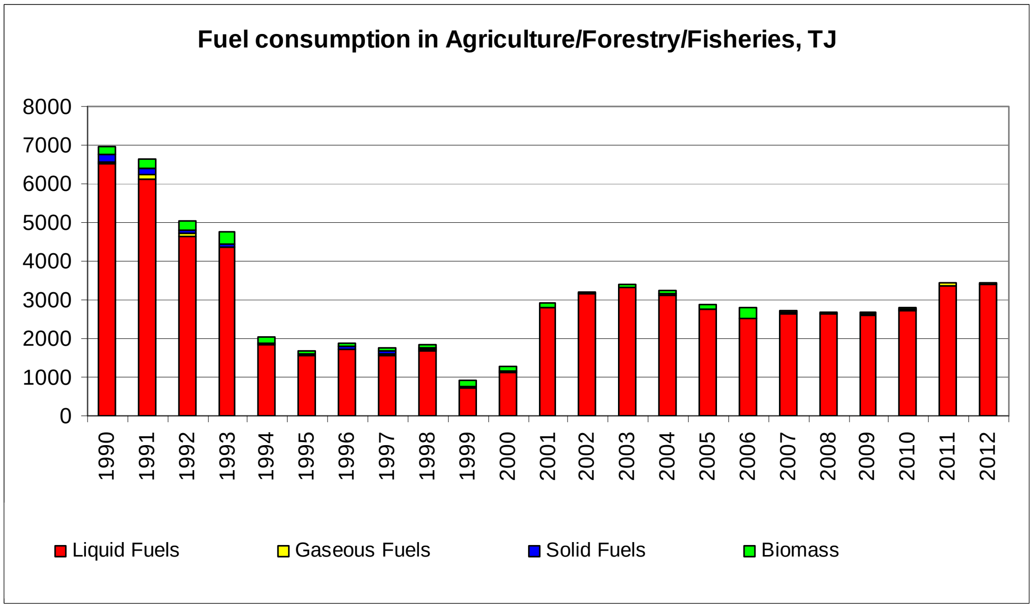


Figure 3.32. Fuel consumption by main fuel groups in Agriculture/Forestry/Fisheries, TJ

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. In 2012, the GHG emissions stayed at the same level as in 2011.

Table 3.33. Emissions from Other Sectors (incl. Commercial/Institutional, Residential and Agriculture) in 1990–2012, (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.4 Other Sectors Total, CO_2 eq	2 000.83	1 875.71	1 067.18	871.06	574.96	631.45	717.22	633.84	560.01	499.49	503.07
1.A.4.a Commercial/Institutional, CO_2 eq	50.61	40.88	50.81	5.41	10.85	7.39	5.40	7.25	15.33	11.82	11.17
1.A.4.b Residential	1 406.02	1 314.71	629.33	507.07	408.50	494.47	564.90	489.74	400.22	426.38	401.11
1.A.4.c Agriculture/Forestry/ Fisheries, CO_2 eq	544.20	520.12	387.05	358.58	155.61	129.58	146.92	136.85	144.46	61.28	90.79

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1.A.4 Other Sectors Total, CO_2 eq	582.39	663.47	656.39	678.29	617.65	564.12	612.46	632.84	614.24	646.58	640.36	641.28
1.A.4.a Commercial/Institutional, CO_2 eq	19.71	48.75	62.88	73.95	61.11	40.99	80.27	87.72	82.68	88.04	45.23	35.18
1.A.4.b Residential	350.54	368.32	330.13	354.05	336.01	319.57	316.86	333.05	318.69	335.41	321.55	330.07
1.A.4.c Agriculture/Forestry/ Fisheries, CO_2 eq	212.13	246.40	263.38	250.29	220.53	203.56	215.33	212.07	212.87	223.12	273.59	276.03

Table 3.34. Emissions from CRF 1.A.5 Other in 1990–2012, (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.5 Other Total, CO_2 eq	44.25	54.22	34.75	10.99	11.16	29.31	16.57	13.94	17.52	17.51	17.18

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1.A.5 Other Total, CO_2 eq	18.84	14.95	19.32	28.21	35.37	32.13	31.11	10.95	29.60	41.56	20.14	23.03

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	2012
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	23 607
Liquid Fuels	3 793	4 213	4 408	4 204	3 606	3 212	3 350	3 389	3 273	3 390	3 958	3 981
Solid Fuels	953	1 108	803	1 134	1 050	780	502	498	342	372	478	409
Gaseous Fuels	1 780	2 262	2 233	2 260	2 434	2 516	3 232	3 528	3 442	3 722	2 955	2 926
Biomass	13 895	13 826	14 680	14 786	12 736	12 474	16 062	16 371	17 379	17 853	15 413	16 291

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

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1.A.5 Liquid Fuels	253	201	259	379	475	432	418	147	398	557	270	309

Emission Factors

Both, IPCC default and national (country specific) emission factors are used.

For LPG, Light Fuel Oil, Diesel Oil, Gasoline, Residual Fuel Oil and Coal Estonia uses the country-specific weighted average CEFs.

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 3.38). 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. Country-specific carbon emission factors used in the calculation of emissions from 1.A.4

Fuel	**CEF, tC/TJ**
Coal	26.08
Light Fuel Oil	20.21
Residual Fuel Oil	21.18
LPG	17.59
Shale Oil (Heavy Fraction)	21.1
Shale Oil (Light Fraction)	20.2

Table 3.38. Emission factors of small combustion of fuels, kg/TJ

	CH_4	**N_2O**	**NOx**	**CO**	**NMVOC**	**Source[8]**
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

[8] 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.

	CH_4	N_2O	NOx	CO	NMVOC	Source[8]
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 3.39 emission factors of motor fuels used for off-road transportation and fishing and leasure boats are presented.

Table 3.39. 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 - 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 3.40 emission factors of motor fuels used in military are presented.

Table 3.40. 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 current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG and Coal have been implemented. The implementation of these CEFs resulted in following recalculations in the CRF source-category 1.A.4.a:

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
1990	CO_2	47.15	47.37

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
1991	CO_2	37.62	37.70
1992	CO_2	47.14	47.48
1993	CO_2	4.51	4.55
1994	CO_2	8.35	8.40
1995	CO_2	6.38	6.44
1996	CO_2	4.57	4.60
1997	CO_2	6.49	6.55
1998	CO_2	14.43	14.60
1999	CO_2	10.60	10.68
2000	CO_2	10.21	10.28
2001	CO_2	18.53	18.71
2002	CO_2	47.61	47.73
2003	CO_2	60.81	60.99
2004	CO_2	70.50	70.79
2005	CO_2	58.49	58.81
2006	CO_2	40.20	40.28
2007	CO_2	78.58	78.73
2008	CO_2	86.78	86.88
2009	CO_2	81.50	81.62
2010	CO_2	86.77	86.91
2011	CO_2	44.13	44.15

2) In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG and Coal have been implemented. The implementation of these CEFs resulted in following recalculations in the CRF source-category 1.A.4.b:

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
1990	CO_2	1 335.33	1 328.04
1991	CO_2	1 244.33	1 238.90
1992	CO_2	578.33	577.72
1993	CO_2	460.82	459.71
1994	CO_2	344.52	344.35
1995	CO_2	371.26	371.53
1996	CO_2	418.77	419.21
1997	CO_2	339.40	339.75
1998	CO_2	283.98	284.45
1999	CO_2	312.62	313.15
2000	CO_2	287.57	288.18
2001	CO_2	240.10	240.66
2002	CO_2	256.79	257.09

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
2003	CO_2	215.33	215.80
2004	CO_2	237.57	237.61
2005	CO_2	235.47	235.49
2006	CO_2	221.86	221.99
2007	CO_2	193.27	193.51
2008	CO_2	205.92	206.78
2009	CO_2	185.54	185.90
2010	CO_2	198.46	198.73
2011	CO_2	202.45	202.60

3) In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG and Coal have been implemented. The implementation of these CEFs resulted in following recalculations in the CRF source-category 1.A.4.c:

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
1990	CO_2	495.62	1328.04
1991	CO_2	472.24	1238.90
1992	CO_2	351.39	577.72
1993	CO_2	327.05	459.71
1994	CO_2	140.23	344.35
1995	CO_2	116.94	371.53
1996	CO_2	133.19	419.21
1997	CO_2	123.61	339.75
1998	CO_2	131.27	284.45
1999	CO_2	55.14	313.15
2000	CO_2	84.37	288.18
2001	CO_2	206.63	240.66
2002	CO_2	234.40	257.09
2003	CO_2	245.17	215.80
2004	CO_2	231.62	237.61
2005	CO_2	203.38	235.49
2006	CO_2	184.74	221.99
2007	CO_2	197.20	193.51
2008	CO_2	195.04	206.78
2009	CO_2	192.20	185.90
2010	CO_2	201.10	198.73
2011	CO_2	249.54	202.60

4) In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG and Coal have been implemented. The implementation of these CEFs resulted in following recalculations in the crf source-category 1.A.5:

Year	GHG	Emissions in 2013 submission, Gg	Emissions in 2014 submission, Gg
1990	CO_2	43.54	43.44
1991	CO_2	53.37	53.23
1992	CO_2	34.24	34.15
1993	CO_2	10.81	10.78
1994	CO_2	10.99	10.96
1995	CO_2	28.79	28.79
1996	CO_2	16.26	16.28
1997	CO_2	13.69	13.70
1998	CO_2	17.20	17.21
1999	CO_2	17.19	17.20
2000	CO_2	16.87	16.88
2001	CO_2	18.52	18.50
2002	CO_2	14.68	14.66
2003	CO_2	18.99	18.97
2004	CO_2	27.76	27.70
2005	CO_2	34.84	34.75
2006	CO_2	31.65	31.57
2007	CO_2	30.62	30.57
2008	CO_2	10.78	10.76
2009	CO_2	29.13	29.07
2010	CO_2	40.87	40.84
2011	CO_2	19.82	19.79

3.2.7.4. Source-specific planned improvements

There are no source-specific planned improvments planned.

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 1990–2012 are presented in Table 3.41. 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 3.41. Oil shale production in Estonia, million tons

Year	Mt	Year	Mt	Year	Mt
1990	22.49	**2001**	9.89	**2012**	18.80
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: Statistics Estonia

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 2012, fugitive emissions from oil and natural gas were 3.65 Gg CH_4 (76.57 Gg CO_2 eq.). It is about 0.45% of the energy sector's emissions and 0.40% of total GHG emissions in Estonia. Corresponding emissions were 177.54 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:

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

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 3.42).

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 3.42. CH_4 emission factors for fugitive emissions from gas activities

	Emission Factor	Unit	Source
GAS			
Distribution of natural gas	165 016	kg CH_4/PJ	CS, FI (Finland)

3.3.2.3. Quantitative overview

In the Table 3.43 CH_4 emissions from oil and gas activities are presented.

Table 3.43. 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.B Natural Gas**	1.B.2.B.4 Distribution
	Gg CO_2 eq	Gg CH_4	Gg CH_4	Gg CH_4
1990	**177.54**	**8.45**	**8.45**	8.45
1991	**178.05**	**8.48**	**8.48**	8.48
1992	**104.01**	**4.95**	**4.95**	4.95
1993	**51.61**	**2.46**	**2.46**	2.46
1994	**74.11**	**3.53**	**3.53**	3.53
1995	**84.51**	**4.02**	**4.02**	4.02
1996	**93.20**	**4.44**	**4.44**	4.44
1997	**90.56**	**4.31**	**4.31**	4.31
1998	**85.95**	**4.09**	**4.09**	4.09
1999	**83.67**	**3.98**	**3.98**	3.98
2000	**96.19**	**4.58**	**4.58**	4.58
2001	**103.28**	**4.92**	**4.92**	4.92
2002	**86.51**	**4.12**	**4.12**	4.12
2003	**95.33**	**4.54**	**4.54**	4.54
2004	**112.48**	**5.36**	**5.36**	5.36
2005	**116.02**	**5.52**	**5.52**	5.52
2006	**117.46**	**5.59**	**5.59**	5.59
2007	**116.83**	**5.56**	**5.56**	5.56
2008	**111.97**	**5.33**	**5.33**	5.33
2009	**76.04**	**3.62**	**3.62**	3.62
2010	**81.62**	**3.89**	**3.89**	3.89
2011	**73.59**	**3.50**	**3.50**	3.50
2012	**76.57**	**3.65**	**3.65**	3.65

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

1) The CH4 emissions from CRF source-categories 1.B.2.a.3 Oil Transport and 1.B.2.a.4 Oil Refining/Storage have been changed to “NO” according to the ERT recommendation.

3.3.2.6. Source-specific planned improvements.

A project was implemented to develop country-specific CH_4 EF for natural gas distribution in Estonia. Data was received from AS Eesti Gaas, that in 2010, the total fugitive emissions from natural gas distribution was 0.629 Gg CH_4 and in 2011 – 2.679 Gg CH_4. Unfortunately, no data for the years 1990–2009 is available. According to the ERT recommendation in 2013, Estonia will collect data for more years, to use actual data for developing CH4 emissions for the period 1990–2009 (as often these emissions are related to maintenance work, accidents, etc.).

4. INDUSTRIAL PROCESSES (CRF 2)

4.1. Overview of the sector

4.1.1. Description and quantitative overview

Estonia's emissions from the industrial processes sector 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, emissions from cement, lime, glass, bricks and tiles production as well as those from lightweight gravel production and soda ash use are reported. 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.

In 2012 the industrial processes sector contributed 3.45% of all GHG emissions in Estonia (Figure 4.1), totalling 662.58 Gg CO_2 equivalent. The most significant emission sources were CO_2 from cement production and lime production at 2.12% and 0.25% respectively, and HFC emissions from refrigeration and air-conditioning equipment at 0.82% of total GHG emissions. F-gas emissions as a whole comprised 0.88% of total GHG emissions.

Industrial CO_2 emissions have fluctuated strongly since 1990 (Figure 4.2 and Table 4.1) reaching their lowest level in 1993. The decrease in emissions during the early 1990s was caused by the transition from a planned economy to a market economy after 1991 when Estonia regained its independence. This led to lower 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. The decrease in emissions in 2002 and 2003 was caused by the reduction in ammonia production, as the only ammonia factory in the country was being reconstructed. The sudden increase in emissions in 2007 was mainly caused by an increase in cement production, as the only cement factory renovated its third kiln. In 2009 the industrial processes sector was affected by the recession. Decline in production was mainly due to insufficient demand on both the domestic and external markets. Increase in 2011 emissions was caused by increase of cement production. Compared to 2011, the emissions from industrial processes increased by 7.88% in 2012.

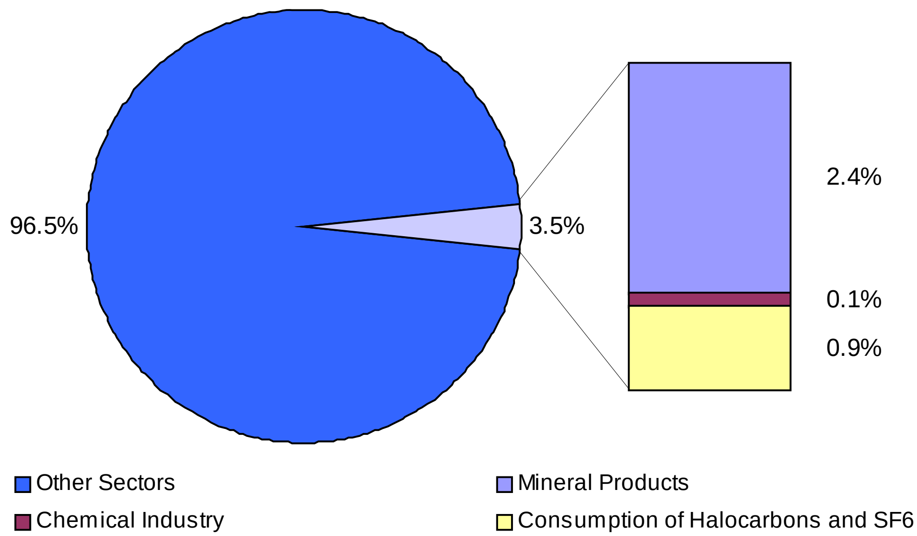


Figure 4.1. Emissions from industrial processes compared with total emissions in 2012

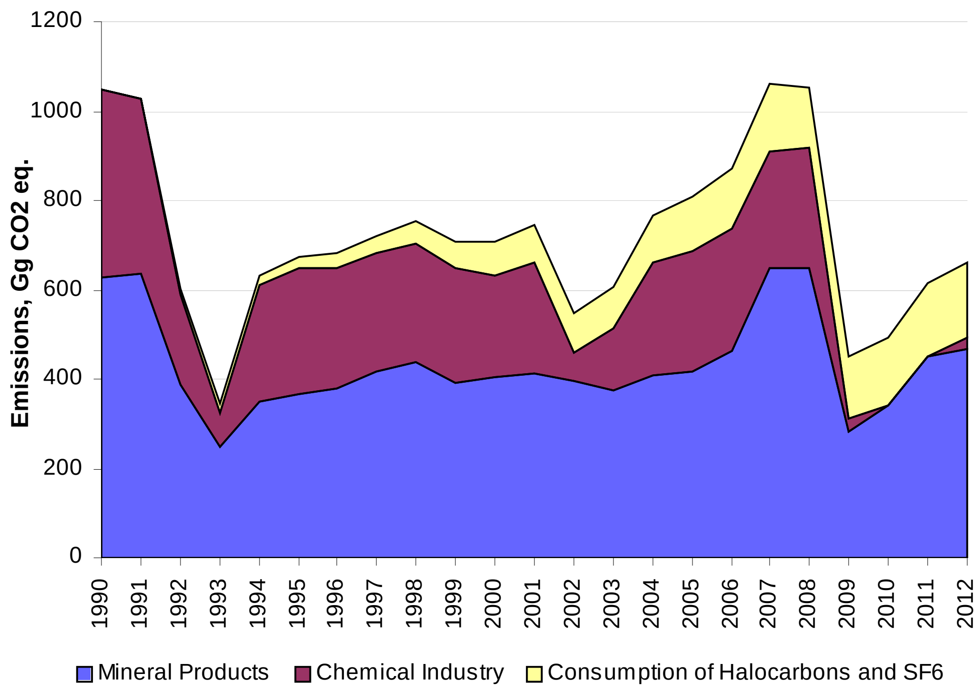


Figure 4.2. Emissions from industrial processes in Estonia in 1990–2012 (Gg CO_2 equivalent)

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	2012
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	468
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	25
HFCs	NO	NO	16	18	21	25	31	36	46	56	70	85	87	92	105	118	135	149	131	138	153	160	167
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	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	1.85	1.96
Total	**1 048**	**1 027**	**603**	**345**	**633**	**676**	**683**	**720**	**754**	**708**	**706**	**746**	**545**	**605**	**765**	**807**	**872**	**1 059**	**1 051**	**451**	**494**	**614**	**663**

Key categories

Key categories in industrial processes in 2012 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 2012 (without LULUCF)

IPCC code	IPCC source category	Gas	Identification criteria
2.A.1	Cement Production	CO_2	Trend
2.B.1	Ammonia Production	CO_2	Trend
2.F.1.2	Commercial Refrigeration	HFCs	Trend

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), reaching their lowest level 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 emissions during the early 1990s was caused by the transition from a planned economy to a market economy after 1991 when Estonia regained its independence. This led to lower 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. The sudden increase in emissions in 2007–2008 was caused by an increase in cement production (in 2007 Kunda Nordic Cement AS renovated third kiln). In 2009 the mineral products sector was affected by the recession. Decline in production was mainly due to insufficient demand on both the domestic and external markets. The increase in emissions in 2010 and 2011 was caused by increase in 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	2012
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	407
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	49
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	0.25
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	9.5
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	2.4
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	NO
Total	**628**	**636**	**387**	**246**	**350**	**367**	**380**	**416**	**438**	**391**	**402**	**411**	**394**	**376**	**408**	**416**	**463**	**649**	**648**	**282**	**339**	**453**	**468**

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:

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

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 4.4).

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 2007–2012. Data on clinker production as well as CKD correction factors between 1990–2012 are presented in Table 4.4.

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 2012 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 4.4) 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 (1997–2012). 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% (2005–2012).

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.

4.2.3.5. Source-specific recalculations

No source-specific recalculations have been done.

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 Agency.

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 1990–2012.

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 (1993–2012) 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 4.4).

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 develop country-specific EFs for Glass Production for future submissions as the encouragement of the UNFCCC review team.

Table 4.4. 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	2012
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	715
$EF_{clinker}$, 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	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	1.039
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	71.8
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	0.68
2.A.4.2																							
Soda ash use, kt	0.74	0.61	0.32	0.22	0.63	0.61	0.68	1.41	2.47	2.15	2.70	2.33	2.26	0.99	1.33	0.89	1.58	1.13	0.67	0.32	0.35	1.25	0.60
$EF_{default}$, t/t	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	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	73.9
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	10.40
$EF_{default}$, 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	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	11.95
$EF_{default}$, 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	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	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	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 4.5). Data on the amount of clay used in bricks production was directly collected from the plants from 1992 to 2012. 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 1992–2012 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 4.5).

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 2009–2012, 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 4.5). 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 4.5).

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 4.5. 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	2012
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	4.64
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	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	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	0.82
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	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	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	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	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 4.6). In Estonia there is only one ammonia production company – Nitrofert AS.

CO_2 emissions from ammonia production have decreased considerably since 1990, reaching their lowest levels in 1993, 2002 and 2009. The decrease in emissions during the early 1990s was caused by the transition from a planned economy to a market economy after 1991 when Estonia regained its independence. This led to lower 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. Nitrofert AS started to produce ammonia again at the beginning of December 2012.

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:

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

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 4.6).

Activity data

The annual ammonia production figures 1990–2012 have been obtained from the production plants and presented in Table 4.6.

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 4.6. Activity data, emission factors and CO_2 emissions from ammonia production in 1990–2012

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
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	17
$EF_{ammonia}$, 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	1.44
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	25
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	6.73
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	0.05

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 1995–2012 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 year 2011. The recalculation in 2011 emission was 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 2012, greenhouse gas emissions under the category CRF 2.F emissions of Consumption of Halocarbons and SF_6 amounted to 169.32 Gg CO_2 equivalent, which is about 0.88% 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 4.7 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 two 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 4.7. Actual emissions of HFCs, PFCs and SF_6, 1990–2012 (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	2012
HFCs	NO	NO	16	18	21	25	31	36	46	56	70	85	87	92	105	118	135	149	131	138	153	160	167
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	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	1.85	1.96
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**	**119.40**	**136.70**	**150.18**	**132.87**	**139.75**	**154.85**	**161.58**	**169.32**

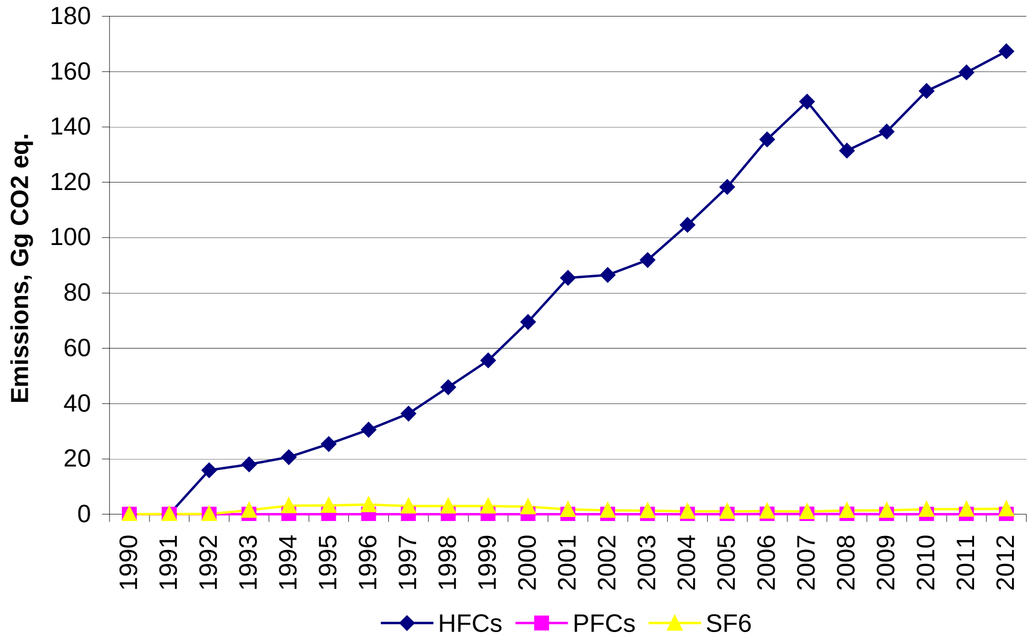


Figure 4.3. Actual emissions of HFCs, PFCs and SF_6, 1990–2012 (Gg CO_2 equivalent)

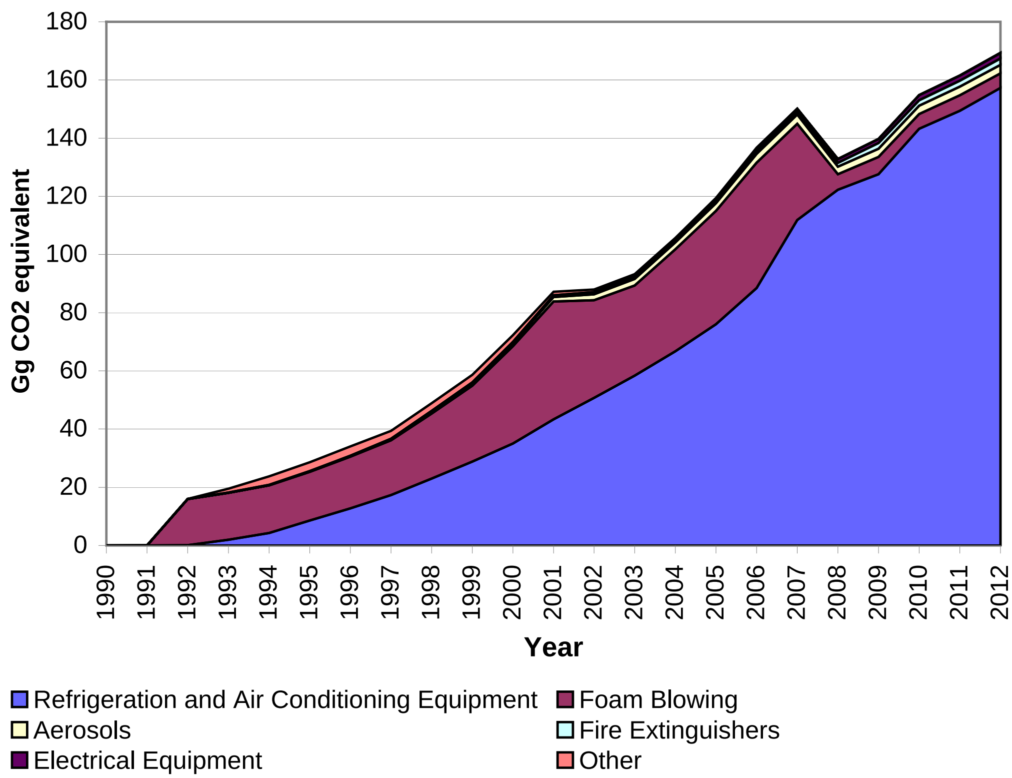


Figure 4.4. Actual emissions of F-gases by subcategory, 1990–2012 (Gg CO_2 equivalent)

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[9].

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 92.87% of the Estonian F-gas emissions (157.25 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).

[9] 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 R-134a is used as refrigerant and as foam insulating gas. R-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 R-134a in 2012. The share of R-134a in the Estonian stock of fridges/freezers is estimated 12.5% (without new equipment in 2007–2012).

4.5.1.1.2. Methodological issues

In 2012 Estonia had – according to the statistical office – about 597 300 households. The number of domestic refrigerators is estimated at 591 924 and the number of newly imported fridges/freezers in 2012 is estimated at 57 661 (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 31 714 (12.5% without new equipment in 2007–2012) à 150 g HFC-134a refrigerant, in total 4 757 kg HFC-134a. In newly imported/bought systems in 2007–2009 – total 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 2012, 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 35 618 from which 12 095 are collected by the recycling companies and sent for treatment to foreign countries; remaining 23 523 are disposed without refrigerant recovery. According to EES Ringlus experts estimates, this number in reality is not as high and could be maximum 13 600 units. If we assume (i) that 5% of these 13 600 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 95.88 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 2012 amount of R-134a emissions is 0.12 tons (stock emissions: 20.06 kg, end-of-life emissions: 95.88 kg) representing 0.151 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, on average 350 g/device); HFC-refrigerants: 55% R-404A, 39% R-134a and 6% other refrigerants (R-422A, R-422D, R-437A and R-401A).
- 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 90.5% of the 2012 HFC stock (mostly used in supermarket systems) and R-134a (about 8.7%, 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 2012 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. 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 2012, refilling data) on the HFC refrigerant consumption of their clients in the supermarket sector. The 2012 stock data compilation from the service companies (69.3 tons HFC) had to be completed in two cases by the assessment of the stock (additional 3.8 tons or 5.1% of the sum of 73.0 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 80.347 tons of HFC for the 2012 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 (690 kg) resulting in a total stock of 7.585 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 three devices with refrigerant charge 350 g/device resulting in about 4.2 tons HFC-refrigerant. The percentage of R-134a is estimated by Estonian experts at 39% (1.658 tons), the percentage of R-404A at 55% (2.29 tons). Other HFC refrigerants (R-422A, R-422D, R-437A and R-401A) 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 3.72 tons R-134a and 0.07 tons R-404A.

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 R-134a in commercial refrigeration, based on 15 years lifetime, first decommissioning emissions occurred in 2008. The amount of R-134a, R-404A and R-407C filled in new equipment in 1997 was decommissioned according to 15 years lifetime in 2012.

Emissions: The service companies were asked for 2012 stock data and refilling data of their clients. In 2012, a detailed research of refilling ratios was carried out in the supermarket sub sector. Ten service companies provided complete stock and refilling data with total refilling ratio 16.8%. Complete 2012 stock (27.332 tons of HFC-404A) and refilling data was available about seven supermarket chain systems – refilling ratio 13.1%.

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)[10].

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 2012 amounts to 8.327 tons (7.922 tons R-404A and 0.405 tons R-134a). The manufacturing emissions from this filling are 42 kg. The HFC stock amounts to 95.909 tons (86.799 tons R-404A, 8.346 tons R-134a and small amounts of R-407C, R-410A, R-422A, R-422D, R-401A, R-437A, R-417A and R-402A). The stock emissions are in total 13.875 tons. The biggest part of them is HFC-404A (13.011 tons) and HFC-134a (0.75 tons), the emissions of the other HFC are only 0.115 tons. Amount of HFC-404A, HFC-134a and R-407C filled in new equipment in 1997 was decommissioned according to 15 years lifetime in 2012. The amount of fluid remained at products at decommissioning amounts to 3.672 tons of R-404A, 0.633 tons of R-134a and 0.028 tons of R-407C. The disposal emissions are in total 2.166 tons (1.836 tons of R-404A, 0.316 tons of R-134a and 0.014 tons of R-407C).

The CO_2 equivalent of all 2012 HFC emissions is 50.123 Gg (50 123 tons).

[10] 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

Activity data in years 2010 and 2011 was recalculated due to more accurate data from companies installing and servicing refrigeration equipment for restaurants, canteens and similar institutions was available on the average charge of the equipment and on the share of different refrigerants. Activity data on vending machines was corrected for the year 2011 as updated information on the share of R-134a and R-404A was available from one company.

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 31.12.2012, 1 445 refrigerated vans and trucks and 1 332 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 2012, 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 2012 quantity of HFCs filled in empty units of refrigerated vehicles in Estonia amounts to 32 kg R-134a and 854.6 kg R-404A, the ‘manufacturing’ emissions on these first fills are 0.32 kg R-134a and 8.55 kg 404A. The HFC stock in refrigerated vehicles amounts to 828 kg R-134a and 16 636 kg R-404A; the stock emissions are 248.4 kg R-134a and 4 991 kg R-404A. The amount of fluid remained at products at decommissioning amounts to 238.4 kg of R-404A and 151 kg of R-134a. The disposal emissions are 45.3 kg R-134a and 71.5 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 2012 HFC emissions is about 17 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

No source-specific recalculations have been done.

Source-specific planned improvements

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

4.5.1.3.2. 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 2012 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 2012 HFC stock emissions from reefer containers attributable to Estonia are 4 865 kg R-134a and 951 kg R-404A. The 2012 emissions from the decommissioning of reefer containers attributable to Estonia are 79.5 kg R-134a and 7.2 kg R-404A. The total is 741.1 t CO_2 equivalent or 0.74 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 90.8 %. 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; www.vet.agri.ee) because companies wishing to handle foodstuff must be approved by the VTA. Approved enterprises: fish industry – about 85 plants with chilling/freezing equipment; meat industry – 100 plants; dairy industry – 30 plants.

Service companies provided the activity data (stock, new installations in 2012, refilling data) on the HFC refrigerant consumption of their industrial clients. 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 14.1 tons or 24.2% of the total HFC stock (58.279 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 R-134a in industrial refrigeration, based on 15 years lifetime, first decommissioning emissions occurred in 2008. The amount of R-404A, R-134a and R-407C filled in new equipment in 1997 was decommissioned according to 15 years lifetime in 2012.

Emissions: The service companies and the industrial companies surveyed by questionnaires were asked for 2012 stock and refilling data. Complete stock and refilling data for R-404A are available for 34 individual companies in the fish, meat, milk and other industry, with an R-404A stock of 15.056 tons. Detailed research indicated that the refilling ratios of the individual companies range from 0 to 84.5%. The average refilling rate is 13.9%.

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 2012 amounts to 3.336 tons (1.645 tons R-143a, 1.52 tons R-125 and 0.17 tons R-134a). The manufacturing emissions from filling are 16.679 kg. The HFC stock amounts to 58.279 tons (27.796 tons R-143a, 25.355 tons R-125, 4.528 tons R-134a, 0.595 tons R-32 and small amount of R-152a). The stock emissions total 8.159 tons. The biggest parts of them are R-143a (3.891 tons), R-125 (3.55 tons) and R-134a (0.634 tons); the emissions of the other HFCs are only 0.084 tons. Amount of R-404A, R-134a and R-407C filled in new equipment in 1997 was decommissioned according to 15 years lifetime in 2012. The amount of fluid remained at products at decommissioning amounts to 3.12 tons of R-404A, 0.049 tons of R-134a and 0.101 tons of R-407C. The disposal emissions are in total 1.635 tons (1.56 tons of R-404A, 0.025 tons of R-134a and 0.05 tons of R-407C).

The CO_2 equivalent of all 2012 HFC emissions is 30.852 Gg (30 852 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. 73 414 systems in 2012 (8 560 ground, 64 070 air and 784 other heat pumps), 13 495 of them were installed in 2012. According to the experts 28 ground and 70 air HP went for decommissioning in 2012. 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 300 kg R-407C, the manufacturing emissions 6 kg R-407C. The 2012 operating stock amounts to 18 688 kg R-407C (ground and other HP) and 64 070 kg R-410A (air HP). The 2012 operating emissions total 467.2 kg R-407C and 1 601.8 kg R-410A. The amount of fluid remained in HP at decommissioning was 60 kg R-407C and 70 kg R-410A. The 2012 disposal emissions in total 18 kg R-407C and 21 kg R-410A.

All global warming emissions together amount to 3 548.569 t CO_2 equivalent (3.55 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 2012 newly installed systems, the total 2012 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 2012 the following numbers of operating systems: 741 chillers, 4 730 ventilation systems and 33 600 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 96.108 t R-134a, 47.867 t R-32 and 49.857 t R-125. Operating emissions: 4.286 t R-134a, 2.743 t R-32, 2.891 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 2012. Disposal emissions: 0.623 t R-134a.

All global warming emissions together amount to 16.276 Gg CO_2 equivalent (16 276 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

Actual emissions from stocks in 2010 were corrected due to mistake in rounding.

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 2012, there were about 602 125 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 2012, 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.[11]

Method according to IPCC Guidelines 2006: Tier 2a with Europe specific determination of EF.

- Country-specific average refrigerant charge: 565 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 137 tons in the year 2012. The HFC-134a emissions from the Estonian passenger car fleet in 2012 total 13.652 tons (10%), the CO_2 equivalent of which is 17 748 tons.

The amount of HFC-134a in the passenger cars MACs disposed in 2012 was estimated 10 502 kg. Disposal emissions from the Estonian passenger car fleet in 2012 total 5 250 kg (EF=50%), the CO_2 equivalent of which is 6 826 tons.

The CO_2 equivalent of all 2012 HFC emissions is 24 574 tons (25 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.

[11] 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 2012, there were about 88 045 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 2012, 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 21 793 kg in the year 2012. The HFC-134a emissions from the Estonian truck fleet in 2012 total 2 764 kg (12.69%), the CO_2 equivalent of which is 3 594 tons.

The amount of HFC-134a in the truck MACs disposed in 2012 was estimated 1 676 kg. Disposal emissions from the Estonian truck fleet in 2012 total 838.2 kg (EF=50%), the CO_2 equivalent of which is 1 090 tons.

The CO_2 equivalent of all 2012 HFC emissions is 4 683 tons (4.68 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 2012, about 3 244 buses were operated in Estonia, 1 967 of which were less than 16 years old (built as of 1996). 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 2012 (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.[12]

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 8 577 kg in the year 2012. The HFC-134a emissions from the Estonian bus fleet in 2012 total 1 295 kg (15.10%), the CO_2 equivalent of which is about 1 684 tons.

The amount of HFC-134a in the bus MACs disposed in 2012 was estimated 660 kg. Disposal emissions from the Estonian bus fleet in 2012 total 330 kg (EF=50%), the CO_2 equivalent of which is 429 tons.

The CO_2 equivalent of all 2012 HFC emissions is 2 112 tons (2.11 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.

[12] 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.

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.

4.5.1.6.4. 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 2012 were provided directly by the ship owners. The estimation of the stock emissions is based on direct measurement (refilling data 2012).

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: 3 794 kg R-134a; 1 234 kg R-404A; 388 kg R-407C, 300 kg R-427A, 405 kg R-407A, 3.7 kg R-410A and 10 kg R-507a.
- Country-specific stock emissions (refills), EF = 30%, which is in accordance with the IPCC Good Practice Guidance: 1 138 kg R-134a; 370 kg R-404A; 116 kg R-407C, 90 kg R-427A, 122 kg R-407A, 1.1 kg R-410A and 3 kg R-507a.

The CO_2 equivalent of the stock emissions (all HFC together) is 3 255 tons (3.26 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

No source-specific recalculations have been done.

Source-specific planned improvements

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

4.5.1.6.5. Railcars

Source category description

In 2012, there were 24 railcars (restaurant cars, sleeping cars, passenger coaches) and 51 engines 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 and 1,3 kg in engines. 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 and 1,3 kg/a of R-134a (engines).
- 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 0.2544 for all types of railcars in 2012, 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 786.3 kg in the year 2012. The HFC-134a emissions from the Estonian railcars in 2012 total 200 kg (25.44%), 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 2012, there were about 6 865 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 2012. 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 2012, the total HFC-134a stock in tractor and mobile machinery MACs in Estonia amounts to 11 560 kg. The HFC-134a emissions from the entire Estonian fleet total 2 461 kg (21.29%) the CO_2 equivalent of which is about 3 199.3 tons (3.2 Gg).

The amount of HFC-134a in the tractor/mobile machinery MACs disposed in 2012 was estimated 890 kg. Disposal emissions from the Estonian fleet in 2012 total 178 kg (EF=20%), the CO_2 equivalent of which is 231,4 tons.

The CO_2 equivalent of all 2012 HFC emissions is 3 431 tons (3.43 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 2012 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%.[13]

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%.

[13] 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 2012 Estonian HFC-134a bank in PU insulation panels amounts to 15 tons, the annual use-phase emissions are 0.075 tons (97 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 2009–2012, 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.[14] 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 2012 the stock constituted of 265.44 kg HFC-365mfc, 33.6 kg HFC-227ea and 30.51 kg HFC-134a. Stock emissions: 2.65 kg HFC-365mfc, 0.34 kg HFC-227ea and 0.3 kg HFC-134a, altogether 3.73 t CO_2 equivalent.

Total global warming emissions: 3.73 t CO_2 equivalent (0.0037 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-

[14] 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 2010–2012, 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%.
- 2012 HFC-134a bank: 8.33 tons.
- 2012 use-phase emissions: 55 kg (0.66%) which is 71.49 t (0.071 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 2010–2012, 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} (0.53%) 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 2012’ is equated to the HFC content of OFC cans sold to the Estonian market and used in 2012. Hence only emissions from manufacturing and use (= stock) are entered in the CRF table, no emissions from disposal. Country specific EF_{manu} is 0.19% (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 2012 HFC-152a consumption was in total 1 138 t and HFC-134a consumption was 6.7 t.

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.

- Country specific EF_{manu}: 0.53% (HFC-152a).

- Country specific EF_{manu}: 0.19% (HFC-134a).
- Country specific EF_{op}: 100%.
- Manufacturing emissions: 6.021 tons HFC-152a or 843 t CO_2 equivalent and 0.013 tons HFC-134a or 16.5 t CO_2 equivalent.
- Stock = use-phase emissions: 28.1 tons HFC-152a or 3 938 t CO_2 equivalent.

The HFC emissions from manufacturing and from stock total to 4 797.7 t or 4.80 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

No source-specific recalculations have been done.

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 1.28% of the Estonian F-gas emissions (2.18 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 2012 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 2012 quantity of F-gases in installed fire fighting systems amounted to 31.27 t (23.31 t HFC-227ea, 2.89 t HFC-23 and 5.52 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: 57.7 kg HFC-23, 11.05 kg HFC-125, 90.58 kg HFC-134a and 466.15 kg HFC-227ea. The CO_2 equivalent of all 2012 HFC emissions is about 2.18 Gg (2 176 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 2005–2011 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 2012 (production + import - export) is the stock of the same year 2012. (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 2012 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 2012 domestic consumption of HFC-134a was 0.95 tons (manufacturing emissions: 28.5 kg), of which 0.86 tons were sold to the domestic market, resulting in use-phase emissions of the same amount.
- Anti-Asthma MDIs: The 2012 domestic market was 1 398 kg, with the same quantity of emissions.
- Overall emissions: 2.281 tons HFC-134a or 2 966 tons CO_2 equivalent (2.97 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 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 1 093 kg. The respective stock amounts to 10 512 kg (HV) and 4 711 kg (MV). Stock emissions: 73.59 kg (HV), 4.71 kg (MV). Total: 78.3 kg.

Total global warming emissions: 1 897 t CO_2 equivalent (1.90 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

2011 emissions from stocks were recalculated due to mistake in activity data of one company.

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 (0.07 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.

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%. In 2012 there was no new equipment nor disposal of old equipment.

Method according to IPCC guidelines 2006: Tier 2a with country specific EF.

- Country specific EF_{op}: 10.4%.

The 2012 stock of SF_6 totals 27.2 kg, the 2012 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

Estonia's emissions from the solvent and other product use sector are divided into the 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 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 Agency. 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 2012

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

In 2012, the solvent and other product use sector contributed 0.10% of all greenhouse gas emissions in Estonia, totalling 18.72 Gg CO_2 eq. Indirect CO_2 emissions from paint application (CRF 3.A) and other (CRF 3.D.5) contributed the main share of total emissions from the sector – 28.64% and 31.93% respectively (see Table 5.2 and Figure 5.1).

Emissions from the solvent and other product use sector have decreased by 29.31% compared to base year 1990. Two major categories where a decrease in 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 1990–2012 has mostly occurred 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 27.36% by the year 2012 (see Table 5.2).

Table 5.2. Emissions from solvent and other product use in 1990–2012 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Indirect CO_2																							
Paint application	5.17	6.09	3.74	3.45	5.22	7.09	8.07	9.01	9.68	9.07	5.32	4.98	5.83	6.11	6.93	7.97	8.51	8.73	5.69	4.52	4.92	5.63	5.36
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	2.28
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	0.74
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	5.98
NMVOC																							
Paint application	2.35	2.77	1.70	1.57	2.37	3.22	3.67	4.09	4.40	4.12	2.42	2.26	2.65	2.78	3.15	3.62	3.87	3.97	2.59	2.06	2.23	2.56	2.44
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	1.04
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	0.34
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	2.8	2.28	2.42	2.72
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	0.01
N_2O from aerosol cans[15]	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	0.03

[15] N_2O emissions from aerosol cans are presented in tons.

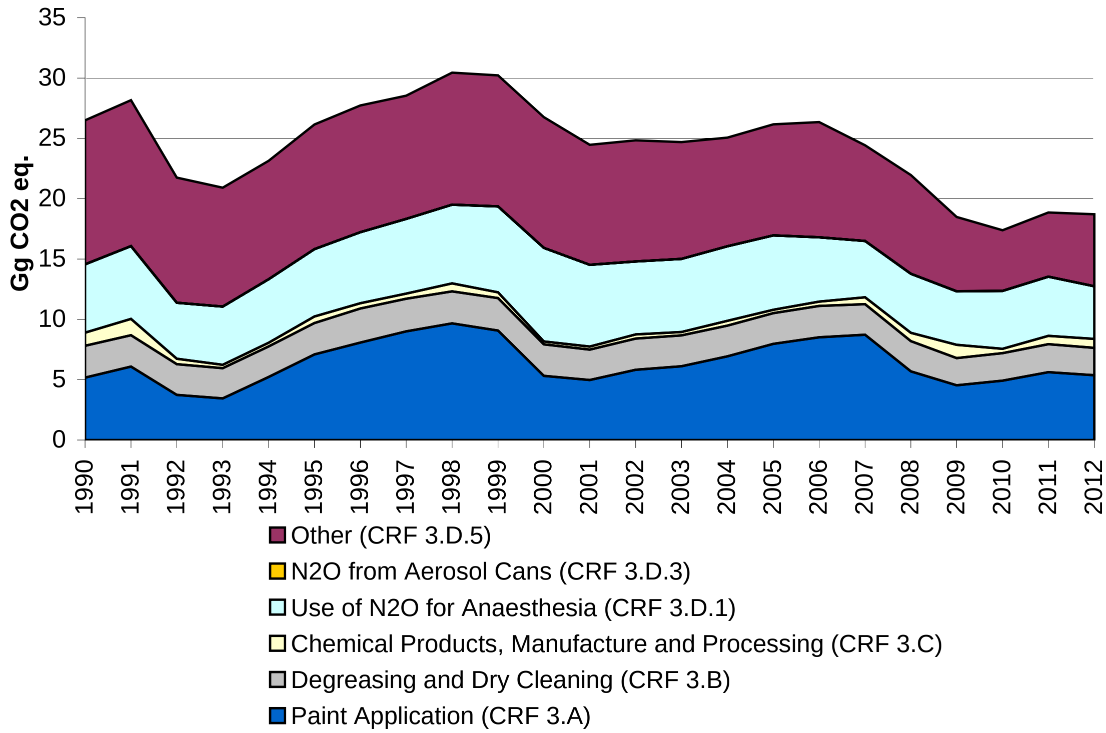


Figure 5.1. Emissions from solvent and other product use in Estonia in 1990–2012 (Gg CO_2 eq.)

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 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:

$$Emissions_{CO2} = Emissions_{NMVOC} \bullet \text{Percent carbon in NMVOCs by mass} \bullet 44/12$$

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 were corrected for the years 1990–1999 due to updates in statistical data and from other product use for the year 2011 due to corrections in NMVOC emission factor. The difference in indirect CO_2 emissions between 2013 Submission and 2014 Submission is shown in Table 5.3.

Table 5.3. Indirect CO_2 emissions from solvent and other product use in 2013 Submission and in 2014 Submission (Gg)

CRF	Source	Year	the 2013 Submission	the 2014 Submission
3.A	Paint application	1990	5.1288	5.1708
		1991	6.0445	6.0902
		1992	3.6792	3.7398
		1993	3.3869	3.4488
		1994	5.1110	5.2232
		1995	6.9595	7.0942
		1996	7.8990	8.0704
		1997	8.8130	9.0074
		1998	9.4864	9.6760
		1999	8.8812	9.0728
3.D.5	Other product use	2011	1.6111	1.6138

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 2012. Activity data for 1990–1991 was estimated based on the surrogate data method. It is assumed that all N_2O sold to Estonian market in a year is 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 2007–2012 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

No source-specific recalculations have been done.

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 1 326.2 Gg CO_2 eq in 2012. The sector contributed about 6.9%[16] 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).

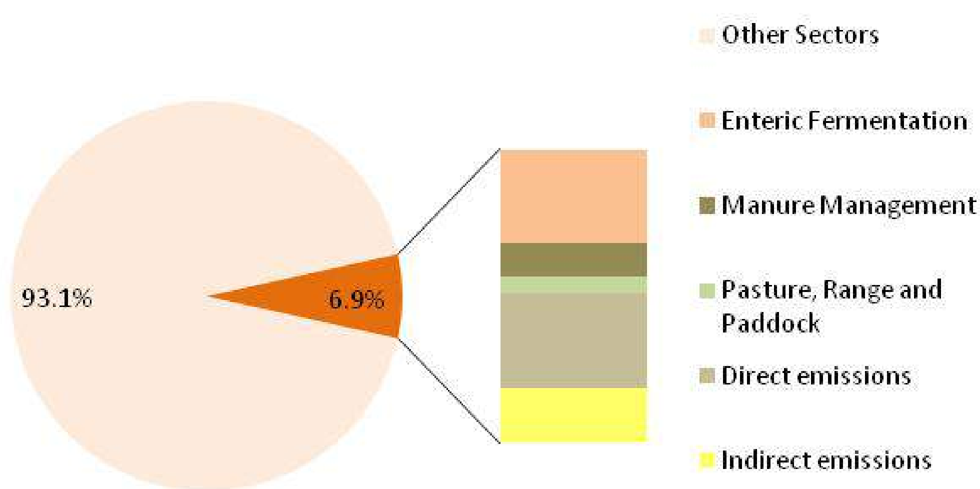


Figure 6.1. Emissions from agriculture compared to total CO_2 eq emissions in 2012, %

CO_2 eq emissions from the agricultural sector declined 58.26 % by 2012 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).

[16] GHG emissions related to LULUCF sector are not included.

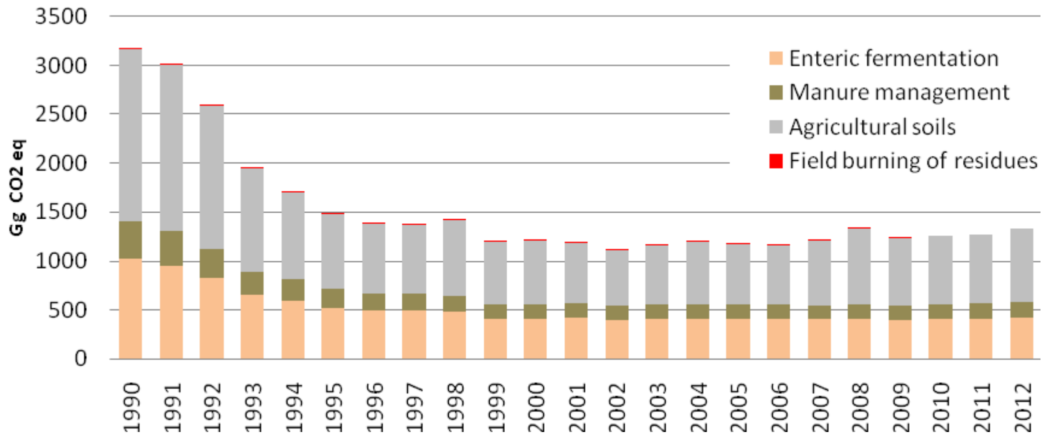


Figure 6.2. Trends in emissions by source categories in Estonia in 1990–2012, Gg CO_2eq

Table 6.1. Estonia's agricultural GHG emissions by sources in 1990–2012, Gg

Year	Enteric fermen-tation	Manure management		Agricultural soils		Field burning of agricultural residues		Total GHG emissions		Total CO_2 eq emission
				Direct	Indirect					
	CH_4	CH_4	N_2O[17]	N_2O	N_2O	CH_4	N_2O	CH_4	N_2O	CO_2eq
1990	48.43	3.60	1.64	3.22	1.84	0.261	0.004	52.29	6.71	3 177.0
1991	45.38	3.25	1.54	3.12	1.76	0.250	0.004	48.89	6.43	3 018.4
1992	39.46	2.35	1.32	2.73	1.47	0.174	0.003	41.98	5.53	2 595.2
1993	31.18	1.88	1.05	2.08	0.95	0.213	0.003	33.27	4.09	1 965.3
1994	28.15	1.88	0.96	1.67	0.85	0.138	0.002	30.17	3.49	1 713.9
1995	24.88	1.76	0.85	1.45	0.71	0.144	0.002	26.78	3.01	1 495.4
1996	23.64	1.36	0.79	1.35	0.63	0.173	0.003	25.18	2.77	1 387.2
1997	23.39	1.40	0.78	1.32	0.68	0.179	0.003	24.97	2.77	1 384.5
1998	22.65	1.43	0.75	1.51	0.73	0.154	0.002	24.23	2.99	1 434.4
1999	19.53	1.24	0.64	1.22	0.61	0.112	0.002	20.88	2.46	1 202.5
2000	19.21	1.25	0.64	1.24	0.64	0.185	0.003	20.64	2.52	1 215.0
2001	19.90	1.38	0.66	1.14	0.62	0.149	0.002	21.43	2.42	1 199.8
2002	18.77	1.37	0.62	1.06	0.56	0.135	0.002	20.27	2.25	1 123.0
2003	19.12	1.70	0.60	1.12	0.65	0.130	0.002	20.96	2.37	1 173.7
2004	19.35	1.70	0.60	1.18	0.67	0.152	0.002	21.20	2.45	1 206.0
2005	19.49	1.76	0.59	1.15	0.61	0.193	0.003	21.44	2.35	1 179.4
2006	19.55	1.81	0.58	1.11	0.64	0.154	0.002	21.51	2.33	1 174.1
2007	19.21	1.95	0.56	1.26	0.67	-	-	21.16	2.49	1 216.4
2008	19.28	1.97	0.58	1.46	0.83	-	-	21.24	2.87	1 336.2
2009	18.99	2.03	0.57	1.28	0.71	-	-	21.02	2.56	1 236.2
2010	19.31	2.24	0.57	1.30	0.74	-	-	21.55	2.61	1 261.8
2011	19.56	2.16	0.58	1.30	0.76	-	-	21.72	2.64	1 273.9
2012	20.17	2.23	0.60	1.36	0.81	-	-	22.40	2.76	1 326.2
%, 2012[18]	31.9	3.5	13.8	31.9	18.8	-	-	35.4	64.6	100.0

[17] N_2O emissions include N_2O emissions from Pasture, Range and Paddock category.
[18] % from the total CO_2 eq emissions, in CO_2 eq.

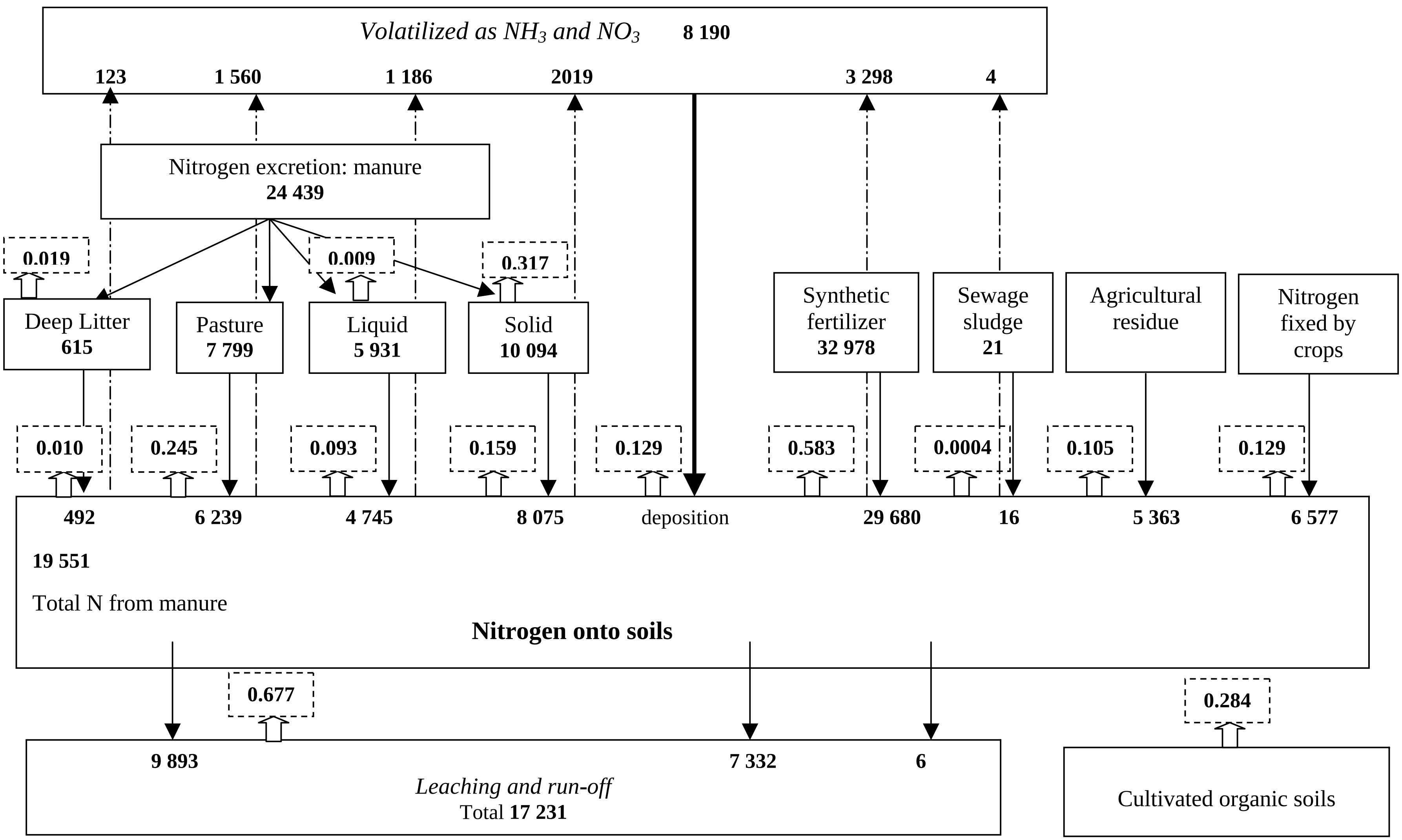


Figure 6.3. Nitrogen flow balance of Estonia's agriculture in 2012 (the scheme was adopted from Finland's NIR (2009))
(Bulk arrows stand for emissions, thin arrows for N flow. Nitrogen amounts are in Mg/year and emissions (fragmental line) in Gg/year)

Results of nitrogen balance of Estonia completed in the 2014 submission are presented in Figure 6.3. The total amount of nitrogen excreted with manure was 24 439 Mg in 2012; 20% of the total nitrogen volatilized as NH_3 and NO_3, the rest of the amount (19 551 Mg) entered into soils in 2012. 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 32 978 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 8 190 Mg, N_2O emissions due to atmospheric deposition were 0.129 Gg; N2O emissions from nitrogen leaching and run-off were 0.677 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).

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(19)	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						
a. Piglets, live weight less than 20 kg	T2	D, CS				

[19] Mature non-dairy cattle and young cattle were grouped and considered in the context ‘Non-Dairy Cattle’ category.

	CH4		N2O		Key category	
	Method applied	Emission factor	Method applied	Emission factor	LULUCF sector is not included	LULUCF sector is included
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			T2	D		
4.C. Rice Cultivation	NA	NA				
4.D. Agricultural soil						
1. Direct Soil Emissions						
a. Synthetic Fertilizers			T1	D	L	L, T
b. Animal Waste Applied to Soils			T1	D	L	L, T
c. N-fixing crops			T1b	D	L, T	L, T
d. Crop Residues			T1b	D		
e. Cultivation of Histosols			T1	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
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	L	L
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
Estonian Environmental Research Centre	http://www.klab.ee/en/	EERC	- activity data handling; - estimation of emissions; - reporting (CRF tables, 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 to fields.
Estonian Animal Recording Centre	www.jkkeskus.ee	EARC	- collection and reporting of data on milk production, fat content in milk; - collection of data on dairy cattle population by dairy-cattle breed.
Estonian Environment Agency	www.keskkonnainfo.ee	EtEA	- providing data on areas of organic soils under cultivation. - collection and reporting of data on amounts of sludge used on agricultural fields.

6.2.2. Livestock characterization

Estonia's livestock population decreased by 2012 in comparison with the base year: the number of dairy cattle decreased by 66 per cent: from 280.7 thousand heads to 96.8 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 149.2 thousand heads in 2012 (Figure 6.4, Figure 6.6). The total number of swine decreased by 56 per cent, i.e. from 859.9 thousand heads in 1990 to 375.1 thousand heads in 2012 (Figure 6.4, Figure 6.7). The population of horses decreased from 8.6 thousand heads in 1990 to 6.2 thousand heads in 2012 – by 28 per cent (Figure 6.4). The number of sheep decreased by 44 per cent – from 138 thousand heads in 1990 to 76.8 thousand heads in 2012. However, the population number of goats increased from 1.8 thousand heads to 4.6 thousand heads from 1990 to 2012 (Figure 6.4). The poultry population decreased by 67 per cent by 2012 compare to the base year – from 6 536.5 thousand heads in 1990 to 2 170.9 thousand heads in 2012 (Figure 6.8).

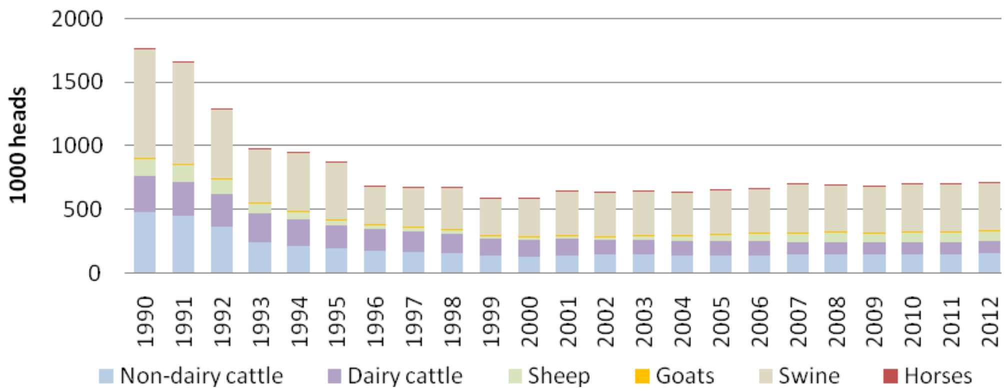


Figure 6.4. Population of livestock in Estonia in 1990–2012, 1000 heads

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 1999–2012 – 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).

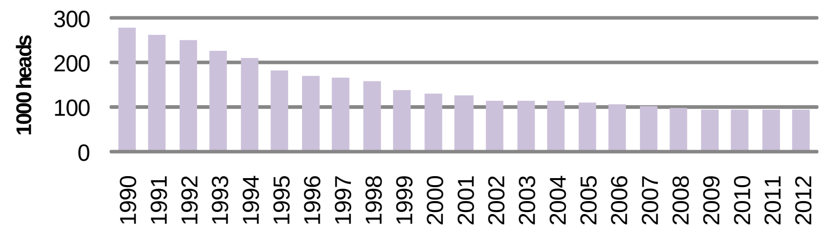


Figure 6.5. Population of dairy cattle in Estonia in 1990–2012, 1000 heads

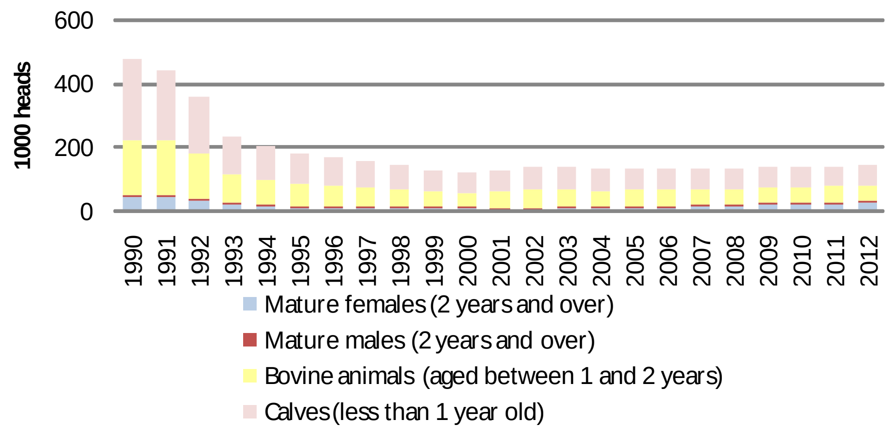


Figure 6.6. Population of non-dairy cattle in Estonia in 1990–2012, 1000 heads

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).

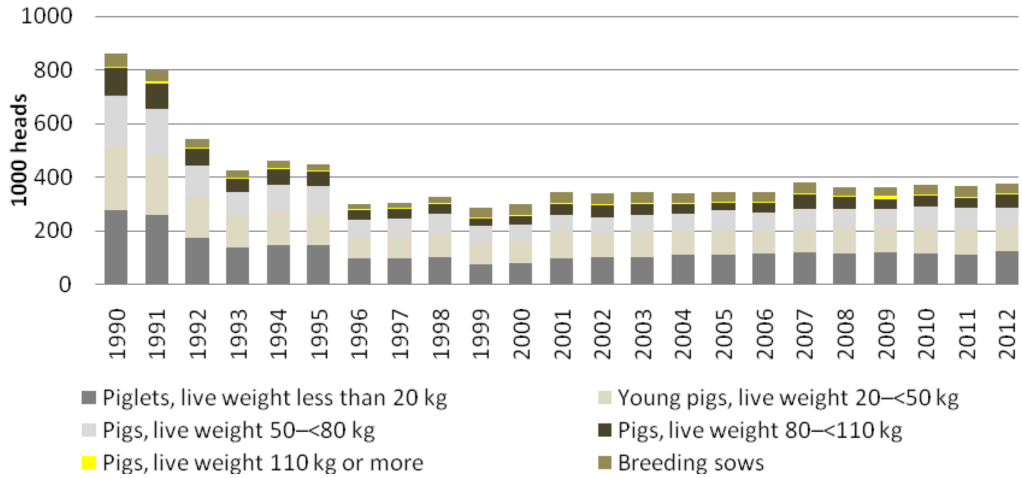


Figure 6.7. Population of swine in Estonia in 1990–2012, 1000 heads

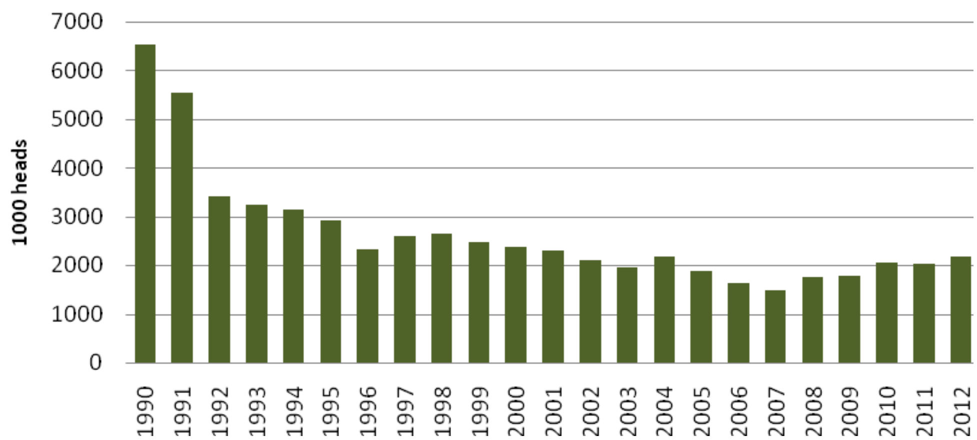


Figure 6.8. Population of poultry in Estonia in 1990–2012, 1000 heads

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).

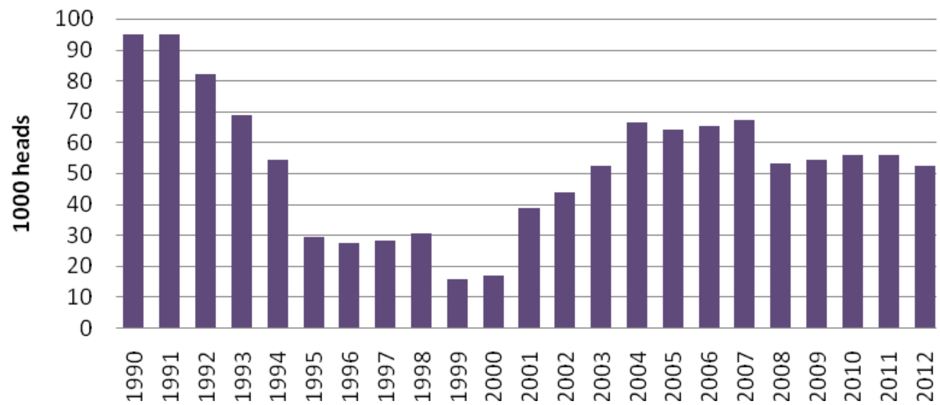


Figure 6.9. Population of fur animals in Estonia in 1990–2012, 1000 heads[20]

The activity data used in the estimations in the 2014 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 2014 submission.

[20] Data on fur animal population in 1994–2012 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 1992–2012, in accordance with SE and the FAO datasets, 1000 heads (SE, 2012; 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	541.1	798.6	121.5	141.9	1.2	NR	6.6	7.8	3 418.1	5704
1993	462.6	614.6	424.3	541.1	82.2	124.2	1.1	NR	5.2	6.6	3 226.1	3500
1994	418.3	463.2	459.8	424.3	60.0	83.3	1.5	NR	5.0	5.2	3 129.7	3 272
1995	369.7	419.5	448.8	459.8	48.2	61.5	1.6	NR	4.6	5.0	2 911.3	3 178
1996	342.4	370.4	298.4	448.8	37.6	49.8	1.6	NR	4.2	4.6	2 324.9	2 962
1997	325.0	343.0	306.3	298.4	33.9	39.2	1.7	NR	4.2	4.2	2 602	2 380
1998	306.7	325.6	326.4	306.3	28.7	33.9	2.1	1.7	3.9	4.2	2 635.7	2 650
1999	267.3	307.5	285.7	326.4	28.2	28.7	2.7	2.1	3.9	3.9	2 461.8	2 684
2000	252.8	267.3	300.2	285.7	29.0	28.2	3.2	2.7	4.2	3.9	2 366.4	2 462
2001	260.5	252.8	344.6	300.2	28.8	29	3.6	3.2	5.5	4.2	2 294.9	2 366
2002	253.9	260.5	340.8	345.0	29.9	28.8	3.9	3.6	5.3	5.5	2 096.3	2 295
2003	257.2	253.9	344.6	340.8	30.8	29.9	3.5	3.9	5,8	5.3	1 945.2	2 096
2004	249.8	257.2	340.1	344.6	38.8	30.8	2.9	3.5	5.1	5.8	2 183.0	1 945
2005	249.5	249.8	346.5	340.1	49.6	38.1	2.8	2.9	4.8	5.1	1 878.7	2 183
2006	244.8	249.5	345.8	346.5	62.7	49.6	3.3	2.8	4.9	4.8	1 638.7	1 879
2007	240.5	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	5.3	5.3	1 757.3	1 477
2009	234.7	237.9	365.1	364.9	76.5	78.2	3.9	3.6	5.4	5.3	1 792.2	1 758
2010	236.3	234.7	371.7	365.1	78.6	76.5	4.1	3.9	6.8	5.4	2 046.4	1 793
2011	238.3	236.3	365.7	371.7	83.9	78.6	4.3	4.1	6.5	6.8	2 032.9	2 047
2012	246.0	238.3	375.1	365.7	76.8	83.9	4.6	4.3	6.2	6.5	2 170.9	2 033

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_2 eq emissions of the agricultural sector in Estonia in 2012. CH_4 emissions in 2012 were 58 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 1990–2012 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	18.12	0.38	0.58	0.020	0.10	NE	0.007	19.21
2008	18.17	0.36	0.63	0.018	0.10	NE	0.005	19.28
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
2012	19.05	0.37	0.61	0.023	0.11	NE	0.005	20.17
%, 2012	94.0	1.8	3.4	0.1	0.6	-	0.0	100

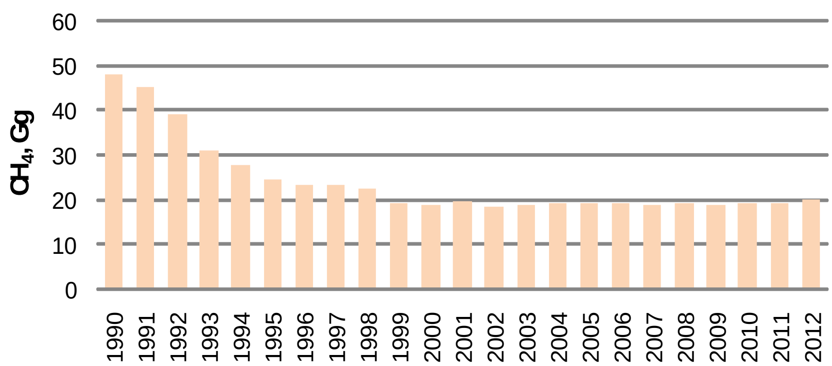


Figure 6.10. CH_4 emissions enteric fermentation from Estonia's livestock in 1990–2012, Gg

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)

$$NE_{mji} = C_{f\ ji} \bullet (weight_{ij})^{0.75} \qquad (6.1)^{21}$$

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[22]

Animal category	C_{fi}
Cattle (non-lactating)	0.322
Cattle (lactating)	0.335

Net energy for activity for animals (6.2)

$$NE_{aji} = C_a \bullet NE_{mji} \qquad (6.2)^{23}$$

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);

[21] IPCC 2000, Agriculture, Equation 4.1, pp. 4.13.
[22] IPCC 2000, Agriculture, Table 4-4, pp. 4.15.
[23] 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[24]

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)

$$NE_{gji} = 4.18 \times \left\{ (0.035 W_{ji}^{0.75} \times WG_{ji}^{1.119}) + WG_{ji} \right\} \quad (6.3)^{25}$$

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)

$$NE_{l_i} = kg\_of\_milk/day_i \times (1.47 + 0.40 \times Fat_i) \quad (6.4)^{26}$$

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)

$$NE_{pregnancy} = C_{pregnancy} \bullet NE_m \quad (6.5)^{27}$$

$NE_{pregnancy}$ – net energy required for pregnancy, MJ/head/day;

$C_{pregnancy}$ – pregnancy coefficient = 0.1[(28)];

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)

$$NE_{ma}/DE_{ji} = 1.123 - (4.092 \times 10^{-3} \times DE_{ji}\%) + (1.126 \times 10^{-5} \times (DE_{ji}\%)^2) - 25.4/DE_{ji}\% \quad (6.6)^{29}$$

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;

[24] IPCC 2000, Agriculture, Table 4.5, pp. 4.15.
[25] IPCC 1997, Agriculture, Reference Manual, Equation 3, pp. 4.18.
[26] IPCC 2000, Agriculture, Equation 4.5a, pp. 4.17.
[27] IPCC 2000, Agriculture, Equation 4.8, pp. 4.18.
[28] IPCC 2000, Agriculture, Table 4.7, pp. 4.19.
[29] 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)

$$NE_g/DE_{ji} = 1.164 - (5.160 \times 10^{-3} \times DE_{ji}\%) + (1.308 \times 10^{-5} \times (DE_{ji}\%)^2) - 37.4/DE_{ji}\% \qquad (6.7)^{30}$$

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)

$$GE = \frac{(NE_{m\,ji} + NE_{feedji} + NE_{lji} + NE_{workji} + NE_{pregnancyji}) \times \left(\frac{100}{DE_{ji}\%}\right)}{(NE/DE)_{ji} + (NE_{gji}/\{NE_g/DE\}_{ji})} \qquad (6.8)^{31}$$

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[32], 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)

$$E = [GE \times Y_m \times (365 days/yr)] / [55.65 MJ / CH_4\ kg] \qquad (6.9)^{33}$$

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.

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[30] IPCC 2000, Agriculture, Equation 4.10, pp. 4.19.
[31] IPCC 2000, Agriculture, Equation 4.11, pp. 4.20 (the equation was slightly modified); IPCC 1997, Agriculture, Reference Manual, Equation 13, pp. 4.21.
[32] Net energy for work was not calculated.
[33] 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[34]	6
Mature non-dairy cattle[35]	
…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)[36]	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 2012; these counties were characterized by high milk production per head of dairy cow.

[34] IPCC 1997, Agriculture, Reference Manual, Table A-1, pp. 4.31.
[35] IPCC 1997, Agriculture, Reference Manual, Table A-2 (Mature Females and Males of Eastern Europe), pp. 4.32.
[36] 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 2012

County	Milk yield per cow, kg/head/year	Fat content[37], %	Emission factor, kg CH_4/head/year
Harju	6 769	4.03	123.56
Hiiu	5 266	4.22	106.83
Ida-Viru	6 554	4.09	121.87
Jõgeva	7 657	4.06	132.83
Järva	7 816	4.03	133.85
Lääne	6 802	4.03	123.90
Lääne-Viru	7 783	4.02	133.45
Põlva	7 980	4.13	136.37
Pärnu	7 690	3.99	132.40
Rapla	7 784	4.09	133.76
Saare	6 633	3.98	121.84
Tartu	8 544	3.91	139.07
Valga	7 125	4.16	128.46
Viljandi	7 220	4.08	128.46
Võru	6 948	4.16	126.79

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 2012, 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 1990–2012, mainly, due to increased milk production per 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 1990–2012 (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

[37] Results of animal recording in Estonia in 1997–2011. Annual Reports. Available at: https://www.jkkeskus.ee/jkk/piimaveised/statistika/.

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
1996	545.9	4.34	3 809	241.2	94.75
1997	546.1	4.32	4 484	250.6	98.40
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
2012	547.8	4.04	7526	334.4	131.16
IPCC default					
EE[38]	550[(39)]		2 550		81[(40)]
WE	550		4 200		100

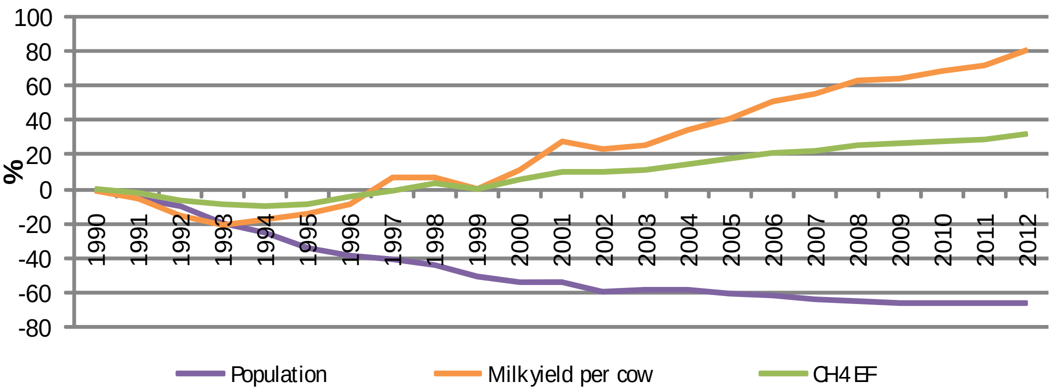

Figure 6.12. The changes in dairy cattle population, milk yield per cow and CH_4 EF in the period of 1990–2012 in relation to the base year (1990), per cent

6.2.2.2. Quantitative overview – CH_4 emissions from enteric fermentation of cattle in 2012

The total CH_4 emissions from enteric fermentation of cattle were 19.05 Gg in 2012. Dairy cattle livestock was the main contributor to CH_4 emissions from cattle enteric fermentation in Estonia in 2012 (Table 6.13). The emissions decreased by 59 per cent by 2012 in comparison to the base year.

[38] EE – Eastern Europe, WE – Western Europe.
[39] IPCC 1997. Agriculture. Reference Manual. Table A-1, pp.4.31.
[40] IPCC 1997. Agriculture, Reference Manual. Table 4-4, pp. 4.11.

Table 6.13. CH_4 emissions from enteric fermentation of cattle in 1990–2012 in Estonia, Gg

Year	Cattle[41]			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	4.33	18.12
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
2012	12.70	2.08	4.27	19.05
%, 2012	66.67	10.92	22.41	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)

$$GE_{ji} = ME_{ji}/DE_{ji}$$

(6.10)[42]

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, %;

$$ME_{ji} = 2.0 \times w_{ji}^{0.63} \quad (6.11)$$[43]

[41] 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.
[42] Oll *et al.*, 1991; Turnpenny *et al.*, 2001.
[43] 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)

$$E = \left[GE \times Y_m \times (365 days/yr)\right] / \left[55.65 MJ / CH_4\ kg\right] \qquad (6.12)^{44}$$

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[45]
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	

[44] IPCC 2000. Agriculture. Equation 4.14, pp. 4.26.
[45] IPCC 1997. Agriculture. Reference Manual. Table 4-3. pp. 4.10.

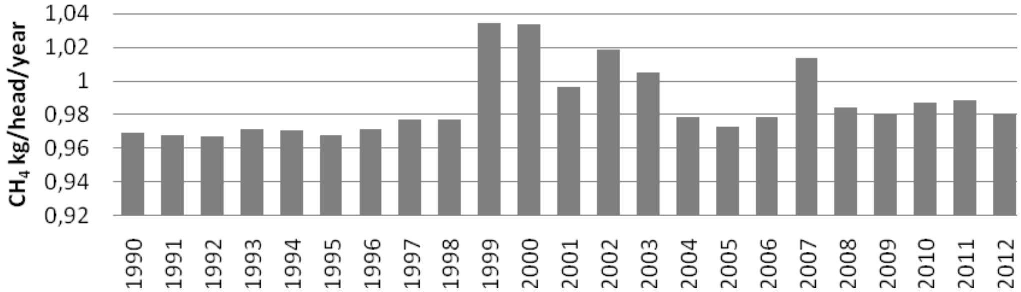

Figure 6.13. Implied emission factor (IEF) of swine enteric fermentation in 1990–2012, CH_4 kg/head/year

6.3.3.2. Quantitative overview – CH_4 emissions from enteric fermentation of swine in 2012

The total CH_4 emissions from swine enteric fermentation were 0.37 Gg in 2012. The emissions decreased by 55 per cent since the base year due to decreasing population of swine (Figure 6.14).

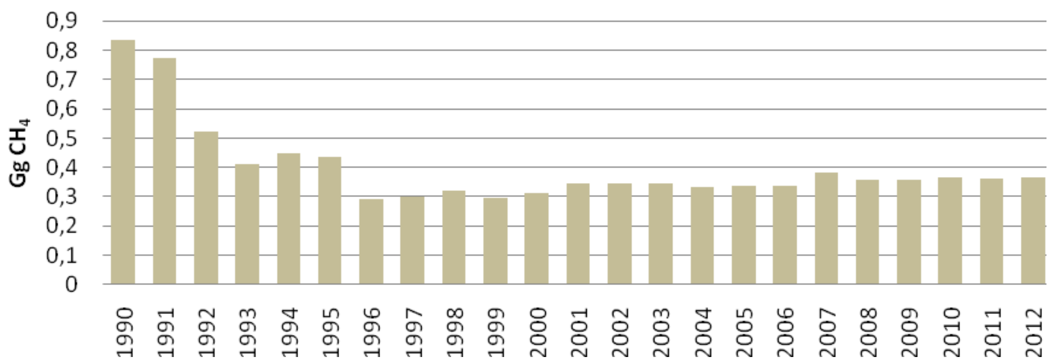

Figure 6.14. CH_4 emissions from enteric fermentation of swine in 1990–2012 in Estonia, Gg

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).

$$CH_4\ \text{Emission} = EF_{ji} \times \text{population}_{ji}/(10^6\ \text{kg/Gg}) \qquad (6.13)$$[46]

CH_4 Emission_{ji} – Methane emissions from enteric fermentation from *j* category of animals in *i* county, Gg CH_4/year;

[46] IPCC 2000. Agriculture. Equation 4.12, pp. 4.25.

EF_{ji} – Methane emission factor for *j* category of animals in *i* county, CH_4 kg/head/year;

$Population_{ji}$ – 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[47]

Livestock category	Emission factor, kg CH_4/head/year
Sheep	8
Goats	5
Horses	18
Poultry	Not estimated
Fur animals	0.1[48]

6.3.4.2. Quantitative overview – CH_4 emissions from enteric fermentation of other livestock categories in 2012

The total CH_4 emissions from enteric fermentation of other livestock were 0.75 Gg in 2012. CH_4 emissions declined by 41 per cent by 2012 in comparison with the base year due to a decrease in number of other livestock population (Figure 6.15).

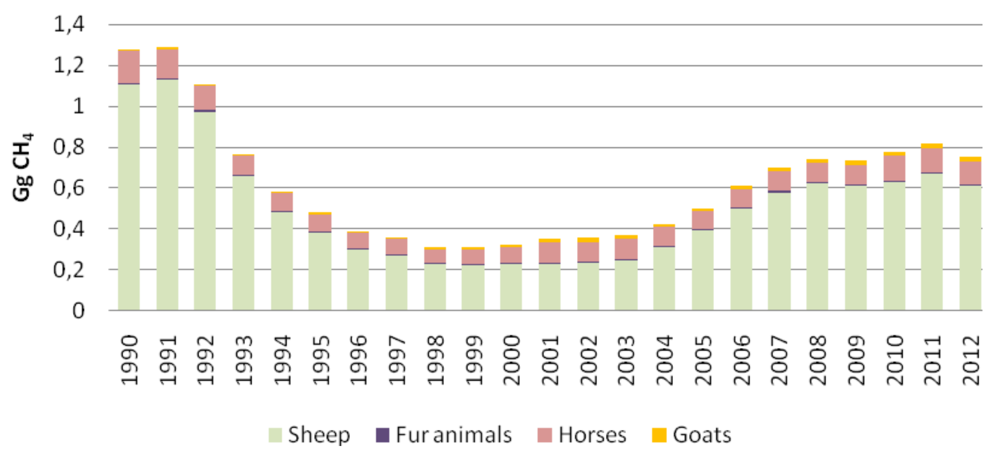

Figure 6.15. CH_4 emissions from enteric fermentation of other livestock categories in 1990–2012, Gg

[47] IPCC 1997. Agriculture. Reference Manual. Table 4-3 (developed countries), pp. 4.10.
[48] 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 were assumed to be similar to fur animals with regard to digestive system and feeding.

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.

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 recalculations performed to estimate CH_4 emissions from enteric fermentation of horses and young cattle: data on livestock population were updated for 2007 and 2008 due to an update made in the Statistics Estonia database. The results of the recalculations are presented in Table 6.18.

Table 6.18. CH_4 emissions from enteric fermentation of horses and young cattle in 2007–2008, Gg

Year	Horses		Young cattle	
	Reported in the 2013 submission	Reported in the 2014 submission	Reported in the 2013 submission	Reported in the 2014 submission
2007			4.35	4.33
2008	0.094	0.095		

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 2012.

The total CH_4 emissions from livestock manure management were 2.234 Gg in Estonia in 2012, the emissions declined by 38 per cent by 2012 in comparison with the base year (Table 6.19, Figure 6.16).

Table 6.19. CH_4 emissions from manure management in 1990–2012 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
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
2012	1.29	0.75	0.015	0.0006	0.009	0.17	0.007	2.23
%, 2012	57.6	33.4	0.7	0.0	0.4	7.6	0.3	100

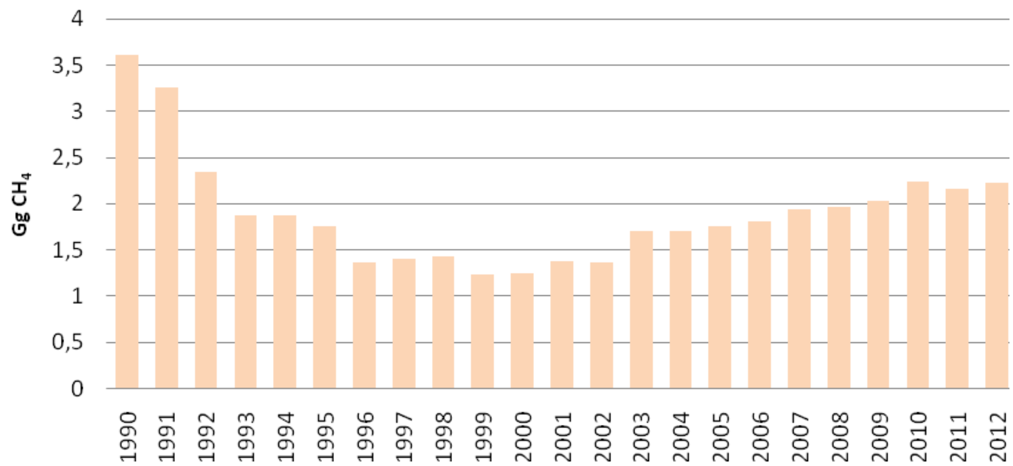

Figure 6.16. CH_4 emissions from Estonia's livestock manure management in 1990–2012, Gg

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).

$$CH_4\_Emissions_{ji} = EF_{ji} \times Population_{ji} / (10^6 \, kg/Gg) \quad (6.14)^{49}$$

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.

$$EF_{ji} = VS_{ji} \times 365\_days/yr \times B_{oji} \times 0.67 kg/m^3 \times \sum_{nK} MCF_{nk} \times MS\%_{jiK} \quad (6.15)^{50}$$

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 6.20);

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*.

[49] IPCC 2000. Agriculture. Equation 4.15, pp. 4.30.
[50] IPCC 2000. Agriculture. Equation 4.17, pp. 4.34.

$$VS_{ji}\ (kg\ \ dm/day) = \frac{GE_{ii}}{18.45} \times (1 - \frac{DE_{ji}\ \%}{100\%}) \times (1 - \frac{ASH\%}{100\%})$$ (6.16)[51]

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 6.20);

ASH – Ash content of the manure as a percentage, % (8%).

Table 6.20. Parameters used in the estimates

Cattle category	Feeding situation	Digestibility of feed, %[52]	CH_4 Conversion, %	Bo, m^3 CH_4/kg VS
Mature cattle[53]				
...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)[54]	Pasture/Range	63	6	0.17
Calves (6-12 months old)[55]	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 6.21. The country-specific CH_4 EFs are 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 6.21. Manure management system usage, methane conversion factors (MCFs) and manure management emission factors for dairy cattle in 2012 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	7,04
Hiiu	0.0	56.2	43.8	2,62
Ida-Viru	17.7	41.7	40.7	7,80
Jõgeva	17.4	42.0	40.7	8,36
Järva	22.7	36.6	40.7	10,02
Lääne	13.3	48.6	38.1	6,72
Lääne-Viru	28.7	33.8	37.5	11,77
Põlva	32.0	28.0	40.0	13,02
Pärnu	34.9	30.1	35.0	13,49
Rapla	29.0	30.8	40.2	11,92

[51] IPCC 2000. Agriculture. Equation 4.16, pp. 4.31.
[52] Kaasik et al., 2002.
[53] 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).
[54] IPCC 1997. Agriculture. Reference Manual. Bovine animals – Table A-2. pp. 4.342-4.343 (replacement/ growing cattle of Western European countries).
[55] IPCC 1997. Agriculture. Reference Manual. Calves – Table A-2, pp. 4.342-4.343 (young cattle of Eastern European countries).

County	Manure management system, %			Emission factor, kg CH_4/head/yr
	Liquid/Slurry	Solid Storage	Pasture/Range	
Saare	15.5	43.6	40.9	7,20
Tartu	43.5	15.3	41.2	16,88
Valga	23.5	33.5	43.1	9,83
Viljandi	23.1	37.5	39.4	9,73
Võru	12.1	45.4	42.5	6,50
Estonian average	25.2	35.2	39.6	10.52
EE[56]	18	68 +1[(57)]	13	6.0
MCFs[58], %	10	1	1	

Implied CH_4 EFs have increased by 2012 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).

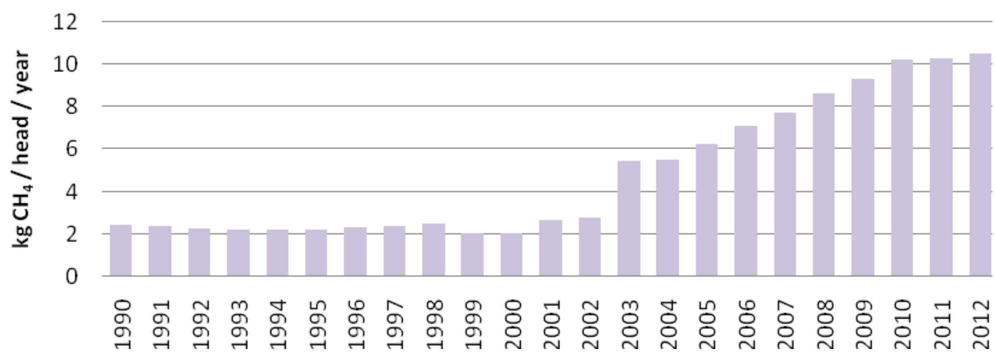

Figure 6.17. Implied CH_4 emission factor for dairy-cattle manure management system in 1990–2012, kg CH_4/head/year

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 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 – 1.10 kgCH_4/head/year and mature females – 1.13 kgCH_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 6.22 (see also Appendix A.3.3_IV).

[56] IPCC 1997. Agriculture. Reference Manual. Table B-3, pp. 4.43.
[57] Daily spread.
[58] IPCC 1997. Agriculture. Reference Manual, Table 4-8, pp. 4.25.

Table 6.22. Manure management system usage, methane conversion factors and manure management emission factors for young cattle in 2012, 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
Estonian average	4.6	43.7	13.0	38.7	2.01	

CH_4 IEFs for young cattle have slightly changed over 1990–2012 (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.

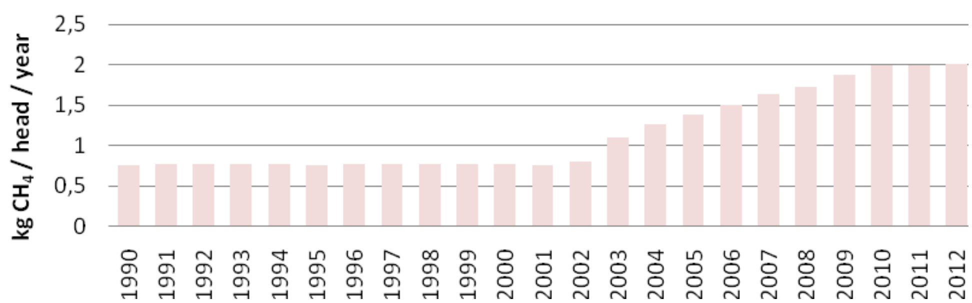

Figure 6.18. Implied CH_4 emission factor for young cattle MMS in 1990–2012, kgCH_4/head/year

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 2012

The total CH_4 emissions from cattle manure management were 1.287 Gg in Estonia in 2012, the emissions increased by 21% by 2012 in comparison with the base year (Table 6.23).

Table 6.23. CH_4 emissions from cattle manure management activities in 1990–2012 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	0.189	1.013
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
2012	1.018	0.04	0.231	1.287
%, 2012	79.1	3.0	17.9	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 6.24.

Table 6.24. Parameter used in the estimates

	Feed digestibility, %[59]	VS, kg/h/d	Bo, m^3 CH_4/kg VS[60]	MCF, %[61]
Piglets, live weight less than 20 kg	85	0.08	0.45	0.6

59 Kaasik et al., 2002.
60 IPCC 1997. Agriculture. Reference Manual. Table B-6, pp. 4.46.
61 IPCC 1997. Agriculture. Reference Manual. Table A-4, pp. 4.35.

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

Table 6.25. MMS usage, methane conversion factor and manure management emission factors for swine in 2012 by county of Estonia

County	Manure management system, %			Emission factor, kg CH_4/head/year					
					Young	Fattening pigs…			Breeding
	Liquid/ Slurry	Solid storage	Pasture, Range	Piglets, live weight less than 20 kg	pigs, live weight 20–<50 kg	...live weight 50–<80 kg	...live weight 80–<110 kg	…live weight 110 kg or more	pigs, live weight 50 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[62]	8[(63)]	39 +14+38[(64)]							4[(65)]
MCFs[66], %	10	1	1						

[62] IPCC 1997. Agriculture. Reference Manual. Table B-6, pp. 4.46.
[63] Anaerobic lagoons.
[64] 14% - Dry lot and 38% – Pits less than 1 month and more than 1 month.
[65] IPCC 1997. Agriculture. Reference Manual. Table 4-6, pp. 4.13.
[66] 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 6.25. 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):

$$CH_{4,treated\_slurry} = VS \cdot B_0 \cdot MCF \cdot 0.67 \cdot E_{lower} \tag{6.17}$$

Where, VS, B_0, MCF were used as described in Table 6.24, E_{lower} for pig slurry treated for biogas was used at 0.60.

Implied CH_4 emission factors for swine manure management system have slightly changed in the period of 1990–2012 due to changes in the structure of swine population, the IEFs are slightly lower in 2006–2012 due to relatively low emissions from treated pig slurry in Saare county. Values of IEFs are reported in Figure 6.19.

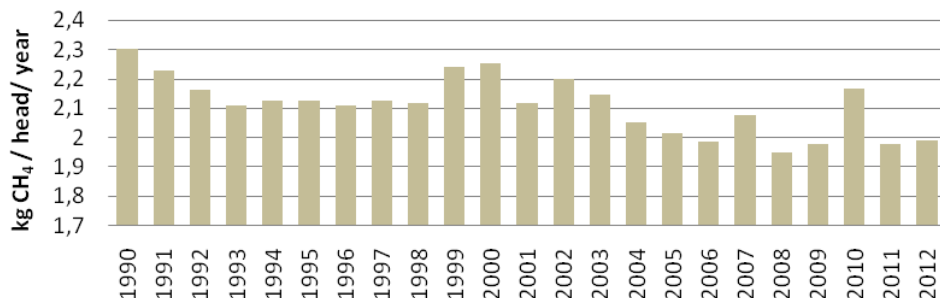

Figure 6.19. Implied CH_4 emission factor for swine manure management system in 1990–2012, kg CH_4/head/year

6.4.1.2.2. Quantitative overview – CH_4 emissions from swine manure management in 2012

The total CH_4 emissions from swine manure management were 0.75 Gg in Estonia in 2012 (Figure 6.20). The emissions decreased by 62 per cent by 2012 in comparison with the base year due to decrease in number of swine population..

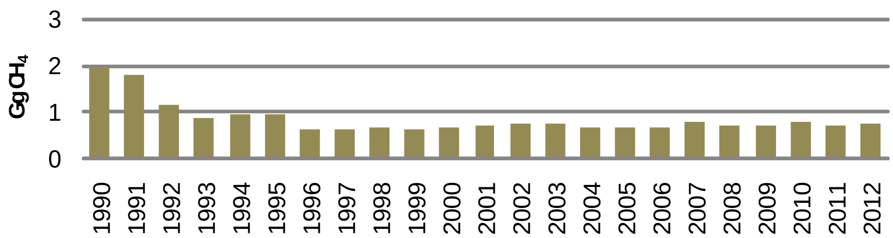

Figure 6.20. CH_4 emissions from swine MMSs in 1990–2012 in Estonia, Gg

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 6.26).

Table 6.26. Manure management system usage and methane emission factors from manure management of other livestock categories[67]

Livestock category	Manure management system, %		Emission factor[68], 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[69]	98.54	1.46	0.078
Fur animals[70]	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 2012 (Figure 6.21). The emission declined by

[67] 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.
[68] IPCC 1997. Agriculture. Reference Manual. Table 4-5 (developed countries, cool climate region), pp. 4-12.
[69] The data of 2011.
[70] The values of manure management factor for fur animals were provided by a finish expert of the Agriculture sector.

66 per cent by 2012 in comparison with the base year due to decrease in the number of other livestock population.

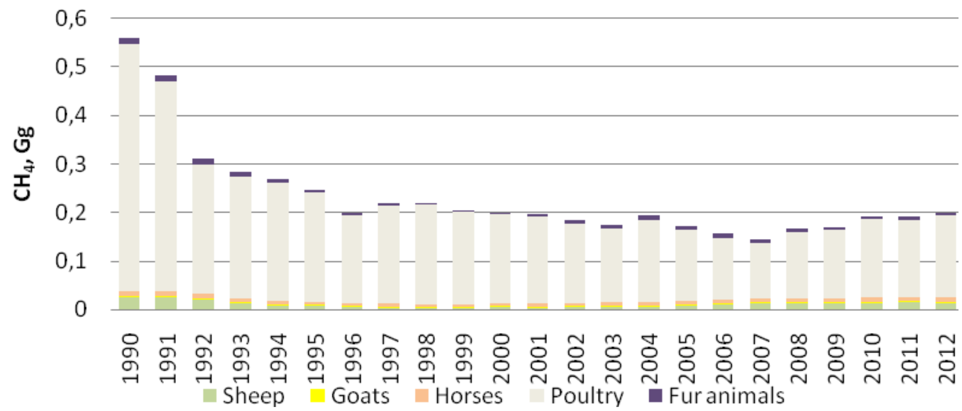

Figure 6.21. CH_4 emissions from other livestock MMSs in 1990–2012 in Estonia, Gg

6.4.1.4. Source-specific recalculations

There are recalculations performed to estimate CH_4 emissions from manure management of horses and young cattle: data on livestock population were updated for 2007 and 2008 due to an update made in the Statistics Estonia database. The results of the recalculations are presented in Table 6.27.

Table 6.27. CH_4 emissions from manure management, Gg

Year	Horses		Young cattle	
	Reported in the 2013 submission	Reported in the 2014 submission	Reported in the 2013 submission	Reported in the 2014 submission
2007			0.190	0.189
2008	0.00728	0.00742		

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).

$$(N_2O - N)_{(mm)} = \sum_{(S)} \{[\sum_{(T)} N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)}] \bullet EF_{3(S)}\} \quad (6.18)^{71}$$

$(N_2O\text{-}N)_{(mm)}$ – 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 6.36);

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):

$$N_2O_{(mm)} = (N_2O - N)_{(mm)} \bullet 44/28 \quad (6.19)$$

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

[71] IPCC 2000. Agriculture. Equation 4.18. pp. 4.42.

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 1990–2012 were obtained from EARC[72].

Table 6.28. Weight, milk yield per cow and protein content of milk in 1990–2012 (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
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	327.2	116.42
2012	547.8	7 526	3.39	334.4	118.09
IPCC default					
EE[73]	550[(74)]	2 550			70[(75)]
WE	550	4 200			100

The trend in (implied) nitrogen excretion rates reported in the CRF are presented in Table 6.28, nitrogen excretion factors for dairy cattle by county of Estonia in 2012 are presented in Table 6.29.

[72] Results of animal recording in Estonia in 1997–2011. Annual Reports. Available at: www.jkkeskus.ee/page.php?page=0147.
[73] IPCC 1997. Agriculture. Reference Manual. Table 4-4, pp. 4.11 and Table A-1, pp. 4.31.
[74] IPCC 1997. Agriculture. Reference Manual. Table A-1, pp. 4.31.
[75] IPCC 1997. Agriculture, Reference Manual. Table 4-20, pp. 4.99.

Table 6.29. Milk yield per cow, gross intake and nitrogen excretion rate in 2012 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	6 769	315.6	113.84
Hiiu county	5 266	271.5	106.10
Ida-Viru county	6 554	311.6	112.97
Jõgeva county	7 657	337.8	118.96
Järva county	7 816	341.0	120.22
Lääne county	6 802	316.4	114.38
Lääne-Viru county	7 783	339.9	120.02
Põlva county	7 980	347.4	122.34
Pärnu county	7 690	336.9	119.33
Rapla county	7 784	341.7	121.10
Saare county	6 633	311.3	112.27
Tartu county	8 544	355.4	122.98
Valga county	7 125	327.1	116.71
Viljandi county	7 220	327.7	116.79
Võru county	6 948	322.8	115.79

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 6.30.

Table 6.30. Nitrogen excretion rates of non-dairy cattle in 1990–2012, 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)[76]	39.67
Calves (0-6 months)	18.28

6.4.2.2.2. Quantitative overview – Nitrogen excretion by cattle livestock in 2012

The total quantity of nitrogen generated by cattle was 17 720 tonnes in Estonia in 2012. The allocation of nitrogen excreted among different types of MMS is presented in Table 6.31.

Table 6.31. 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

[76] 2-round production cycle was applied for calves (0-6 months and 6-12 months).

Year	Liquid system	Solid storage	Deep litter	Pasture range and paddock	Total nitrogen
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
2012	3 094	6 969	615	7 042	17 720

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 6.32).

Table 6.32. 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[77]

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.

[77] IPCC 1997. Agriculture, Reference Manual. Table 4-20, pp. 4.99.

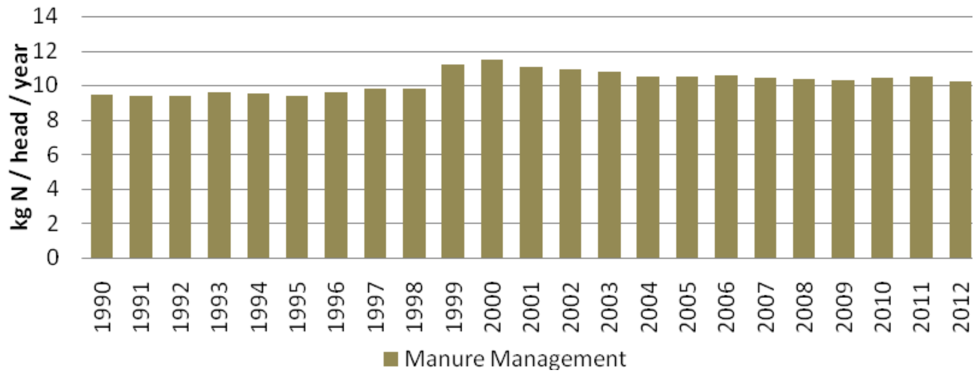

Figure 6.22. Implied swine nitrogen excretion factor reported in the CRF for 1990–2012, kg N/head/year

6.4.2.3.2. Quantitative overview – Nitrogen excretion by swine livestock in 2012

The total quantity of nitrogen generated by pigs was 3 842 tonnes in Estonia in 2012. The allocation of nitrogen excreted among different types of manure management system is presented in Table 6.33.

Table 6.33. 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
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
2012	2 837	994	11	3 842

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 6.26 and nitrogen excretion rates (Table 6.34) were obtained from the Revised 1996 IPCC Guidelines (IPCC, 1997).

Table 6.34. Nitrogen excretion factors per head of animal, kg N/head/year

Livestock category[78]	Nitrogen excretion rate, kg N/head/year
Poultry	0.6
Sheep	16
Horses, Goats	25
Fur farming[79]	
…Foxes and Raccoon	2.3
…Minks	1.3

6.4.2.4.2. Quantitative overview – Nitrogen excretion by other livestock in 2012

The total amount of nitrogen generated by other livestock was 2 876 tonnes in 2012. The breakdown of the quantity of nitrogen excreted by other livestock categories is reported in Table 6.35.

Table 6.35. 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
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	133	1 054	77	1 872	733	2 605
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
2012	1 229	115	155	1 303	75	2 131	745	2 876

[78] IPCC 1997. Agriculture, Reference Manual. Table 4-20, pp. 4.99.
[79] The values of emission excretion rates from manure management of fur animals was provided by an Finish expert in the agriculture sector.

6.4.2.4.3. Quantitative overview – N_2O emissions from manure management systems in Estonia in 2012

The total quantity of nitrogen generated by livestock and stored in solid, liquid and deep litter types of MMSs was 16 640 tonnes in 2012 (Table 6.37). N_2O emissions at 0.346 Gg occurred from the stored manure. The breakdown of N_2O emissions released from different types of manure management systems is reported in Table 6.36.

Table 6.36. Emission factors of manure management practice[80]

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

[80] IPCC 2000. Agriculture. Table 4.12, pp 4.43.

Table 6.37. Total nitrogen (in manure) excreted by livestock and N_2O emissions from manure management systems in Estonia during 1990–2012

Year	Nitrogen excreted, tonnes					N_2O emissions, Gg			
	Liquid/ Slurry	Solid storage	Deep Litter	Pasture/ Range	Total	Liquid/ Slurry	Solid storage	Deep Litter	Total [81]
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	4 926	9 928	435	7 286	22 575	0.008	0.312	0.014	0.334
2008	5 275	10 176	475	7 681	23 607	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
2012	5 931	10 094	615	7 799	24 439	0.009	0.317	0.019	0.346
2012, %	24.3	41.3	2.5	31.9	100	2.7	91.7	5.6	100

[81] 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 6.38).

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 6.38), 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 6.38).

Table 6.38. 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

Activity data on livestock population:

1) Activity data on horse and young cattle population in 2007–2008 were updated due to an update in the Statistics Estonia database;

Initial parameters used to estimate gross energy intake were recalculated (for cattle):
2) data on weight of bovine cattle (aged between 1 and 2 years) were updated;

Nitrogen excretion rates were recalculated:

3) as a result of a question raised by the ERT during the previous review regarding the nitrogen (N) excretion calculation, Estonia has corrected a copy and paste omission in the reporting of N excretion values for dairy cattle and fur-bearing animals in CRF table;

4) nitrogen excretion rates of horses and young cattle were recalculated based on the updated data.

The recalculated data is given in tables 6.39–6.41.

Table 6.39. Nitrogen excretion by cattle livestock categories in 2007–2008, t N/year

Year	Young cattle		Horses	
	Reported in the 2013 submission	Reported in the 2014 submission	Reported in the 2013 submission	Reported in the 2014 submission
2007	4 790	4 767		
2008			130	133

Table 6.40. Nitrogen excretion values for dairy cattle and fur animals, t N/ year

Year	Dairy cattle		Fur animals	
	Reported in the 2013 submission	Reported in the 2014 submission	Reported in the 2013 submission	Reported in the 2014 submission
2011	116.14	116.42	1.41660	1.41885

Table 6.41. N_2O emissions from Estonian livestock MMSs in 2007–2008, Gg

Year	Liquid/Slurry MMS		Solid storage MMS		Deep Litter MMS	
	2013	2014	2013	2014	2013	2014
2007	0.0077	0.0077	0.3124	0.3120	0.0137	0.0137
2008	0.0083	0.0083	0.3197	0.3198	0.0149	0.0149

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 1.36 Gg in Estonia in 2012 (Figure 6.23). N_2O emissions decreased by 57.8% by 2012 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).

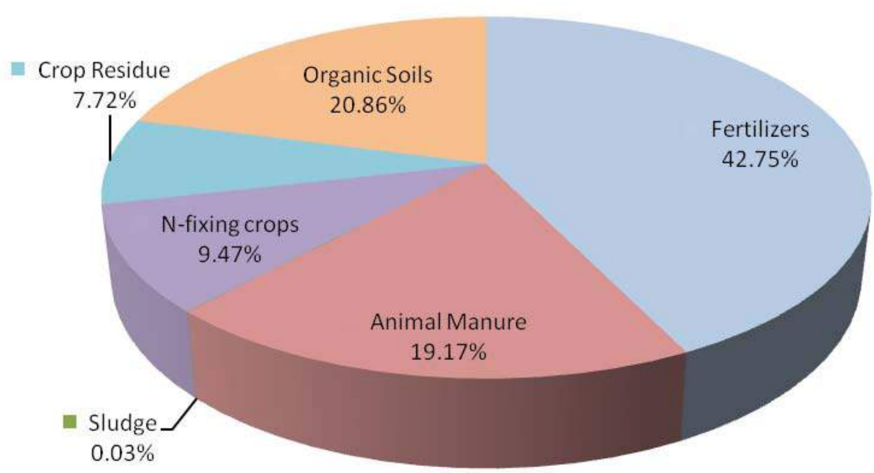

Figure 6.23. Direct N_2O emissions from agricultural soils in Estonia in 2012, %

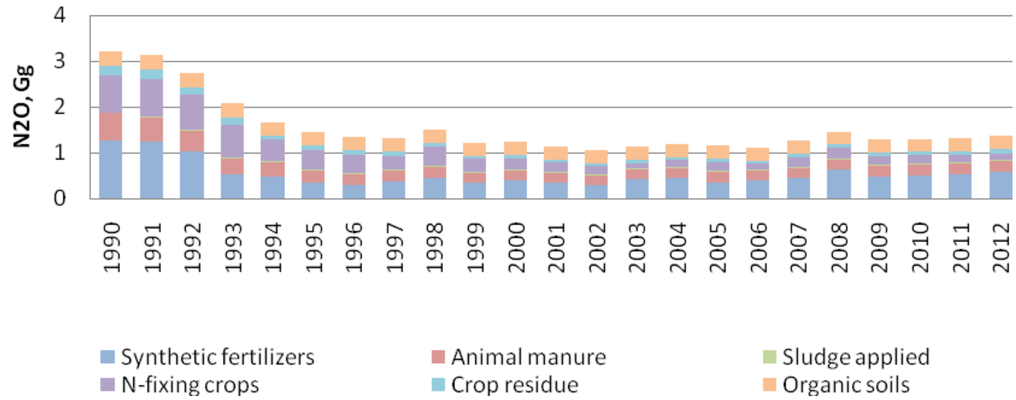

Figure 6.24. Direct N_2O emissions from agricultural soils in Estonia in 1990–2012, Gg

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 EtEA. 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).

$$F_{SN} = N_{FERT} \times (1 - Frac_{GASF})$$
(6.21)[82]

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.);

N_2O emissions into the atmosphere from using of synthetic nitrogen were calculated based on the formula (6.21).

$$N_2O_{direct} - N = F_{SN} \bullet EF_1 \bullet 44/28 \qquad (6.22)$$

Table 6.42. IPCC default factors used in the estimation

Factors	Value
EF_1 for F_{SN}	1.25%[83]
$Frac_{GASF}$	0.1 kg NH_3-N + NO_x-N/kg of synthetic fertilizer nitrogen applied[84]

[82] IPCC 2000. Agriculture. Equation 4.22, pp. 4.56.
[83] IPCC 2000. Agriculture. Table 4-17, pp. 4.60.

6.5.3.1. Quantitative overview – N_2O emissions from synthetic fertilizers applied to soils in 2012

The total N_2O emissions from synthetic fertilizers applied onto agricultural soils were 0.583 Gg in Estonia in 2012 (Figure 6.26). The emissions declined by 54 per cent by 2012 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).

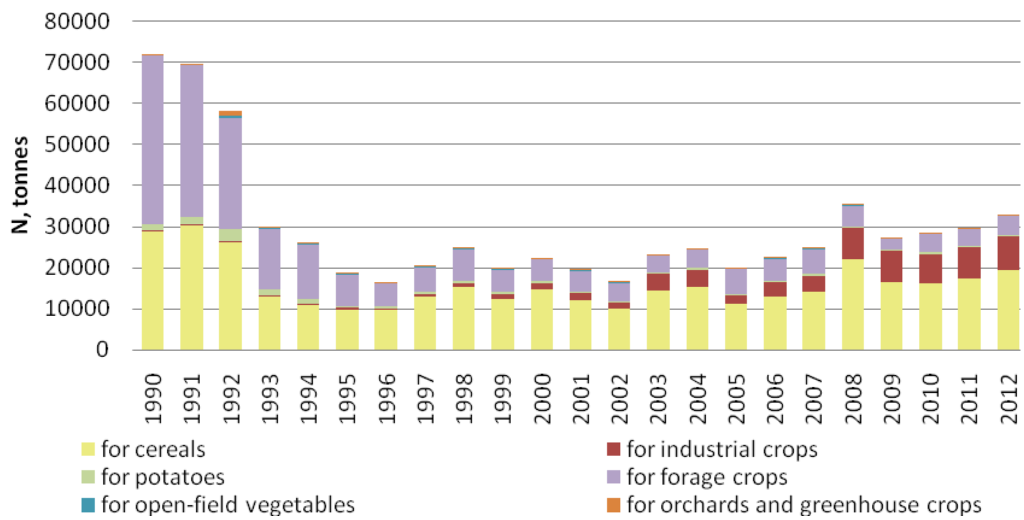

Figure 6.25. Quantity of synthetic fertilizers applied to agricultural soils in 1990–2012 in Estonia, tonnes[85]

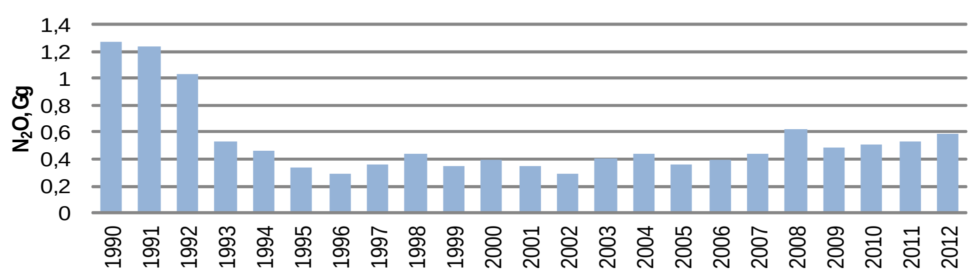

Figure 6.26. N_2O emissions from synthetic fertilizers applied to agricultural soils in 1990–2012 in Estonia, Gg

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.

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[84] IPCC 1997. Agriculture. Reference Manual. Table 4-19, pp. 4.94.
[85] The fraction lost as NH_3 and NO_x has not been substracted.

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).

$$N_2O_{direct} - N = F_{AM} \bullet EF_1 \qquad (6.23)$$

$$F_{AM} = \sum_T (N_{(T)} \bullet Nex_{(T)} \bullet (1 - Frac_{GASM}))[1 - (Frac_{FUEL\text{-}AM} + Frac_{PRP})] \qquad (6.24)$$ [86]

F_{AM} – 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 6.43).

Table 6.43. IPCC default factors used in the estimation of N_2O emissions from animal waste applied to soils[87]

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 2012

The total N_2O emissions from animal manure applied on agricultural soils were 0.261 Gg in Estonia in 2012 (Figure 6.27). The emission decreased by 57 per cent by 2012 compared to the base year, due to the decline in number of livestock population.

[86] IPCC 2000. Agriculture. Equations 4.23, pp 4.56.
[87] IPCC 1997. Agriculture, Reference Manual. Table 4-19, pp. 4.94.

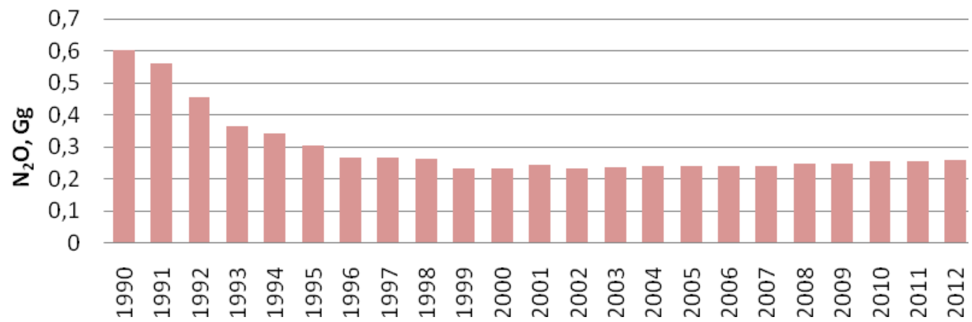

Figure 6.27. N_2O emissions from animal manure applied to agricultural soils in 1990–2012 in Estonia, Gg

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).

$$F_{BN} = \sum_i [Crop_{BF} \bullet (1 + Res_{BF_i} / Crop_{BF_i}) \bullet Frac_{DM_i} \bullet Frac_{NCRBF_i}] \qquad (6.25)$$ [88]

$Crop_{BF}$ – 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;

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 6.44).

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 6.44; production data of N-fixing crops in Estonia in 1990–2011 are presented in Figure 6.29, Figure 6.30.

[88] IPCC 2000. Agriculture. Equation 4.26, pp. 4.57.

6.5.5.2. Quantitative overview – N_2O emissions from growing of N-fixing crops in 2012

The total production of legumes (i.e., dry bean and peas) was 11,462 tonnes and 411,120 tonnes of clover and alfalfa in Estonia in 2012.
The total N_2O emissions from growing of N-fixing crops were 0.129 Gg in Estonia in 2012 (Figure 6.28).

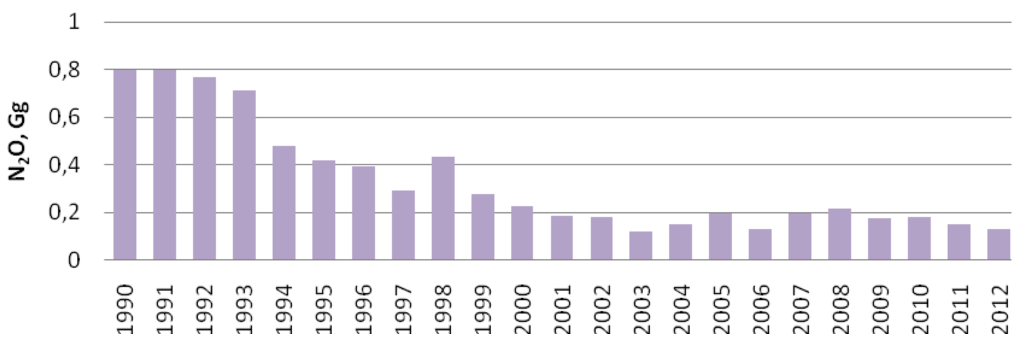

Figure 6.28. N_2O emissions from growing of N-fixing crops in 1990–2012 in Estonia, Gg

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).

$$F_{CF} = \sum_i (Crop_{O_i} \bullet Res_{O_i}/Crop_{O_i} \bullet Frac_{DM_i} \bullet Frac_{NCRO_i}) \bullet (1 - Frac_{BURN_i} - Frac_R) + \sum_j Crop_{O_j} \bullet Res_{O_j}/Crop_{O_j} \bullet Frac_{DM_j} \bullet Frac_{NCRO_j}) \bullet (1 - Frac_{BURN_j} - Frac_R) \quad (6.27)$$[89]

$Crop_{BF}$ - 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.

[89] IPCC 2000. Agriculture. Equation 4.29, pp. 4.59.

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 6.44, Table 6.45.

Table 6.44. 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[90]	-	0.86	0.018
Alfalfa	-	0.86	0.018

Table 6.45. Factors used in the algorithm to estimate N_2O emissions from crop residues[91]

Factor	Unit
$Frac_R$	0 kg N/kg crop-N[92]
$Frac_{BURN}$	0 [(93)], kg N/kg crop-N
EF_1 for F_{CF}	1.25%[(94)]

6.5.6.2. Quantitative overview – N_2O emissions from crop-residues in 2012

In 2012, production of cereals was 991,2 thousand tonnes, maize – 105 thousand tonnes, potatoes – 138.9 thousand tonnes and legumes and fodder roots – 12.9 and 0.2 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).

[90] Austria's NIR 2011, Table 196. pp. 293.
[91] IPCC 1997. Agriculture. Workbook. Table 4-17, pp 4.35.
[92] $Frac_R$ at value of 0 was applied because of a recommendation of the TERT (conducted in 2012).
[93] Since 2007 the activities to burn crop residues have been prohibited by law (Põllumajandusministri määrus nr 57, 20.04.2007 and nr 20, 23.02.2011).
[94] IPCC 2000. Agriculture. Table 4-17, pp. 4.60.

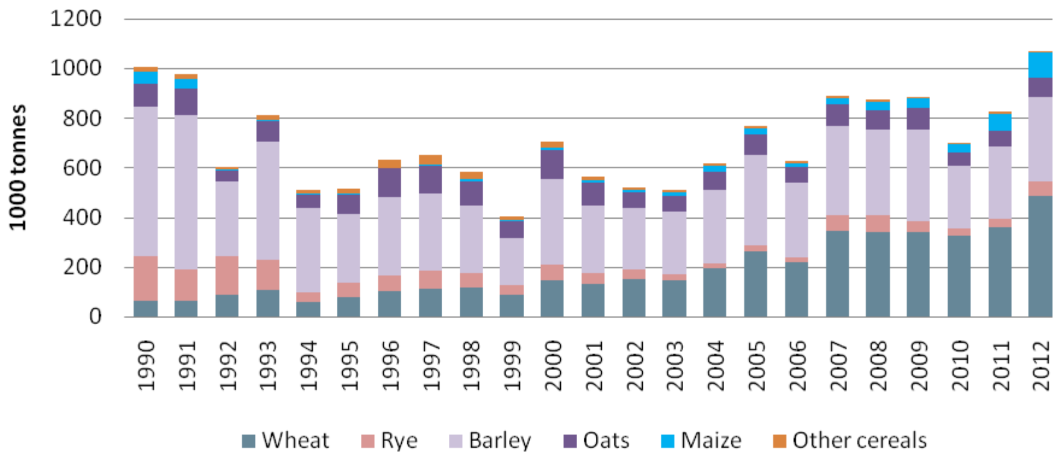

Figure 6.29. Cereals and maize production in 1990–2012 in Estonia, 1000 tonnes

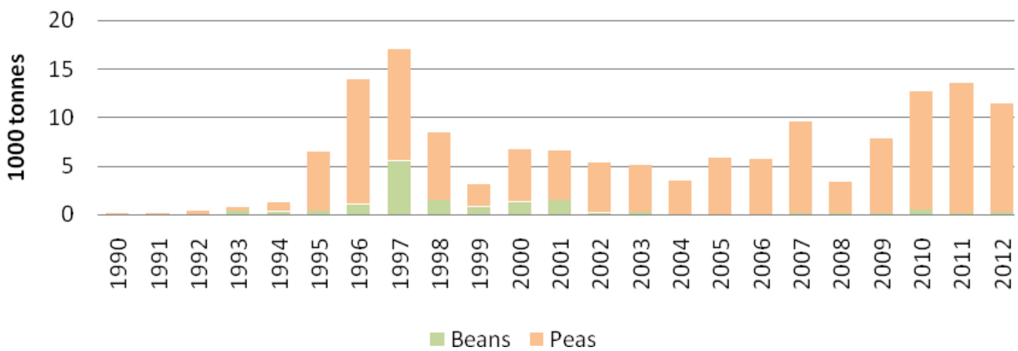

Figure 6.30. Production of legumes in 1990–2012 in Estonia, 1000 tonnes

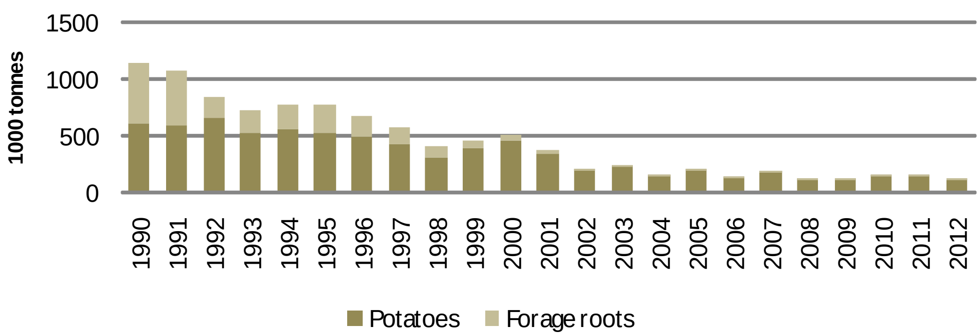

Figure 6.31. Tuber and root production in 1990–2012 in Estonia, 1000 tonnes

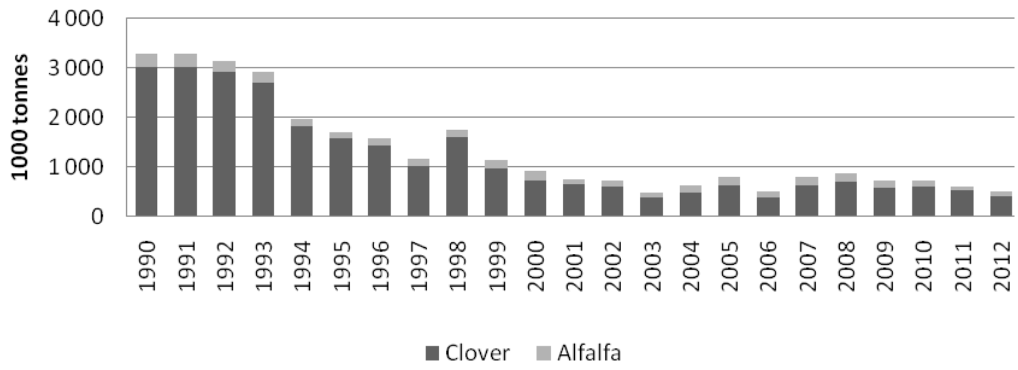

Figure 6.32. Clover and alfalfa production in 1990–2012 in Estonia, 1000 tonnes

The total N_2O emissions from crop residues left on agricultural land was 0.084 Gg in 2012 (Figure 6.33).

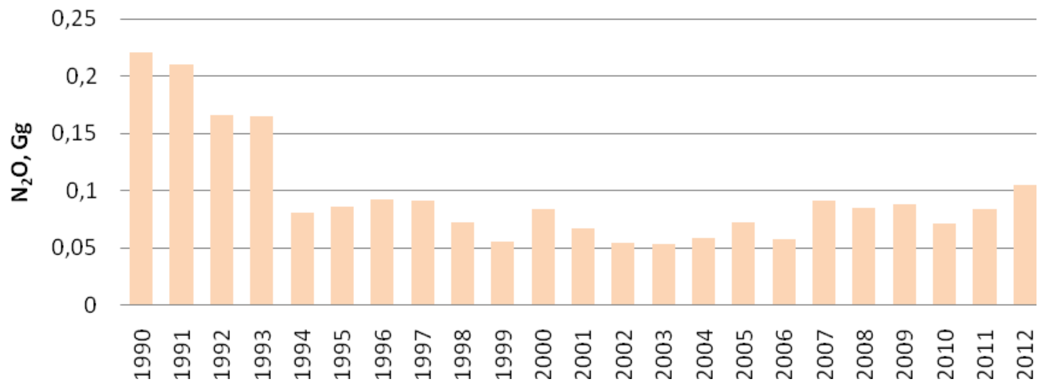

Figure 6.33. N_2O emissions from crop residues left on agricultural fields in 1990–2012 in Estonia, Gg

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).

$$N_2O_{direct} = F_{OS} \bullet EF_2 \bullet 44/28 \qquad (6.29)$$

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 6.46).

Table 6.46. Factors used in the algorithm used to estimate N_2O emission from cultivated organic soils [95]

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 0.284 Gg in 2012 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).

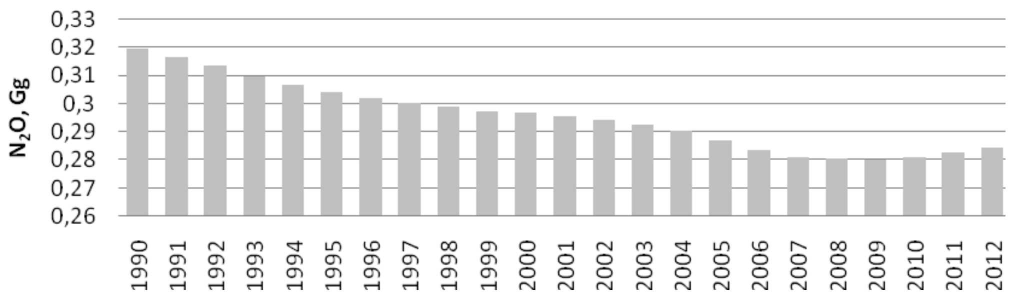

Figure 6.34. N_2O emissions from cultivation of organic soils in Estonia in 1990–2012, Gg

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 6.47 illustrates amounts of sewage sludge used for improvement of environmental situation (R10). Data for years 1999–2012 were obtained from datasets of EtEA.

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 6.47).

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).

[95] IPCC 2000. Agriculture. Table 4.17, pp. 4.60.

Table 6.47. Amounts of municipal sludge application on agricultural land, tonnes[96]

Year	R10
1990	7 434
1991	7 825
1992	8 237
1993	9 081
1994	14 306
1995	27 073
1996	30 041
1997	30 028
1998	12 724
1999	17 302
2000	26 489
2001	2 770
2002	4 048
2003	9 799
2004	1 025
2005	6 992
2006	12 285
2007	24 292
2008	18 948
2009	15 189
2010	23 663
2011	4 317
2012	4 193

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).

$$F_{SL} = N_{FERT} \times (1 - Frac_{GASM}) \quad (6.30)$$ [97]

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 6.48.

Table 6.48. Parameters and factors used in the estimates

Factor	Value	
FracGASM[98]	0.20	kg NH_3-N+NOx-N/kg of sludge nitrogen applied
EF for F_{SL}	1.25%	
N content of sewage sludge[99]	4.9	% dry matter

[96] R10 of the European Waste Catalogue (2002) – Land treatment resulting in benefit to agriculture or ecological improvement.
[97] IPCC 1997. Agriculture. Workbook. Equation1, pp. 4.33.
[98] IPCC 1997. Agriculture. Reference Manual. Table 4-19, pp. 4.94.
[99] (Final report, 2008).

6.5.8.2. Quantitative overview – N_2O emissions from sludge applied on agricultural land in 2012 (CRF 4.D.1.6)

The total N_2O emissions from sludge applied on agricultural land were 0.0003 Gg in Estonia in 2012 (Figure 6.35).

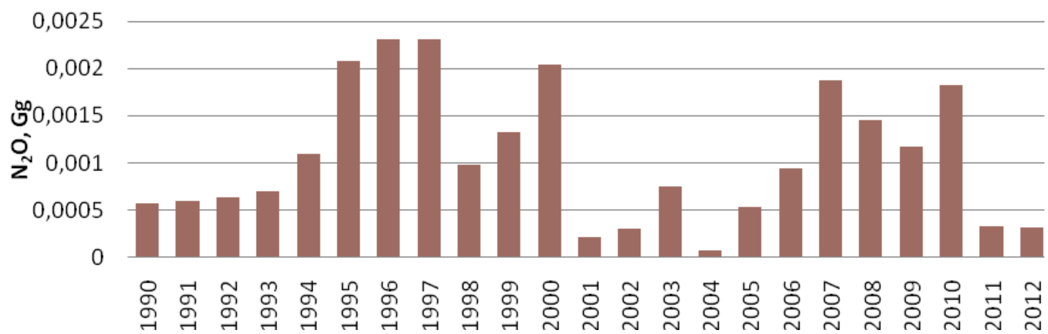

Figure 6.35. N_2O emissions from sewage sludge applied on agricultural land in Estonia in 1990–2012, Gg

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 6.49).

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 6.49) (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 6.49) as the value of the factor is 0.0125 with a range of 0.0025–0.0225 (IPCC, 1997).

Table 6.49. 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

(1) 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). The results of the recalculations performed are presented in Table 6.50.

(2) Sewage sludge applied on agricultural lands (CRF 4.D.1.5) – data on quantities of sewage sludge used in 2002–2011 for land treatment resulting in benefit to agriculture or ecological improvement were revised by the EtEA. The changes in quantities of sewage sludge affected the years 2002, 2007, 2010 and 2011. According to the revised activity data the recalculated N_2O emissions from sewage sludge application on agricultural soils for 2002, 2007, 2010 and 2011 are reported in Table 6.51.

(3) During the 2012 review ERT noted that, in the calculation of N_2O emissions from atmospheric deposition of nitrogen after application of sewage sludge to soils, Estonia

inappropriately used the default IPCC good practice guidance value for the fraction of nitrogen that volatilizes as ammonia (NH_3) and nitrogen oxides (NO_X) from synthetic fertilizers (0.1; $Frac_{GASF}$) instead of the default value for the fraction of nitrogen that volatilizes as NH_3 and NO_X from animal manure (0.2; $Frac_{GASM}$). In the 2014 submission the methodology of reporting direct N_2O emissions from sewage sludge application on agricultural soils was also adjusted accordingly and the correct value (0.2; $Frac_{GASM}$) for the whole timeseries was used in the calculations. The results of the recalculations performed for the years 1990–2011 are presented in Table 6.51.

Table 6.50. N_2O emissions due to cultivation of organic soils in 1990–2011, Gg

Year	Reported N_2O emissions in the 2013 submission	Reported N_2O emissions in the 2014 submission
1990	0.2869	0.3198
1991	0.2828	0.3167
1992	0.2787	0.3136
1993	0.2737	0.3098
1994	0.2696	0.3067
1995	0.2662	0.3041
1996	0.2636	0.3022
1997	0.2619	0.3002
1998	0.2610	0.2989
1999	0.2601	0.2976
2000	0.2601	0.2969
2001	0.2601	0.2956
2002	0.2601	0.2945
2003	0.2601	0.2927
2004	0.2595	0.2905
2005	0.2590	0.2870
2006	0.2585	0.2835
2007	0.2586	0.2812
2008	0.2599	0.2804
2009	0.2617	0.2800
2010	0.2642	0.2809
2011	0.2674	0.2828

Table 6.51. N_2O emissions from sewage sludge application on agricultural soils in 1990–2011, Gg

Year	Reported N_2O emissions in the 2013 submission	Recalculated N_2O emissions in the 2014 submission
1990	0.000644	0.000572
1991	0.000678	0.000603
1992	0.000714	0.000634
1993	0.000787	0.000699
1994	0.001239	0.001102
1995	0.002345	0.002085
1996	0.002602	0.002313
1997	0.002601	0.002312
1998	0.001102	0.000980
1999	0.001499	0.001332
2000	0.002295	0.002040
2001	0.000240	0.000213
2002	0.000986	0.000312
2003	0.000849	0.000755
2004	0.000089	0.000079
2005	0.000606	0.000538
2006	0.001064	0.000946

Year	Reported N_2O emissions in the 2013 submission	Recalculated N_2O emissions in the 2014 submission
2007	0.000389	0.001870
2008	0.001641	0.001459
2009	0.001316	0.001170
2010	0.001806	0.001822
2011	0.002884	0.000332

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 burnt) 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 2012

The total N_2O emissions from pasture, range and paddock made up 0.245 Gg in 2012. The emission decreased by 62 per cent compared to the base year due to decline in number of livestock population (Figure 6.36).

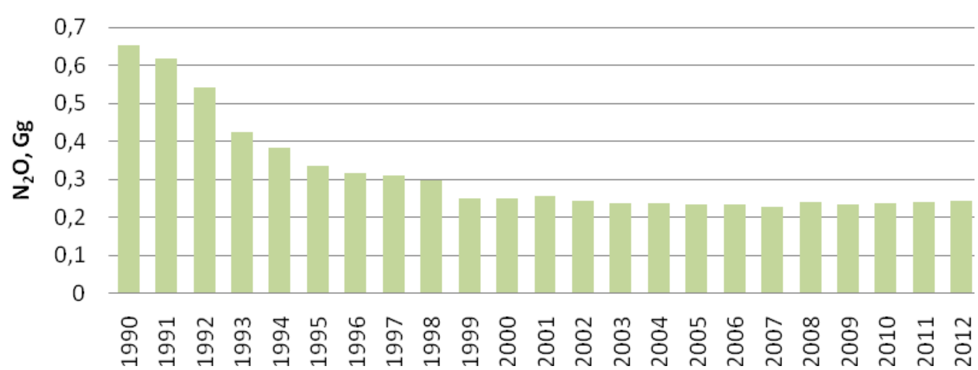

Figure 6.36. N_2O emissions from pasture, range and paddock in 1990–2012, Gg

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 2014 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 6.52.

In addition there was an omission amended in the reporting of activity data for pasture in CRF table 4.D for 2011 which results are presented in Table 6.53.

Table 6.52. N_2O emissions from pasture, range and paddock manure management in 2007–2008, Gg

Year	Reported N_2O emissions in the 2013 submission	Reported N_2O emissions in the 2014 submission
2007	0.230	0.229
2008	0.242	0.241

Table 6.53. N excretion on pasture range and paddock, kgN/year

Year	Reported in the 2013 submission	Reported in the 2014 submission
2011	7 636 210	7 641 558

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 0.806 Gg in 2012 (Figure 6.37). The emissions declined by 56 per cent by 2012 due to decrease in number of livestock population and synthetic and sludge application onto agricultural land.

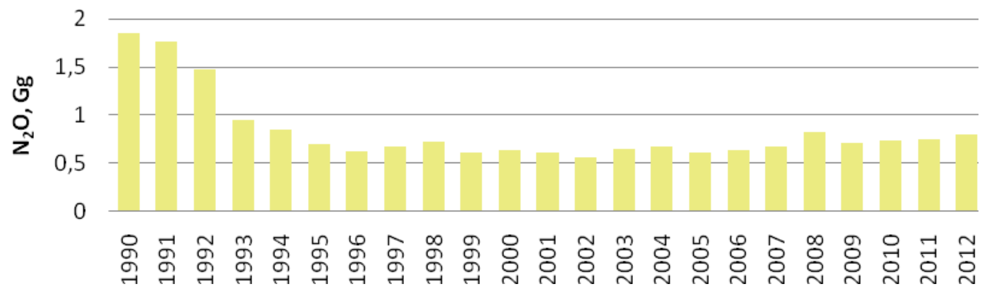

Figure 6.37. Indirect N_2O emissions from agricultural soils in Estonia in 1990–2012, Gg

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)[100]

$N_2O_{(G)}$ – 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 6.54);

$Frac_{GASM}$ – 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 6.54);

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 6.54).

Table 6.54. 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[101]
$Frac_{GASM}$	0.2 kg NH_3-N + NO_x-N/kg of nitrogen excreted by livestock[102]
EF_4	0.01 kg N_2O-N per kg NH_3-N and NO_x-N emitted[103]

[100] IPCC 2000. Agriculture. Equation 4.32, pp 4.70.
[101] IPCC 1997. Agriculture. Workbook. Table 4-17, pp. 4.35.
[102] IPCC 1997. Agriculture. Workbook. Table 4-17, pp. 4.35.

6.7.2.2. Quantitative overview – Atmospheric deposition of NO_x and NH_4 in 2012

Total N_2O emissions from atmospheric deposition were 0.129 Gg in 2012 in Estonia (Figure 6.38). The emissions decreased by 57 per cent by 2012 compared to the base year.

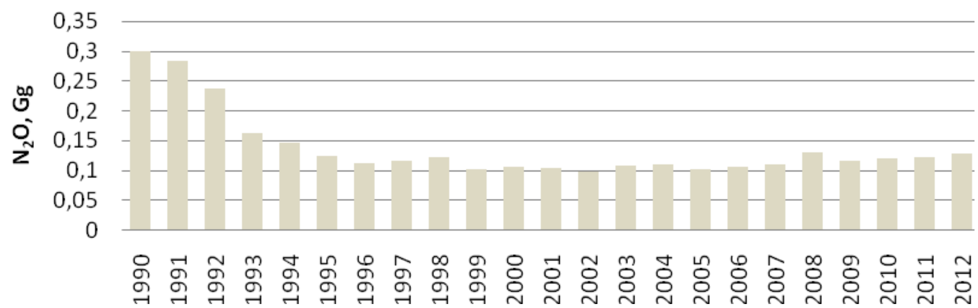

Figure 6.38. Atmospheric deposition of NO_x and NH_4 in 1990–2012, Gg

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).

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

(6.33)[104]

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 6.54).

Table 6.54. 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[105]
EF_5	0.025 kg N_2O-N per kg NH_3-N and NO_x-N emitted[106]

[103] IPCC 1997. Agriculture. Reference Manual. Table 4-23, pp. 4.105.
[104] IPCC 2000. Agriculture. Equation 4.36, pp. 4.71.
[105] IPCC 1997. Agriculture. Workbook. Table 4-17, pp. 4.35.
[106] IPCC 2000. Agriculture. Table 4-18, pp. 4.73.

6.7.3.2. Quantitative overview – Leaching/Run-off of applied or deposited nitrogen in 2012

The total N_2O emissions from leaching and run-off were 0.677 Gg in 2012 in Estonia (Figure 6.39). The emissions decreased by 56 % by 2012 in comparison with the base year.

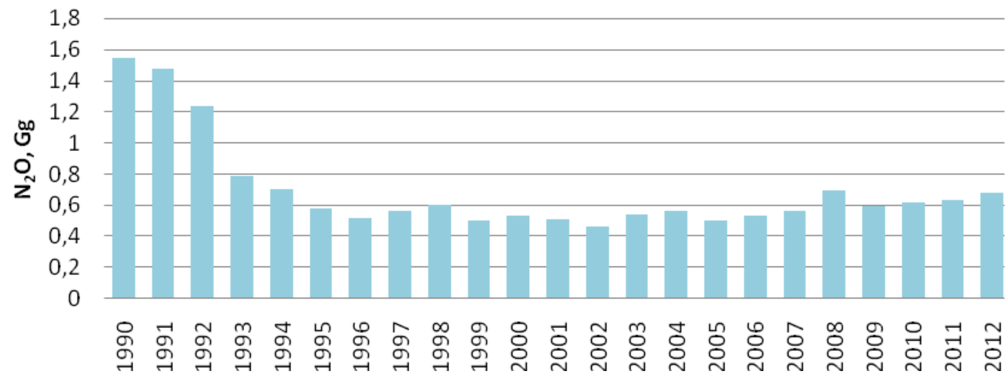

Figure 6.39. Leaching and run-off of NO_x and NH_4 in 1990–2012 in Estonia, Gg

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 6.55).

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 6.55).

Table 6.55. Estimated values of uncertainties used in agriculture sector

Input	Uncertainties	References
Activity data		
Estonia's livestock population (cattle,		

Input	Uncertainties	References
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 since the data on quantities of sewage sludge used in 2002–2011 for land treatment resulting in benefit to agriculture or ecological improvement were revised by the EtEA.

The results of the recalculations reported in the 2014 submission are provided in Table 6.56.

Table 6.56. Indirect N_2O emissions from agricultural soils in Estonia in 2002, 2007, 2010 and 2011, Gg

Year	Reported N_2O emissions in the 2013 submission	Recalculated N_2O emissions in the 2014 submission
2002	0.5625	0.5619
2007	0.6714	0.6725
2010	0.7393	0.7395
2011	0.7578	0.7557

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):

$$DM_{BN} = Crop_{BN} \times RC_{RATIO} \times DM_{FRACTION} \qquad (6.34)$$

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.

$$TBB = DM_{BN} \times OX \qquad (6.35)$$

TBB – Total biomass burned, Gg;

OX – Fraction of biomass oxidized for each crop type (default 0.9[107]).

$$C\_emission = TBB \times Cfraction \times Ratios\_for\_CH_4\_or\_CO \qquad (6.36)$$

$$N\_emission = TBB \times Nfraction \times Ratios\_for\_N_2O\_or\_NO_X$$

C_emission – Emissions of carbon as methane and carbon monoxide (CO), Gg;

Cfraction – carbon content of each crop type, GgC/Gg DM;

[107] IPCC 1997. Agriculture. Workbook. pp. 4.30

Ratios for CH_4 or CO – Emissions ratios for CH_4 or CO (IPCC, 1997) [108];

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).

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 and Figure 6.41.

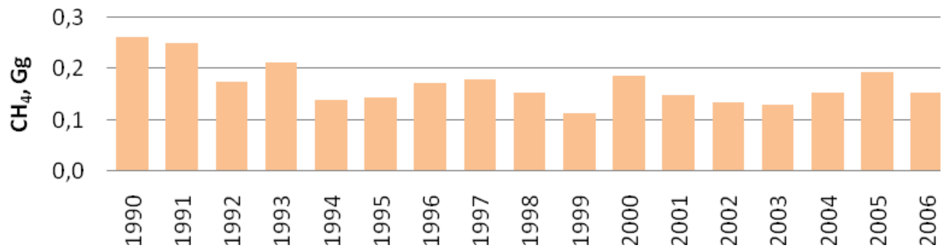

Figure 6.40. CH_4 emissions from field burning of agricultural residues in 1990–2006, Gg

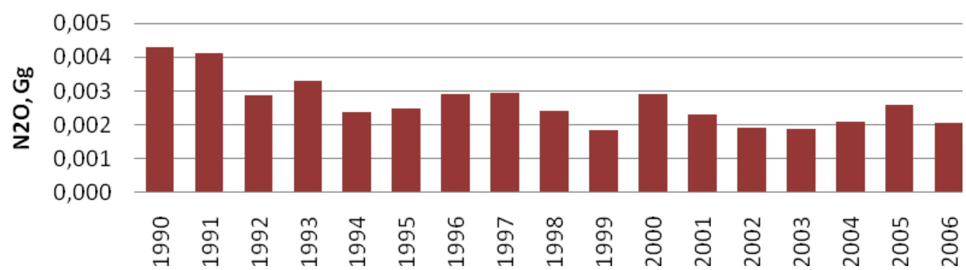

Figure 6.41. N_2O emissions from field burning of agricultural residues in 1990–2006, Gg

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 6.57).

Table 6.57. 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		

[108] IPCC 1997. Agriculture. Reference Manual. Table 4-16, pp. 4.31

Input	Uncertainties	References
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 the 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 the 2011 submission, the area of Estonia has been reported using *Approach 2* method that allows to track land-use transitions between categories.

In 2012, LULUCF sector acted as a CO_2 sink, resulting in net carbon uptake about 1 951 Gg CO_2 equivalent (Figure 2.9), meaning that total removals arising from the sector exceed total emissions.

In the 2014 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, 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, Grassland and Wetlands conversion to Other land.

Estonia does not have currently 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 from the Sweden National Inventory Report 2013[109]. Estonia has launched several projects aimed to get country-

[109] This approach is approved by ERT (FCCC/ARR/2012/EST para.94, 104; FCCC/ARR/2013/EST para. 63)

specific data regarding omitted pools for future submissions (see Chapters 7.2.6, 7.3.6 & 7.4.6 Source-specific planned improvements).

The *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 peatland emissions.

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	D, OTH	NA	NA	NA	NA
Biomass Burning	IE[110]		T2	D	T2	D
Land converted to Forest Land	T1, T2	D, 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, OTH	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[111]	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[112]	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	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.

The LULUCF sector inventory is carried out by the Estonian Environment Agency (EtEA, former Estonian Environment Information Centre), department of Forest Monitoring. Additionally, annual reports published by different institutions (EtEA, Ministry of Agriculture, Statistics Estonia (SE) etc.; see Table 7.2) have been used in the estimation of carbon fluxes related to the LULUCF sector.

[110] The stock-change method used for biomass estimates includes CO_2 loss from burning.
[111] 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.
[112] SS reporting is not mandatory.

Table 7.2. List of institutions (datasets) involved in the inventory of the LULUCF sector

References	Link	Abbreviation	Activity
Estonian Environment Agency	www.keskkonnainfo.ee	EtEA	- collecting and providing data for the 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 1990–2012 - wildfires inventory in field (started 2013) - area and amount of storm-damaged forest
Estonian Rescue Service; State Forest Management Centre	www.rescue.ee www.rmk.ee	ERS; SFMC	- collecting and publishing data on forest fires (location, type, cause etc)
Statistics Estonia	www.stat.ee	SE	- providing data on liming (2009–2012) - area of orchards - area of storm damaged forest
Ministry of Agriculture	www.agri.ee	MoA	- providing data on liming (1990–2008)
Estonian Peat Assocciation	www.turbaliit.ee	-	- providing data on peat extraction
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 50.2% in 2012 (an increase of 289 thousand hectares). The increase has taken place mostly due to the abandonment of grasslands and the overgrowth of wetlands. The area of grasslands and wetlands decreased 463 and 69 thousand hectares, respectively, during the same period. The area of agricultural land – cropland increased until the 1990s and started to decline after that due to the economical processes taking place in the Estonian agricultural sector. Cropland area has been on a rising trend again since the last decade due to the increasing subsidies from the government and the European Union. The area of settlements has been increasing continuously, about 32% during the period of last forty years.

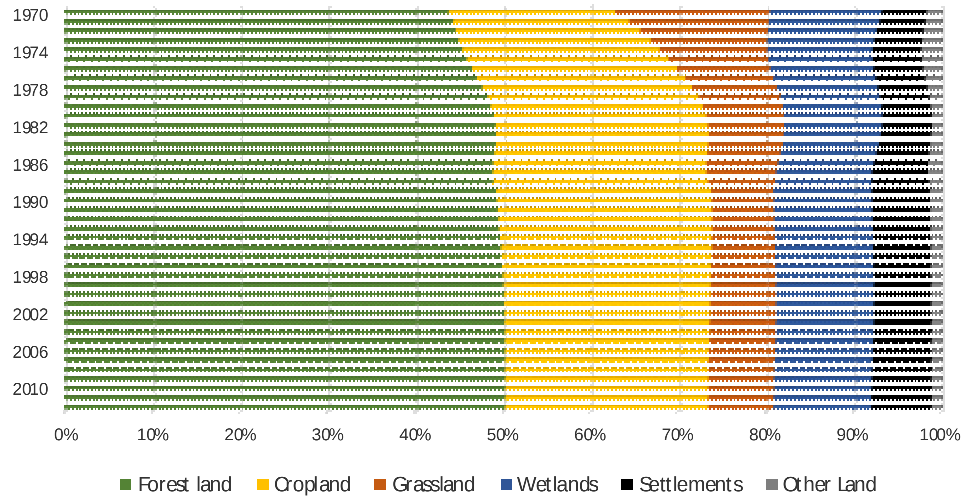

Figure 7.1. Land use in Estonia in 1970–2012, %

The areas of land use defined in accordance with the IPCC land use definitions are reported in Table 7.3. Peat extraction sites are a 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, the 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 the National Forest Inventory (NFI). The 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[113]–2012 (NFI), 1000 ha

	Forest land	Cropland	Grassland	Unmanaged wetlands	Peatland (Wetlands)	Settlements	Other land
1989	2 227.4	1 107.7	322.3	492.31	15.56	297.0	60.4
1990	2 231.1	1 105.9	321.9	492.24	15.58	296.4	59.6
1991	2 234.8	1 103.7	321.8	492.07	15.59	295.9	58.8
1992	2 238.3	1 101.1	322.2	491.84	15.68	295.5	58.1
1993	2 241.7	1 097.7	323.5	491.46	15.76	295.1	57.5
1994	2 245.2	1 093.5	325.2	491.08	15.85	294.8	57.0
1995	2 248.9	1 089.1	327.0	490.69	15.94	294.6	56.6
1996	2 252.3	1 084.2	329.4	490.35	16.02	294.4	56.1

[113] These are areas in the end of the year, eg 1989 is the area in 31.12.1989 and is applied as the initial area in 1990.

	Forest land	Cropland	Grassland	Unmanaged wetlands	Peatland (Wetlands)	Settlements	Other land
1997	2 255.5	1 079.3	332.0	490.04	16.02	294.2	55.6
1998	2 258.7	1 074.9	334.4	489.81	16.02	293.9	55.1
1999	2 261.3	1 071.0	336.6	489.61	16.02	293.6	54.5
2000	2 263.3	1 067.7	338.9	489.29	16.02	293.5	53.9
2001	2 265.0	1 064.6	340.8	489.08	16.02	293.7	53.5
2002	2 266.3	1 062.0	341.9	488.88	16.02	294.4	53.2
2003	2 267.3	1 059.8	342.5	488.74	16.02	295.5	52.9
2004	2 268.2	1 057.7	342.7	488.64	16.11	296.9	52.5
2005	2 269.0	1 055.7	342.1	488.51	16.31	298.7	52.3
2006	2 269.6	1 054.2	341.3	488.30	16.52	300.7	52.1
2007	2 270.1	1 052.8	340.5	488.12	16.73	302.6	51.9
2008	2 270.0	1 051.8	339.7	487.93	17.20	304.3	51.8
2009	2 269.7	1 051.2	338.9	487.60	17.58	305.9	51.8
2010	2 269.5	1 050.9	338.4	487.40	17.84	307.0	51.6
2011	2 269.3	1 050.9	337.6	487.24	18.18	307.8	51.6
2012	2 269.2	1 051.2	336.7	487.03	18.59	308.3	51.6

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 73% of all LULUCF sector emissions in absolute values (Figure 2.9). Emissions and uptake from forest land is predominantly determined by changes in forest growing stock. For the period 1990−1998, the growing stock of forest land has been extrapolated based on Estonia Land Board data. In 1999 the National Forest Inventory (NFI) was established, and since then estimations are obtained from annual field inventory.

Forest is the prevailing land-use category in Estonia. Due to the comparatively intensive use of forest resources, carbon flows derived from the forest category have the largest influence on the whole LULUCF sector's total carbon balance, being also the major cause of emissions in the 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 1992, 2002 and 2006, extensive wildfires spread, having impact on the annual emissions of these years. Inter-annual variability in estimates is also influenced by statistical fluctuation of activity data caused by random error of sampling.

Figure 7.2, Figure 7.3 and Figure 7.4 show LULUCF sector emissions by gas during the period 1990–2012.

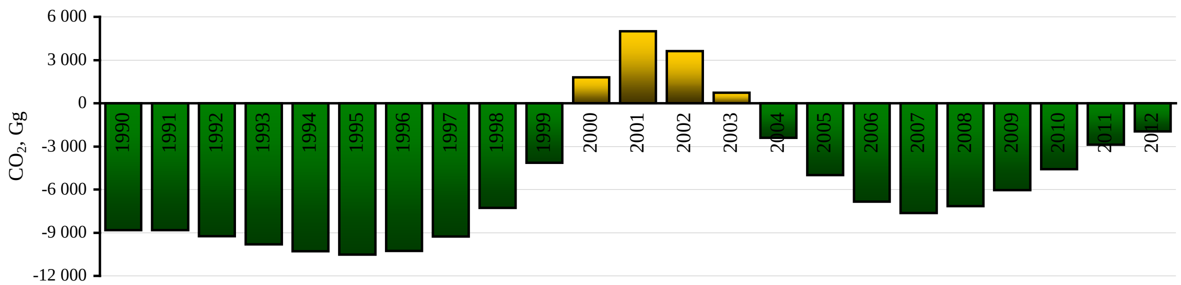

Figure 7.2. Annual change in emissions/removals of CO_2 from Estonian LULUCF sector in 1990−2012, CO_2 Gg

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.

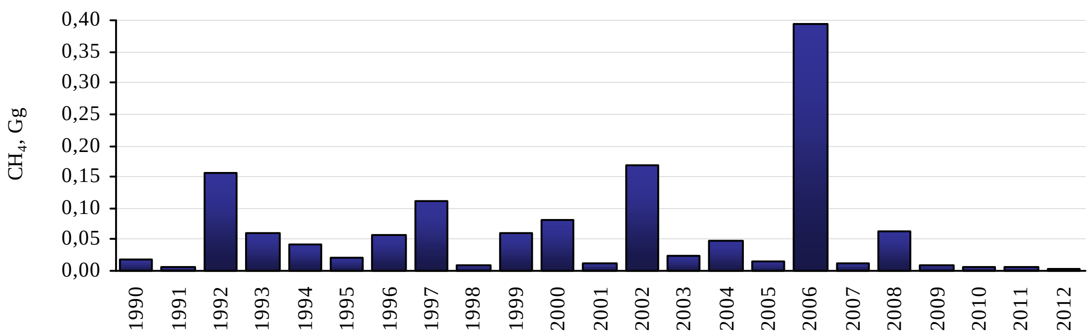

Figure 7.3. Emissions of CH_4 from the LULUCF sector in Estonia in 1990–2012, CH_4 Gg

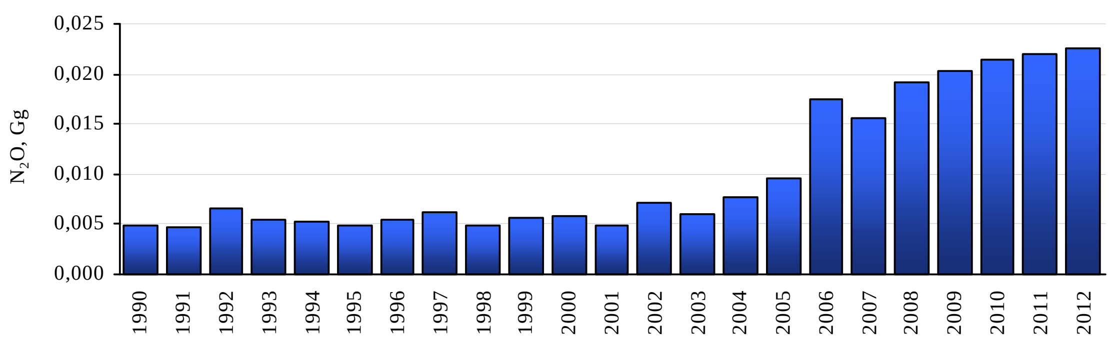

Figure 7.4. Emissions of N_2O from the LULUCF sector in Estonia in 1990–2012, N_2O Gg

Large inter-annual differences in emissions of non-CO_2 gases are caused mainly by the unpredictable 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

LULUCF land categories presented in the inventory report 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 obtained from the NFI and carried out by the Forest Monitoring Department of the Estonian Environment Agency.

The NFI is a systematic collection of forest information on randomly based sample plots that cover the whole country (Figure 7.5) and all land-use classes. The NFI also provides information on soils, distribution of 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 7.6). 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 31.12.2012. The 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 23 years. This change is mostly a result of reallocation of grasslands to the forest land category, when the tree crown cover of grasslands exceeds 30% due to natural succession, then the land is counted as forest land.

Table 7.4. The land-use change matrix for IPCC land-use categories from 31.12.1989 to 31.12.2012 (1 000 ha)

	Initial						
Final	**Forest land**	**Cropland**	**Grass-land**	**Wetlands**	**Settle-ments**	**Other land**	**Final area**
Forest land	2 214.37	16.7	21.98	5.88	3.06	7.20	2 269.20
Cropland	0.00	1041.08	10.14	0.00	0.00	0.00	1 051.22
Grassland	5.76	40.90	286.10	1.00	1.92	1.07	336.74
Wetlands	3.47	0.00	0.26	500.63	0.00	1.26	505.63
Settlements	8.80	4.55	3.26	0.00	290.91	0.77	308.29
Other land	2.42	0.48	0.06	0.14	0.00	48.52	51.63
Initial area	2 227.4	1 107.7	322.3	507.9	297.0	60.4	4 522.71
LUC since 1990	20.45	62.64	35.70	7.03	4.98	10.30	
Change 2012/1990 %	1.9	-5.1	4.5	-0.4	3.8	-14.5	

Implementation of IPCC land-use categories in the Estonian inventory is described below.

7.1.2.1. Forest land and definitions

Under the Kyoto Protocol, Parties are requested to make national parameter choices for the forest definition within the ranges allowed by Decision 16/CMP.1. Estonia established the ‘definition of forest in the context of the Kyoto Protocol’ in 2006 with the main parameters of the forest definition shown in Table 7.5. Estonia applies the same forest definition for both UNFCCC and KP reporting.

Table 7.5. Parameters for forest definition

Minimum tree crown cover	30%
Minimum land area	0.5 ha
Minimum tree height	2 m

The definition of forest has been amended several times in the Estonian Forest Act 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.

To meet the requirements of UNFCCC and its Kyoto protocol reporting, the NFI is compiling statistical analyses based on both the national and the Kyoto Protocol definition of a forest regarding the minimum area of a forest. The NFI has been recording information on forests, which remain in the area between 0.1 ha and 0.5 ha due to the fact that criterion of 0.5 ha has been a minimum forest area in one of the earlier redactions of the Forest Act, thus there is activity data that is applicable for LULUCF reporting. The same information is used for estimating forest area according to the FRA definition

The criterion of 1.3 m has caused some confusion in earlier greenhouse gas inventory reports; however it should be noted that it is not 'the minimum tree height' in context of the forest land definition. Actually, 1.3 m is the criteria for counting unstocked forest area as stocked forest. The minimum tree height *in situ* by the forest definition of the Forest Act is defined by tree species, the stand's age and site index. Thus, there is no constant criteria for tree height in the national definition. As there are no forest‒tree species in Estonia that could not reach the height of 2 m at maturity, the hight criterion of the Kyoto Protocol forest definition has been met in NFI statistics.

All temporarily unstocked forest areas and regeneration areas which have yet to reach a crown density of 30 per cent and a tree height of 2 meters are also included as forest, as are areas 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.

All forest land is considered managed in Estonia – 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 or perennial crops are growing (incl. fallow, orchards, short-term and long-term cultural grasslands and temporary greenhouses)'. It does not include built garden land 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 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 and grassland from wild lands (– 'natural grassland'). Overgrown wooded pasture with canopy cover between 30 and 50% is classified as grassland or forest, depending on the main land-use purpose.

The 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[114].

7.1.2.4. Wetlands

Land permanently saturated by water and/or areas where the peat layer is at least 30 cm and the minimum potential tree height does not conform to the forest land definition. It does include smaller bog holes.

The NFI wetland areas are defined as IPCC wetlands. Activity data is obtained from the NFI (for 1990–2012) and Land Balances (for 1970–1989).

7.1.2.5. Settlements

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 (including permanent greenhouses), and open cast areas (except peat extraction areas) are reported under the settlements land-use category (Table 7.3). Activity data on settlements area is obtained from the NFI (for 1990−2012) 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

[114] Area of bushes was reported under 'Other lands' until the 2009 submission. It was recommended by the ERT to include areas of bushes to 'Grassland' category.

forest survey too. The planned economy, which had existed for 50 years, was replaced by a market economy resulting in the intensive cutting of forests. As 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 Estonian forests. Intensified forest management together with 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 the 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.

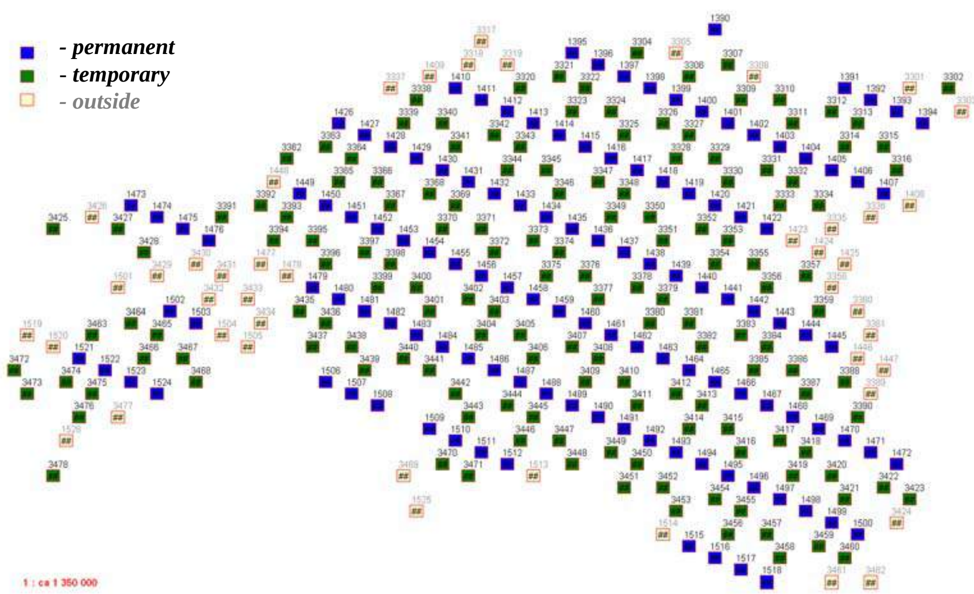

Figure 7.5. Cluster network of Estonian national forest inventory

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 the effective management of forests and future projections – in large-area forest management planning such as pland for cutting forests at the national level. At present, the actual themes of the NFI monitoring system include global carbon cycles and the 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 under the United Nations Framework Convention on Climate Change.

Statistical design of 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.

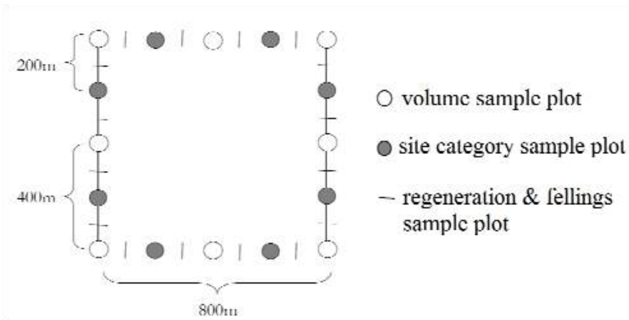

Figure 7.6. Estonian NFI cluster design

Sample plots are organized into clusters (Figure 7.6) 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 the National Forest Inventories[115] (2010).

In order to collect data about land-use transitions, additional field studies started in 2009 in the framework of NFI. This method follows the example of the Finnish. Collected data and 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 the 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

[115] pp.177-183; http://www.springer.com/life+sciences/forestry/book/978-90-481-3232-4.

1999 there has been information available on permanent sample plots. The resulting data set is a matrix with 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.

The NFI determines more land categories than in the IPCC GPG LULUCF, therefore some aggregation has been made, which is shown in Table 7.6.

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																	
Forest land (M)	Unstocked forest land (MM)	Low productive 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. LULUCF cross-cutting issue: climate zones

According to GPG-LULUCF 2003 and IPCC 2006 Vol. 4, Estonia is near the transitional border of the boreal and cold temperate climatic zones, falling under the cold temperate moist climate designation. However, most recent reports (e.g. the 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 the boreal zone is selected for Forest Land category. Grasslands biomass parameters are also chosen from Boreal zone. All other land-use categories follow the default allocation by IPCC 2003.

The issue related to using emission factors from different climate zones was also raised by the Joint Research Centre of the European Commission during assistance[116] in 2013. Since soil, biomass and other parameter values for the abovementioned climate zones are significantly different, it may cause a large bias under land-use change estimates, when the lands are in different climate zones. However, this is not the case in the current report, as most land-use change emission factors for soil are

[116] ADMINISTRATIVE ARRANGEMENT Nº071201/2011/611111/CLIMA.A2 (Analysis of and proposals for enhancing, monitoring, reporting and verification of land use, land use change and forestry in the EU - LULUCF MRV).

obtained from the Swedish inventory report because Estonia does not currently have respective country-specific values. In some cases, e.g. cropland mineral and organic soil, emission factors have the same value in both boreal and temperate zones[117].

Estonia assessed the impact of using temperate zone factors instead of the boreal zone for living biomass estimates[118]. The result was that CO_2 sink increased almost 2 fold, which is an obvious overestimation based on expert opinions and does not follow the UNFCCC recommended conservative approach. For those reasons, Estonia has decided to continue using boreal climate zone parameters in the forest land category.

7.1.5. Key Categories

The key categories of the 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. The LULUCF sector constitutes 25% of the total inventory emissions in absolute values.

Table 7.7. Key categories in the LULUCF sector (CRF 5) in 2012 (quantitative approach, Tier 2)

IPCC source category		**Gas**	**Identification criteria**
5.A.1	Forest Land remaining Forest Land - living biomass	CO_2	Level (1990, 2012), Trend
5.A.1	Forest Land remaining Forest Land - mineral soils	CO_2	Level (1990, 2012), Trend
5.A.1	Forest Land remaining Forest Land - organic soils	CO_2	Level (1990, 2012), Trend
5.A.1	Forest Land remaining Forest Land - dead wood	CO_2	Level (2012), Trend
5.A.2.2	Grassland converted to Forest Land - living biomass	CO_2	Level (2012), Trend
5.A.2.1	Cropland converted to Forest Land - mineral soil	CO_2	Trend
5.B.1	Cropland remaining Cropland - organic soils	CO_2	Level (1990, 2012), Trend
5.B.1	Cropland remaining Cropland - mineral soils	CO_2	Level (1990, 2012), Trend
5.B.2.2	Grassland converted to Cropland - mineral soils	CO_2	Trend
5.B.2.2	Grassland converted to Cropland - organic soils	CO_2	Trend
5.C.1	Grassland remaining Grassland - living biomass	CO_2	Level (2012), Trend
5.C.1	Grassland remaining Grassland - organic soils	CO_2	Level (2012), Trend
5.C.2	Land converted to Grassland - mineral soils	CO_2	Level (2012), Trend

[117] IPCC 2006, Vol 4 (AFOLU), Table 5.5 & Table 5.6, p. 5.17-5.19
[118] Kaie Kriiska, LULUCF leading expert, Estonian Environment Agency, 2014.

IPCC source category		Gas	Identification criteria
5.D.1	Wetlands remaining Wetlands\Peatland - organic soils managed for peat extraction	CO_2	Level (2012), Trend
5.D.2.1	Forest Land converted to Wetlands - living biomass	CO_2	Level (2012), Trend
5.E.2	Land converted to Settlements – living biomass	CO_2	Level (2012), Trend
5.E.2	Land converted to Settlements – soils	CO_2	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 the overgrowth of wetlands (Figure 7.7).

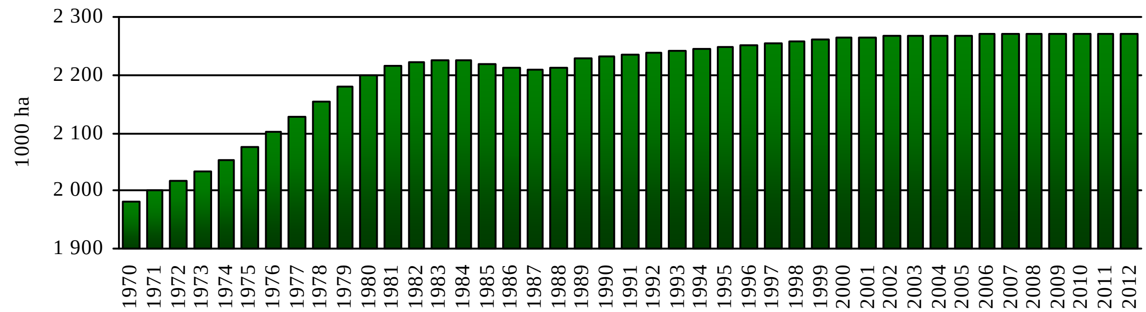

Figure 7.7. Forest land area in Estonia in 1970–2012, 1000 ha

The forest land category constitutes about 73% of all LULUCF sector emissions and removals. The net removal from forest land was 3 073 Gg CO_2 eq. in 2012 (Figure 7.8). During 2000−2003, the forest land category acted as a net source of CO_2 mainly due to intensive harvesting. Estimations in Figure 7.8 include emissions and removals from living biomass, dead organic matter, mineral and organic soils and biomass burning.

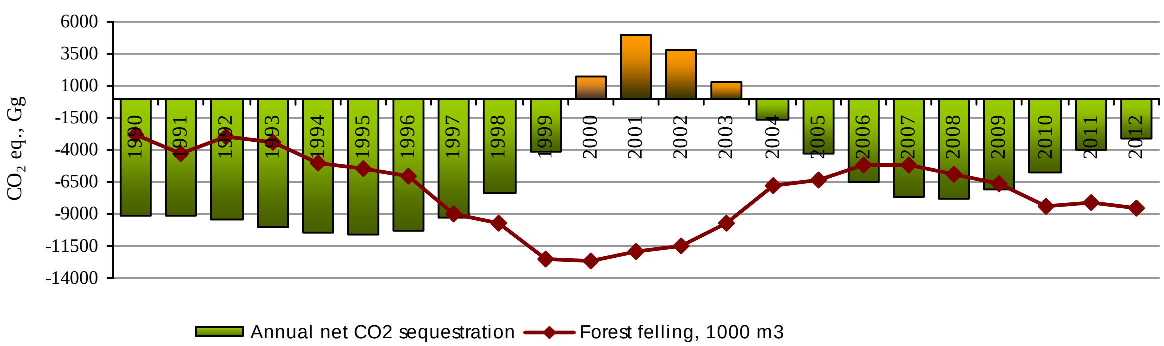

Figure 7.8. Annual net change in CO_2 removals (-)/emissions (+) from Forest Land category in 1990–2012, Gg CO_2 eq.

7.2.2. Methodological issues

The 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.[119]

$$\Delta C_{FF} = (\Delta C_{FF_{LB}} + \Delta C_{FF_{DOM}} + \Delta C_{FF_{Soils}})$$

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 the land remaining Forest Land category, the *Tier 2* approach and *Method 2* – the stock-difference method (Equation 7.2) was applied. The NFI annually provides data for growing stock and area for forest land remaining forest land, also on land converted to forest land.

It should be noted that the stock change method also comprises 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)).

A net carbon stock change is the output of the stock-difference method, therefore gains and losses are not listed separately either in the CRF reporter nor in the NIR[120].

Equation 7.2[121]

$$\Delta C_{FF_{LB}} = \Delta C_B = (C_{t_2} - C_{t_1})/(t_2 - t_1)$$

and

$$C = \sum_{i,j} \{A_{i,j} \bullet V_{i,j} \bullet BCEF_{S\,i,j} \bullet (1 + R_{i,j}) \bullet CF_{i,j}\}$$

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, $m^3\ ha^{-1}$;

[119] GPG-LULUCF 2003, Equation 3.2.1., p 3.23.
[120] In ARR2013, para 59, the ERT encouraged to separate carbon stock gains and losses except in cases where, due to the methods used, it is technically impossible
[121] IPCC 2006, Vol 4 (AFOLU), Equation 2.8, p 2.12.

i – ecological zone i;
j – climate domain j;
$BCEF_S$ – 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 the calculations of carbon stock changes in living biomass under the land converted to Forest land subcategory.

In Forest Land category, the boreal climatic zone default IPCC parameter values are applied (see Chapter 7.1.4 for more information).

Table 7.8. Implemented values of $BCEF_S$[122]

Boreal	Growing stock level (m^3)			
Forest type	< 20	21-50	51-100	> 100
pines	1.20	0.68	0.57	0.50
firs and spruces	1.16	0.66	0.58	0.53
hardwoods	0.90	0.70	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[123].

[122] IPCC 2006, Vol 4 (AFOLU), Table 4.5, p. 4.50.
[123] See more information about dividing land-use changes into human-induced and natural regeneration in Chapter 11.1.3.

Table 7.9. Default values of root-to-shoot ratio R[124]

	Land remaining Forest Land		Land converted to Forest Land	
Domain	Above-ground biomass, t/ha	Root-shoot ratio R	Above-ground biomass, t/ha	Root-shoot ratio 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[125] recommended implementing 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.[126]

7.2.2.2. Annual change in carbon stock due to biomass changes in forest land

In Estonia, forest area increased 41 809 hectares by 2012 in comparison to the base year. The distribution of the 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[127]

Tree species	Land remaining Forest Land	Land converted to Forest Land	
		Human induced	Natural regeneration
Pinus sylvestris	0.304	0.43	0.18
Picea abies	0.237	0.53	0.11
Betula	0.226		
Populus tremula	0.075		
Alnus glutinosa	0.050		
Alnus incana	0.069		
Salix	0.010		
Quercus robur	0.006		
Fraxinus excelsior	0.011		
Other	0.013	0.05 (mainly *Betula*)	0.7 (broadleaf)

[124] IPCC 2006, Vol 4 (AFOLU), Table 4.4, p. 4.49.
[125] ARR2012, para. 97.
[126] ARR2012, para.126.
[127] Adermann, V. (Forest statistics by NFI, 2014).

Table 7.11. General characteristics of Estonian forest in 2012[128]

Main tree species	Area, 1000 ha	Relative error ±%	Growing stock, 1000 m^3	Relative error ±%	Increment, 1000 m^3 yr^{-1}
Pine	721.1	*3.1*	175 112	*3.4*	3 463
Spruce	378.1	*4.4*	81 853	*5*	2 838
Birch	697.4	*3.1*	126 465	*3.5*	3 366
Aspen	128.5	*7.8*	30 708	*9.3*	773
Common alder	76.7	*10.1*	18 455	*11.2*	374
Grey alder	194.7	*6.3*	31 462	*6.3*	1 444
Other	37.4	*14.6*	6 236	*18.5*	190
Total	2 233.9	*1.3*	470 292	*1.5*	12 447

In Table 7.12 the cumulative area and proportion of land use changes to Forest Land in 2012 are shown, as well as applied emission factors for mineral and organic soils. In the case of missing or insufficient country-specific data, emission factors from the Sweden 2013 annual submission were implemented with the agreement of ERT[129].

Table 7.12. Cumulative land use changes to Forest Land in 2012 and implemented soil emission factors[130]

Land-use change	kha	%	EF mineral soil Mg C ha^{-1}	EF organic soil Mg C ha^{-1}
Cropland→Forest Land	16.7	30%	-0.85	-0.57
Grassland→Forest Land	22.0	40%	-0.225	-0.57
Wetlands→ Forest Land	5.9	11%	0.17	-0.57
Settlements→ Forest Land	3.1	6%	0.17	-0.57
Other Land→ Forest Land	7.2	13%	0.17	-0.57
Total	54.8	100%		

Data presented in Figure 7.9 characterizes carbon stock changes in living biomass under land remaining Forest Land and land converted to Forest Land in 1990–2012. The estimation for 1990–1998 is based on interpolated data, since no exhaustive forest statistics were carried out during these years. The National Forest Inventory that covers the whole country started in 1999.

From 1999 to 2003, the rate of harvesting (see Figure 7.10) was about twice as high than usual due to the economic boom in Estonia. The volume of harvested timber exceeded the annual biomass increment in forest, as a result the Forest land category acted as a net source during that period (Figure 7.8).

[128] by national definition of forest. Adermann, V. (Forest statistics by NFI, 2014).
[129] ARR2012, para 94.
[130] All EF-s for organic and mineral soils are taken from the Swedish 2013 annual submission, except CL→FL mineral soil, that is based on the Tier 1 method implemented with Estonias country-specific data.

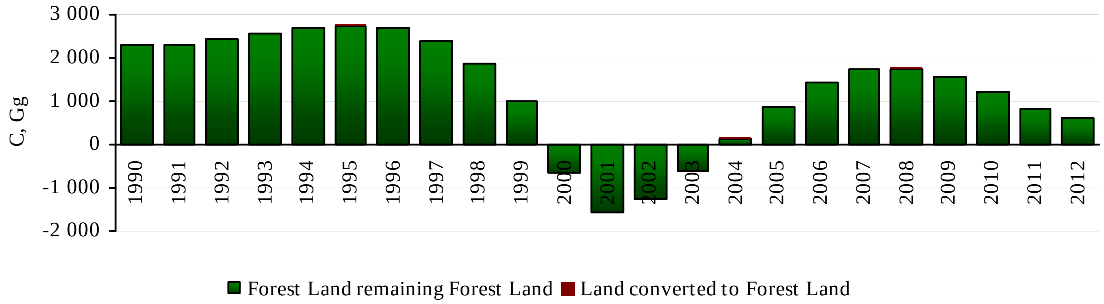

Figure 7.9. Annual carbon stock change in Forest Land living biomass in 1990–2012, Gg C

In the previous annual submissions, there was a high variability in forest land living biomass estimates. Living biomass is calculated via growing stock, data is obtained from the NFI. However, the accuracy of the NFI sample includes sampling errors that make estimates vary annually. Following the recommendation by ERT[131], the inter-annual fluctuations were reduced by data set smoothing (curve fitting) to create an approximating function that attempts to capture important patterns, while leaving out the noise. Algorithm of 5th degree polynomial was applied to NFI's actual data.

Data about forest fellings is estimated by NFI since 1999 (data starting in 1998). Statistics Estonia (SE) collects forest harvesting data based on loggings planned (so-called 'forest notices'). As the latter method underestimated cuttings during the 1990s, the data provided by SE for 1990 to 1997 are adjusted using the different approach between the statistics of SE and the NFI. Data about total fellings during the last 23 years is illustrated in Figure 7.10.

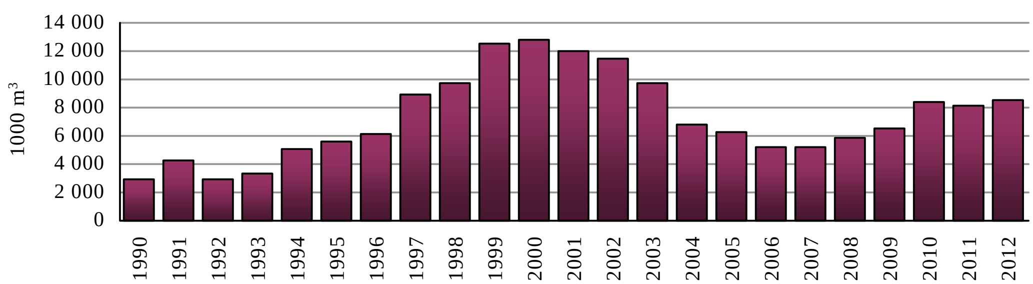

Figure 7.10. Harvested volume[132] on forest land in Estonia in 1990–2012, 1000 m^3

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[133]. In figure Figure 7.11 the forest area affected by storms is shown. There is

[131] ARR2013, para. 66; ARR2012, para. 98.
[132] Stem volume, over bark, without stump and branches, NFI.
[133] Adermann, V., NFI

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 was: 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.

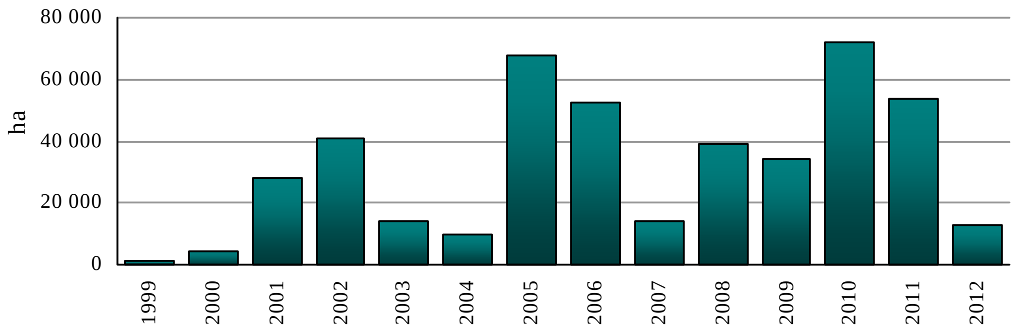

Figure 7.11. Storm-damaged forest area 1999–2012, ha (NFI, SE)

7.2.2.3. CO_2 emissions/removals from/by dead wood

For estimating carbon stock changes in the dead wood pool, the *Tier 2* and stock change method was applied. The NFI annually provides 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. 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[134].

Equation 7.3[135]

$$\Delta C_{FF_{DW}} = \left[A \bullet \left(B_{t2} - B_{t1}\right)/T\right] \bullet CF$$

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 (tonne d.m.)$^{-1}$.

[134] 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.
[135] GPG-LULUCF 2003, Equation 3.2.12., p 3.34.

Equation 7.3 is also used for estimating dead wood stock change in the land converted to Forest land subcategory.

Figure 7.12 illustrates annual dead organic matter stock changes on land remaining forest land and land converted to forest land. Increase in dead wood carbon stocks is the result of big storms in 2002, 2005 and 2006. Over time, these dead wood stocks started to decay, causing the amount of dead wood to decrease in recent years.

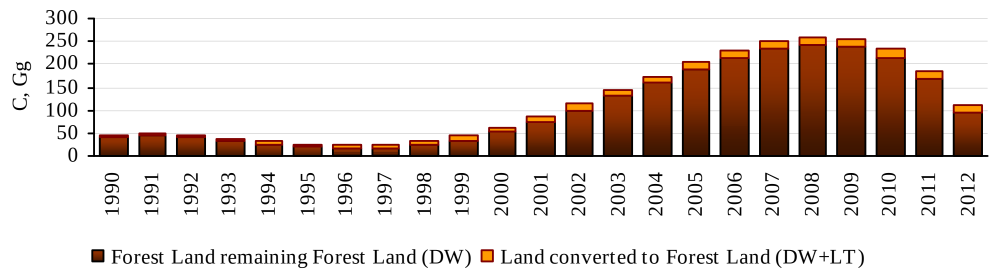

Figure 7.12. Net carbon stock change in forest dead organic matter pool 1990–2012, Gg C

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, the *Tier 1* method was implemented, assuming that carbon stocks are in equilibrium, thus the changes in the litter pool are assumed to be zero. Under land conversion to forest land, the emission factor from Sweden[136] (0.3 Mg C ha^{-1} yr^{-1}) is used for litter, maintaining consistency between the Convention and KP-LULUCF reporting. It was also possible to apply the Swedish EF of litter on land remaining Forest land, but it would have resulted in a carbon increase in the pool. Therefore Estonia decided to implement a more conservative approach, i.e. *Tier 1*, assuming no change in the pool.

7.2.2.5. CO_2 emissions/removals from/by mineral forest soils

Due to insufficient country-specific data regarding carbon stock changes in forest mineral soil, the emission factor from Sweden[137] (0.15 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 (Table 7.12), except for cropland conversion to forest land, where *Tier 1* and national SOC_{REF} stocks are applied (Table 7.14).

In 2012, there was a net increase in the carbon stock of forest mineral soils by 236 Gg, of which 253 Gg was contributed by land remaining forest, whereas land conversion to forest resulted a decrease of -17 Gg carbon. On the whole, annual carbon sequestration has decreased by 7% since 1990 by forest mineral soil (Figure 7.13).

[136] Sweden NIR 2013, Annexes, Table A 3:2.9, p. 85
[137] The average implied emission factor of 1990-2011 in Sweden CRF tables 2013.

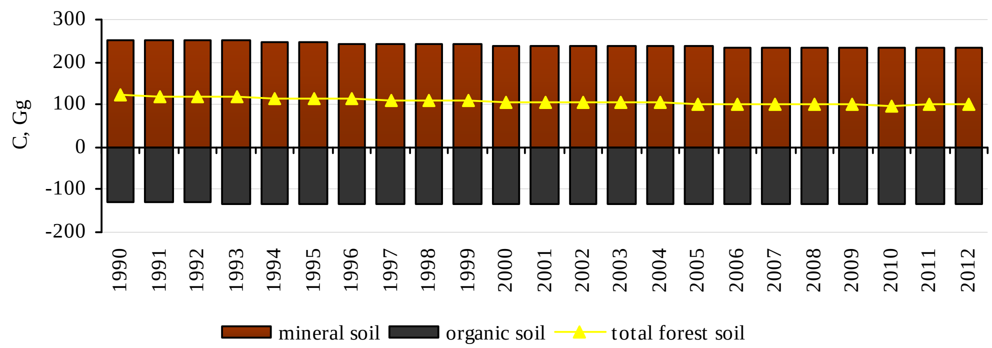

Figure 7.13. Annual stock change in forest land mineral and organic soil pools 1990–2012, Gg C

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[138]

$$\Delta C_{FF\,Organic} = A_{Drained} \bullet EF_{Drainage}$$

Where:

$\Delta C_{FF\ Organic}$ – 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.

ERT recommended Estonia to apply Swedish emission factors (Table 7.12) for drained organic forest soils, since default GPG-LULUCF 2003 EF-s would likely cause underestimation of emissions[139].

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 7.13) have increased by 2.5% since 1990.

7.2.3. Uncertainty and time-series consistency

Uncertainties of activity data and emission factors are presented in Table 7.13.

[138] GPG-LULUCF 2003, Equation 3.2.15, p. 3.42.
[139] ARR2012, para. 94

Table 7.13. Uncertainties in Forest Land category

IPCC Source Category		Activity data %[140]	Emission factor %	EF References
5.A.1	Forest Land remaining Forest Land - living biomass	1.67	46.95	IPCC 2003 & 2006[141]
5.A.1	Forest Land remaining Forest Land - mineral soils	1.89	35.00	Sweden NIR 2013, Table 7.5, p. 296
5.A.1	Forest Land remaining Forest Land - organic soils	4.31	35.00	Sweden NIR 2013, Table 7.5, p. 296
5.A.1	Forest Land remaining Forest Land - dead wood	1.97	12.89	Sandström *et al*. 2007
5.A.2.1	Cropland converted to Forest Land - living biomass	24.38	46.95	IPCC 2003 & 2006
5.A.2.1	Cropland converted to Forest Land - mineral soil	23.24	35.00	Kõlli *et al.* 2004 & 2009
5.A.2.1	Cropland converted to Forest Land - dead wood	92.05	12.89	Sandström *et al*. 2007
5.A.2.2	Grassland converted to Forest Land - living biomass	21.80	46.95	IPCC 2003 & 2006
5.A.2.2	Grassland converted to Forest Land - mineral soils	21.11	35.00	Sweden NIR 2013, Table 7.5, p. 296
5.A.2.2	Grassland converted to Forest Land - organic soils	73.77	35.00	Sweden NIR 2013, Table 7.5, p. 296
5.A.2.2	Grassland converted to Forest Land - dead wood	27.97	12.89	Sandström *et al*. 2007
5.A.2.3	Wetlands converted to Forest Land - living biomass	40.17	46.95	IPCC 2003 & 2006
5.A.2.3	Wetlands converted to Forest Land - organic soils	39.49	35.00	Sweden NIR 2013, Table 7.5, p. 296
5.A.2.3	Wetlands converted to Forest Land - dead wood	97.43	12.89	Sandström *et al*. 2007
5.A.2.4	Settlements converted to Forest Land - living biomass	52.11	46.95	IPCC 2003 & 2006
5.A.2.4	Settlements converted to Forest Land - mineral soils	55.58	35.00	Sweden NIR 2013, Table 7.5, p. 296
5.A.2.4	Settlements converted to Forest Land - organic soils	138.58	35.00	Sweden NIR 2013, Table 7.5, p. 296
5.A.2.4	Settlements converted to Forest Land - dead wood	102.92	12.89	Sandström *et al*. 2007
5.A.2.5	Other Land converted to Forest Land - living biomass	34.65	46.95	IPCC 2003 & 2006
5.A.2.5	Other Land converted to Forest Land - mineral soil	33.85	35.00	Sweden NIR 2013, Table 7.5, p. 296
5.A.2.5	Other Land converted to Forest Land - dead wood	95.28	12.89	Sandström *et al*. 2007

[140] All activity data uncertainty estimates are obtained from NFI.
[141] Parameters were applied from the 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.

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 the IPCC *Tier 1* method. The activities are carried out every year during the inventory. The QC check list is used during inventory.

Carbon Budget Model

The European Commission, through the Joint Research Centre, is working on the provision of ad-hoc support on issues related to measuring, reporting and the verification of Land Use Land Use Change and Forestry (LULUCF) under the Kyoto Protocol. The proposed support includes comparison of estimates for Forest Management (FM) done with the forest Carbon Budget Model (CBM, run by the JRC), with the GHG inventory from the country (FM or forest land remaining forest land). In line with the IPCC guidance, this comparison could be seen as a possible "verification activity", whose purpose is to build confidence on the reported estimates and trends, help scientific understanding, and when relevant provide possible inputs to improve inventories. It is important to note that no full match is necessarily to be expected between the model estimates and the GHG inventory (due to different methods used). However, a similar overall trend could be expected[142].

Estonian CBM model analysis was based on data provided by the NFI (2010–2011), reporting area (distinguished by age classes and species), volume and increment (by species).

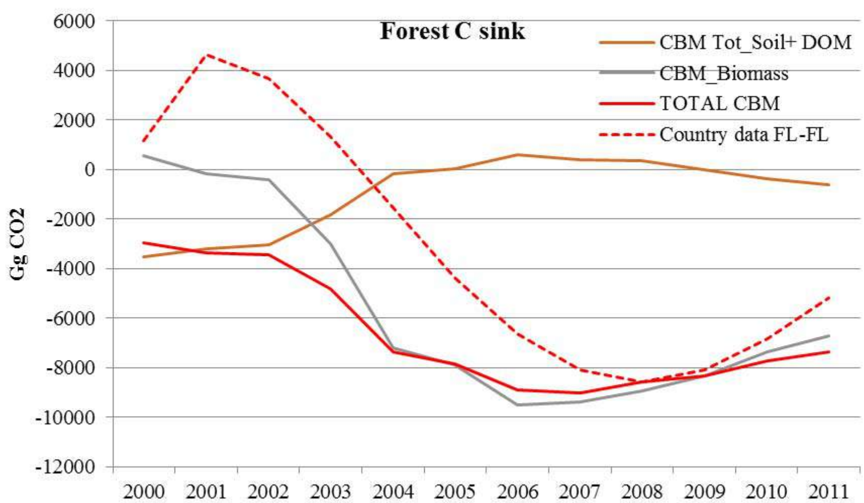

Figure 7.14. Biomass, soil+DOM and total C sink estimated by CBM model compared with country data (2013 submission) referred to FL remaining FL

[142] Technical assistance on Land Use, Land use Change and Forestry (LULUCF) reporting and accounting. ESTONIA - Preliminary report. European Commission, Joint Research Centre, Institute for Environment and Sustainability, Forest Resources and Climate Unit. October 2013 ADMINISTRATIVE ARRANGEMENT Nº071201/2011/611111/CLIMA.A2 (Analysis of and proposals for enhancing, monitoring, reporting and verification of land use, land use change and forestry in the EU - LULUCF MRV).

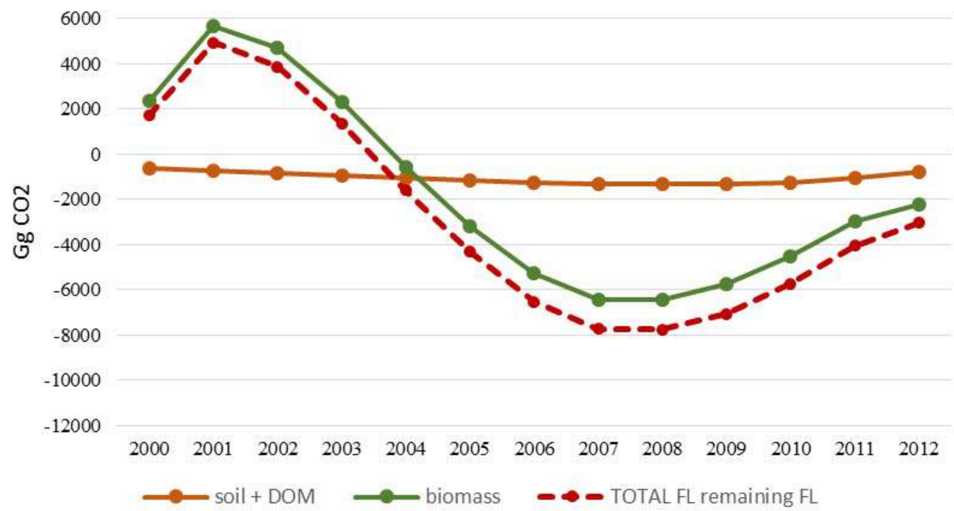

Figure 7.15. Biomass, soil+DOM and total C sink reported in Estonia's 15.04.2014 submission

In Figure 7.14 and Figure 7.15 a comparison of the CBM model and current submission estimates is shown. The CBM model output follows the national reported trend quite well from 2006–2011. From 2000–2005, the CBM model indicates significantly higher sink both in biomass and soil+DOM pools compared to the national NFI data. It could be explained by the fact that the CBM model simulates dead organic matter pool and soil C using a process-based approach, where estimates are derived from site productivity and harvest demand, whereas NFI field data is the basis for national reporting. However, more information will be provided to rerun the CBM model by JRC in order to get more precise results.

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 7.14) with the default SOC_{REF} values given in the IPCC 2006[143] 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 a 2-fold difference between Estonian EF and Swedish EF for CF and 4.5-fold difference for GF emission factors, therefore only the country-specific CF emission factor was applied in the report calculations.

[143] IPCC 2006, Vol 4, Table 2.3, p 2.31.

Table 7.14. Comparison of SOC_{REF} stocks estimated based on national publications and IPCC 2006

SOC_{REF} (Mg C ha^{-1})	Forest Land	Cropland	Grassland
National research data[144]	68.15	85.21	88.33
IPCC 2006 default	74.36	85.37	75.88

7.2.5. Source-specific recalculations

The entire time series of activity data is 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 into overall activity data.

Soil emission factors were updated for land remaining Forest Land.

In Table 7.15 changes in applied parameters and in Table 7.16 quantitative overview of recalculations is shown.

Table 7.15. Parameters used in Forest Land category recalculations (15.04.2013 submission and 15.04.2014 submission)

Land use category	**Parameter**	**2013 Submission**		**Source**	**2014 Submission**		**Source**
Forest Land remaining Forest Land	EF organic soil [Mg C ha^{-1} yr^{-1}]	EF Sweden	-0.57	Sweden NIR 2012 (Annex 3:2.9, p 84)	EF Sweden	-0.59	Sweden 2013, CRF (1990-2011 average)
	EF mineral soil [Mg C ha^{-1} yr^{-1}]	EF Sweden	0.16	Sweden 2012, CRF (1990-2010 average)	EF Sweden	0.15	Sweden 2013, CRF (1990-2011 average)

144 Kõlli et al, 2004, Organic Carbon Pools in Estonian Forest Soils, Baltic Forestry, Vol 10, No 1 (18), 19-26; Kõlli et al, 2009, Stocks of organic carbon in Estonian soils, Estonian Journal of Earth Sciences, 58, 2, 95-108; Kõlli et al, 2007, Organic matter of Estonian grassland soils, Agronomy Research, 5(2), 109-122.

Table 7.16. Quantitative overview of recalculations, Gg C (15.04.2013 submission/15.04.2014 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	2 316.0	2 321.0	**0.2**	2 737.1	2 760.1	**0.8**	-520.9	-644.7	**19.2**	856.1	867.5	**1.3**	1 484.6	1 225.3	**-21.2**
	Dead organic matter	41.6	42.7	**2.5**	19.6	19.0	**-3.3**	51.4	51.6	**0.4**	184.9	188.7	**2.0**	225.3	214.8	**-4.9**
	Mineral soil	277.3	254.1	**-9.1**	277.1	254.0	**-9.1**	276.9	253.8	**-9.1**	276.2	253.1	**-9.2**	274.9	251.9	**-9.1**
	Organic soil	-124.9	-130.7	**4.5**	-124.8	-130.7	**4.5**	-124.8	-130.6	**4.5**	-124.5	-130.4	**4.5**	-124.07	-129.8	**4.4**
Land converted to Forest Land	Living biomass	2.3	0.2	**-1 211.2**	3.4	3.2	**-6.9**	6.7	6.3	**-6.6**	11.4	11.4	**-0.2**	10.1	10.5	**4.3**
	Dead organic matter	1.15	1.17	**1.6**	7.38	7.01	**-5.2**	12.52	11.97	**-4.6**	15.69	15.47	**-1.4**	18.89	18.88	**-0.1**
	Mineral soil	-0.88	-1.13	**22.1**	-8.07	-7.87	**-2.5**	-13.43	-13.79	**2.6**	-15.38	-16.96	**9.3**	-17.01	-19.22	**11.5**
	Organic soil	-0.16	-0.18	**11.1**	-1.15	-1.29	**10.8**	-1.95	-2.00	**2.5**	-2.77	-3.07	**9.8**	-4.27	-4.55	**6.2**
	TOTAL Forest Land net CO_2	-9 212.1	-9 119.3	**-1.0**	-10 672.2	-10 645.7	**-0.2**	1 149.4	1 713.8	**32.9**	-4 406.3	-4 347.6	**-1.4**	-6 850.7	-5 748.5	**-19.2**

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.

The Estonian Environment Agency has initialized in cooperation with the University of Tartu a pilot project aimed obtaining 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.

Estonia was selected to participate in the Specific Contract (SC) 12 taskforce on harmonization of LULUCF inventories: modeling forest soil with Yasso. The Specific Contract 12 is a framework contract for the provision of forest data and services in support of the European Forest Data Centre. The general objective of SC 12 is to provide support for a limited number of member states on modeling carbon stock change of forest mineral soils implementing Yasso07.

The Estonian Environment Agency has ordered a review study from the University of Life Sciences on "Forest soil emissions depending on the type and intensity of forest fellings". The aim of the study is to give an overview of the impact of harvest activities on soil emissions based on studies from neighbouring countries (Finland, Sweden). This review could potentially provide an informed basis for further research on this matter.

A project titled „Applied research of greenhouse gases in LULUCF sector in the framework of UNFCCC and Kyōto protocol reporting" was launched in June 2013, funded by the Environmental Investment Centre. The project covers several issues, ie acquiring missing country-specific data related to the current and next Kyoto commitment period. However, many of the activities provide only preliminary assessment and further research, verification and analysis is necessary in the future. Project activites and their description is presented in Table 7.17.

In addition, a study comparing the results of 2 soil surveys conducted in 1990–1994 and 2006–2008 (BioSoil) is being conducted. The aim of the study is to determine any changes in soil carbon stocks during the period 1990–2008.

Table 7.17. Applied research of greenhouse gases in the LULUCF sector in the framework of UNFCCC and Kyōto protocol reporting

Project activities		Description and outcome
1	Changes in cropland soil organic carbon stocks	Conducting fieldwork, resampling previous sample plots and estimating carbon stock changes in cultivated mineral and organic soils. Developing country-specific emission factors for cropland mineral and organic soils.
2	Changes in grassland soil organic carbon stocks	Conducting fieldwork, resampling previous sample plots and estimating carbon stock changes in natural and semi-natural grassland soils. Developing country-specific emission factors for grassland soils.
3	Harvested wood products-half-life values	Give an overview of studies made about half-life values of harvested wood products (HWP) in neighbouring countries (Finland, Sweden etc). Give suggestions on most appropriate methodologies suitable for estimating HWP half-life values in Estonia for paper, wood panels and sawn wood.

4	Harvested wood product-emissions and removals resulting from changes in the pool of harvested wood products	Give an overview of methodologies implemented for estimating emissions and removals resulting from changes in the pool of harvested wood products in neighbouring countries. Give an overview of available data present for conducting emission estimates for HWP in Estonia. Refer to existing data gaps. Recommend the most suitable methodology for estimating HWP emissions and removals in Estonia.
5	Belowground carbon cycle in forests- soil respiration	Soil respiration measurements in 8 different pine and spruce stand types- *Cladina, Myrtillus, Vaccinium, Fragaria, Calamagrostis alvar, Oxaclis, Polytrichum*.
6	Belowground carbon cycle in forests- soil, litter and fineroots	Determine fineroot biomass, increment and turnover rates, decomposition of tree litter and fine root litter on 8 *ICP Forests* sample plots. Obtained data is input for soil carbon cycle calculations and Yasso modelling.
7	Belowground carbon cycle in forests- chemical analysis of soil, fineroots and litter	Determine chemical composition of soil, fineroots and tree litter. Obtained data is input for soil carbon cycle calculations and Yasso modelling.
8	Forest litter	Conduct fieldwork, *inter alia*, collecting monthly tree litter on *ICP Forests* sample plots (mainly spruce and pine forests), data analysis, determine annual litter input to soil.
9	Belowground carbon cycle in forests- modelling soil carbon stock changes	Modelling soil carbon stock changes in Estonian forests implementing the Yasso model.
10	Afforestation/reforestation (AR)	Verify the location (georeference) and area of afforestation and reforestation activities using NFI datasets, old forestry maps, and aerial photographs. Create digital AR maps. Conduct fieldwork on AR areas, determine stand composition, biomass, soil type and annual land-use changes.
11	Natural forests	Based on available NFI and other datasets as well as fieldwork, determine the area and location of natural forests according to new reporting requirements for the second Kyōto commitment period. Create GIS map.

The University of Life Sciences is preparing a study on determining wood densities and carbon content in different dead wood categories in Estonia.

7.3. Cropland (CRF 5.B)

7.3.1. Source category description

Total net CO_2 eq. emissions from cropland are presented in Figure 7.16. The 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. Emissions from organic soils are evened out by uptake by mineral soils, therefore inter-annual emission fluctuations in the cropland category are mainly caused by changes in living biomass and varying liming intensity in different years.

Net CO_2 emissions from cropland were 195 Gg and 176 Gg, respectively in 2012 and 1990.

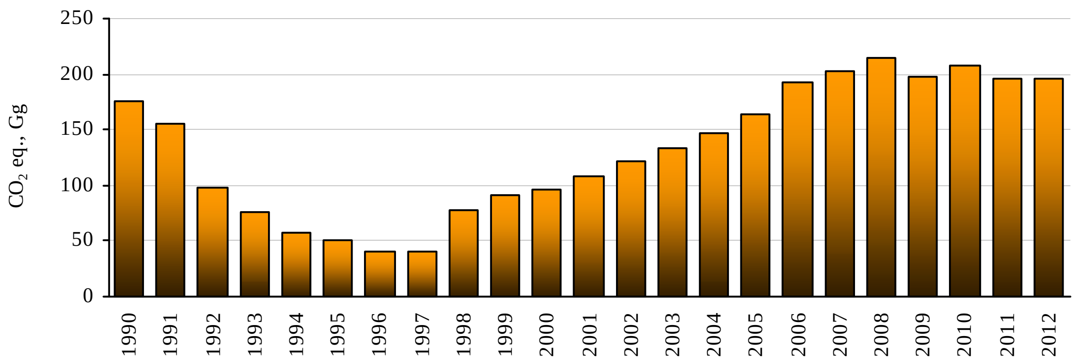

Figure 7.16. Total emissions(+)/uptake(-) from Cropland category in 1990–2012, Gg CO_2 eq.

The area of cropland (Figure 7.17) increased until the 1990s due to the propitious conditions in agricultural sector in Estonia. The biggest influences on the sector were the remarkable support provided by the early former Soviet Union, a large market and raw material basis, and a low market price for energy, which kept agriculture artificially alive. After Estonia regained its independence in 1991, these beneficial conditions were abolished[145]. From 1991 until 2005, an overall decline characterised Estonia's agriculture. Arable lands were abandoned due to the reduced demand for local food products, which was caused by the availability of cheap import goods as the result of opened markets. As from 2005, the cropland area 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.

[145] Mäemets, M. (2006). An Outline of Agriculture in Estonia from the year 1990 until 2004, Bachelor's thesis, University of Tartu.

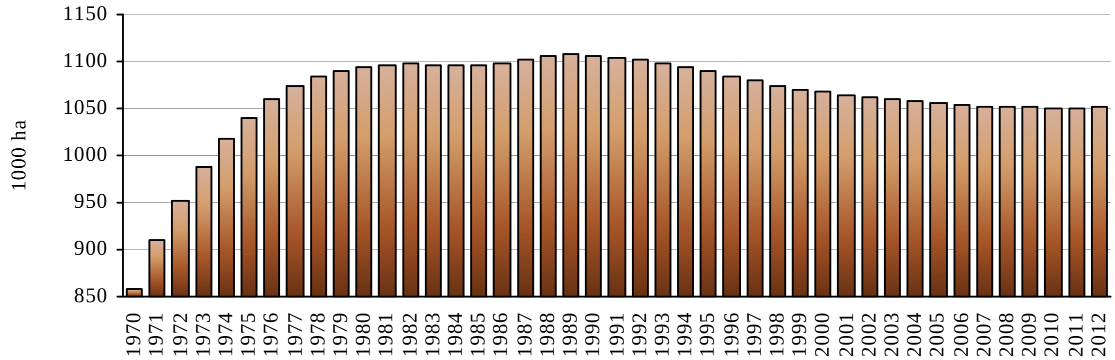

Figure 7.17. Cropland area in Estonia in 1970–2012, 1000 ha

Activity data used to estimate carbon fluxes related to cropland has been obtained from NFI (1990–2012) and Statistics Estonia (till 1990).

7.3.2. Methodological issues

7.3.2.1. Change in carbon stocks in living biomass

In 2012, the Estonian Environment Information Centre launched a project in order to determine perennial woody crops biomass in croplands. The aim was 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 the *Repola*[146] biomass function, which was implemented to estimate average aboveground, belowground and total biomass of orchards. The results are shown in Table 7.18.

Table 7.18. Average biomass stock on cropland orchards

	Living biomass stock, t d.m./ha
Total biomass	20.68
Aboveground	16.60
Belowground	4.07

Annual carbon stock change was calculated based on interannual area changes (Equation 7.5, *Tier 2*).

Equation 7.5

$$\Delta C_{CC_{LB}} = \left[B_{total} \bullet \left(A_{t2} - A_{t1}\right)\right] \bullet CF$$

Where:

[146] 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.

$\Delta C_{CC\ LB}$ – 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 7.18);
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.)$^{-1}$.

The area of orchards is obtained from Statistics Estonia. The area of orchards has declined continuously, from 9 293 ha in 1990 to 3 780 ha in 2012, thus the carbon stocks in have been decreased as well as seen in Figure 7.18.

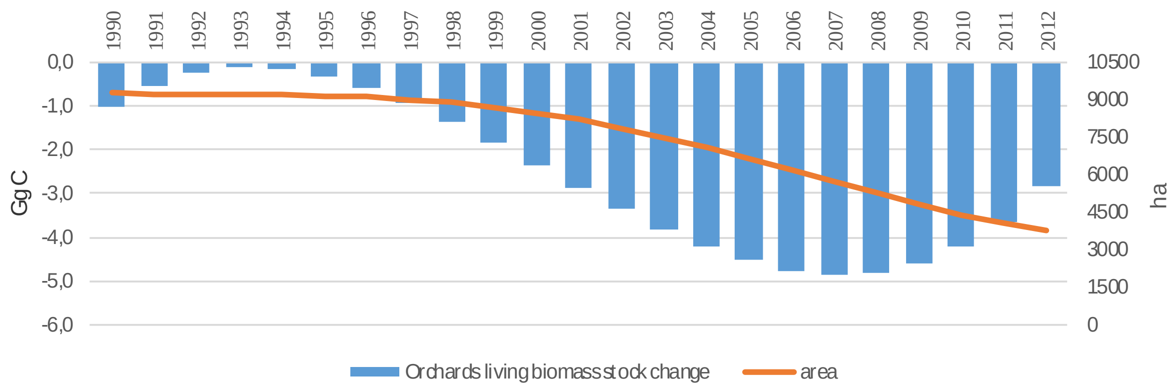

Figure 7.18. Area (ha) and annual change in cropland perennial woody crops (orchards) living biomass stock (Gg C)

7.3.2.2. Mineral soils

In Table 7.19 the area and applied emissions factors of land remaining and converted to cropland are shown.

For mineral soils, *Tier 1* and Equation 7.6 is used to estimate change in soil organic carbon stocks. Cropland SOC_{REF} (Table 7.14) 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 (Cold, temperate moist climate).

Equation 7.6[147]

$$\Delta C_{Mineral} = \frac{\left(SOC_0 - SOC_{(0-T))}\right)}{D}$$

$$SOC = \sum_{c,s,i}\left(SOC_{REF_{c,s,i}} \bullet F_{LU_{c,s,i}} \bullet F_{MG_{c,s,i}} \bullet F_{I_{c,s,i}} \bullet A_{c,s,i}\right)$$

Where:

$\Delta C_{Mineral}$ – annual change in carbon stocks in mineral soils, tonnes C yr^{-1};
SOC_0 – soil organic carbon stock in the last year of an inventory time period, tonnes C;

[147] IPCC 2006 (Vol 4), Equation 2.25, p. 2.30.

SOC_{0-T} – soil organic carbon stock at the beginning of the inventory time period, tonnes C;
D – default time period (20 years) for transition between equilibrium SOC values;
c – represents the climate zones, s the soil types, and I the set of management systems;
SOC_{REF} – the reference carbon stock, tonnes C ha^{-1} (Table 7.14);
F_{LU} / F_{MG} / F_I – stock change factors for land-use sustems/management regime, input of organic matter, dimensionless[148];
A – land area of the stratum being estimated, ha.

Grassland conversion to cropland is the only land-use change occurring in Estonia to the cropland category. EF for this land-use change was obtained by implementing IPCC *Tier 1* method, Equation 7.6.

Table 7.19. Cumulative land use changes to Cropland in 2012 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	1 041.1	0.09[149]	-5.0
Grassland→ Cropland	10.1	-1.37	-5.0

Table 7.20 shows the share of different cropland management practices in Estonia (Estonian Research Institute of Agriculture). The proportions differ from year-to-year. In Table 7.20, the average proportions during the period 1990-2012 are shown.

Table 7.20. Proportions of cropland different management activities (ERIA, SE)

F_{LU}	Long term cultivated	Perennial/ Tree crop	Set aside (<20 yrs)	Total
Proportion of cropland area	0.740	0.007	0.253	1.00
F_{MG}	Full tillage	Reduced tillage	No-till	Total
Proportion of cropland area	0.5	0.4	0.1	1.00
F_I	Low	High with manure	Medium	Total
Proportion of cropland area	0.140	0.005	0.855	1.00

[148] IPCC 2006 (Vol 4), Table 5.5, p. 5.17. (Temperate/Boreal)
[149] 1990-2012 average mineral soil EF

7.3.2.3. Organic soils

The *Tier 1* method was applied in order to estimate CO_2 emissions from cultivated organic soils.

Equation 7.7[150]

$$\Delta C_{CCOrganic} = \sum_c (A \bullet EF)_c$$

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}.

Equation 7.7 was also used for calculations of organic soil emissions on the 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.

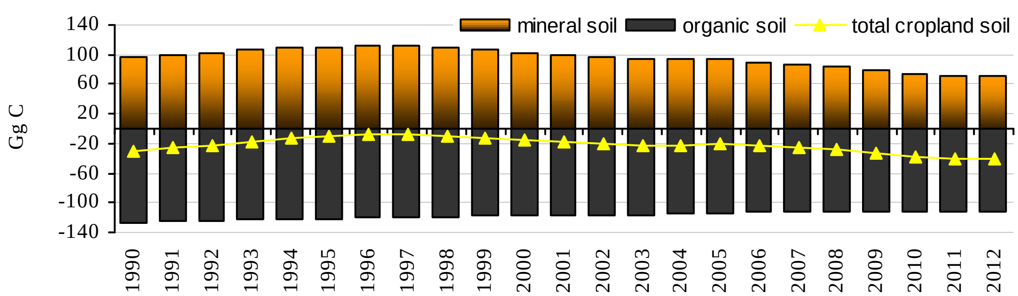

Figure 7.19. Annual stock change in Cropland mineral and organic soil pools 1990–2012, Gg C

Figure 7.19 illustrates annual carbon stock changes in cultivated cropland soils. In 2012, total CO_2 emissions from cropland soils were 150 Gg, which is 25% more compared to 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. The *Tier 1* method (Equation 7.8) 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 the default C:N ratio [15 kg C (kg N)$^{-1}$] were applied.

[150] GPG-LULUCF 2003, Equation 3.3.5, p. 3.79.

Equation 7.8[151]

$$N_2O_{net-\min} - N = EF_1 \bullet N_{net-\min}$$

$$N_{net-\min} = \Delta C_{LC_{Mineral}} \bullet 1/C : N_{ratio}$$

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};
$\Delta C_{LC\ Mineral}$ – change in carbon stocks in mineral soils in land converted to cropland, kg C 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.

In 2012, 9 446 ha of grasslands on mineral soils had been converted to cropland since 1990, resulting in N_2O emission of 16.9 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, quick-acting fine dusty limes are mainly applied[152].

The *Tier 1* method (Equation 7.9) was used to estimate CO_2 emissions from the liming of croplands. Activity data on agricultural land areas on which lime was applied was obtained from the 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 at a landowner’s own expence is left out of the statistics. However, the scope of liming carried out at a landowner’s own expence is considered to be marginal according to the 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 the Estonian Research Institute of Agriculture[153]. Since 2009, Statistics Estonia has been collecting detailed data about the area and applied amount of liming.

Equation 7.9[154]

$$\Delta C_{CC_{Lime}} = M_{Limestone} \bullet EF_{Limestone} + M_{Dolomite} \bullet EF_{Dolomite}$$

Where:

$\Delta C_{CC\ Lime}$ – annual C emissions from agricultural lime application, tonnes C yr^{-1};

[151] GPG-LULUCF 2003, Equation 3.3.13–3.3.15, p. 3.93–3.94.
[152] Loide, V. (2010). Relieving the calcium deficiency of field soils by means of liming, Agronomy Research 8 (Special Issue II), pp. 415–420.
[153] Järvan, M. (2005). Põldude lupjamine, Eesti Maaviljeluse Instituut, Saku.
[154] GPG-LULUCF 2003, Equation 3.3.6., p. 3.80.

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 $CaMg(CO_3)_2$).

The area of liming has fluctuated widely over the years, depending significantly on government subsidies.

Area and emissions from the liming of croplands is illustrated in Figure 7.20. Type of lime applied to croplands could not be separated into limestone and dolomite due to the combined application of limestone and dolomite, thus the total emission from liming is reported.

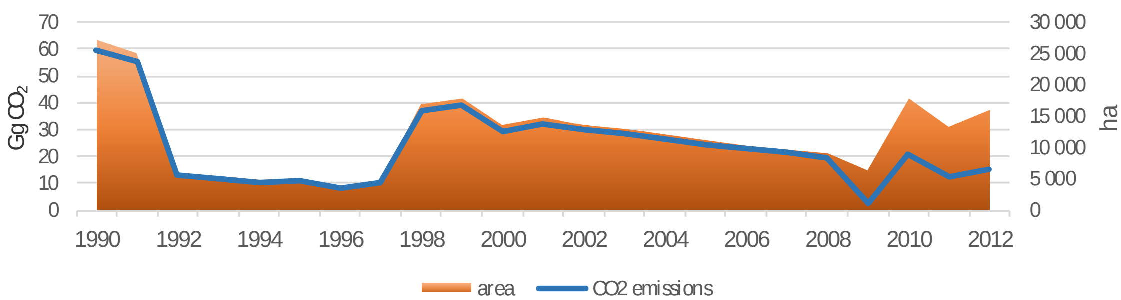

Figure 7.20. Area and CO_2 emissions from lime application on agricultural lands in 1990–2012

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 the Estonian NFI, national statistics and the 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 7.21.

Table 7.21. Uncertainties in the Cropland category

IPCC Source Category		Uncertainties %		EF References
		Activity data[155]	Emission factors	
5.B.1	Cropland remaining Cropland - living biomass	39.29	46.95	NFI, SE, Repola (2007)
5.B.1	Cropland remaining Cropland - mineral soils	2.76	50.00	IPCC 2006; Kõlli *et al*, 2009
5.B.1	Cropland remaining Cropland - organic soils	21.41	90.00	IPCC 2006
5.B.2.2	Grassland converted to Cropland - living biomass	33.28	46.95	IPCC 2003 & 2006
5.B.2.2	Grassland converted to Cropland - mineral soils	33.24	30.00	Kõlli *et al*, 2009

[155] All activity data uncertainty estimates are obtained from NFI.

IPCC Source Category		Uncertainties %		EF References
		Activity data[155]	Emission factors	
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)	33.24	50.00	LULUCF GPG 2003
5.B\5(IV)	CO_2 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.

Country-specific cropland reference soil organic carbon stocks (SOC_{REF}) for mineral soils were compared with the estimates following IPCC 2006 methodology (Table 7.14) for verification purposes.

7.3.5. Source-specific recalculations

The entire time series of activity data is 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 into overall activity data.

In Table 7.22 a quantitative overview of recalculations has been shown.

7.3.6. Source-specific planned improvements

The Agricultural Research Centre of Estonia is conducting fieldwork and estimating carbon stock changes in cultivated mineral and organic soils (Table 7.17).

Table 7.22. Quantitative overview of recalculations, Gg C (15.04.2013 submission/15.04.2014 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	97.1	96.6	**-0.5**	110.9	110.5	**-0.4**	101.1	102.3	**1.2**	92.8	96.9	**4.2**	82.2	86.5	**5.0**
	Organic soil	-144.1	-127.2	**10.3**	-105.9	-121.0	**12.5**	-103.4	-118.1	**12.4**	-103.0	-114.1	**9.8**	-102.4	-109.6	**6.6**
Land converted to Cropland	Living biomass	NO	NO	**-**	NO	NO	**-**	NO	NO	**-**	-14.2	-12.0	**-18.4**	-6.8	-7.6	**10.8**
	Dead organic matter	NO	NO	**-**	NO	NO	**-**	NO	NO	**-**	NO	-0.13	**-100**	NO	-0.13	**-100**
	Mineral soil	NO	NO	**-**	NO	NO	**-**	NO	NO	**-**	-4.4	-3.5	**-24.0**	-13.1	-12.2	**-6.9**
	Organic soil	NO	NO	**-**	NO	NO	**-**	NO	NO	**-**	NO	NO	-	-2.7	-2.1	**-29.0**
	N_2O	NO	NO	**-**	NO	NO	**-**	NO	NO	**-**	0.006	0.005	**-24.0**	0.017	0.016	**-6.9**
	TOTAL Cropland net CO_2	125.4	175.7	**28.6**	-6.1	50.6	**112.0**	46.9	96.1	**51.2**	146.8	162.1	**9.4**	193.5	202.3	**4.4**

7.4. Grassland (CRF 5.C)

7.4.1. Source category description

The spatial share of the grassland category is 7.4% of the overall Estonian area, ranking grasslands as the fourth largest land-use category after wetlands. By 2012, the area of grasslands decreased 58% compared to 1970s (Figure 7.21) due to: i) abandonment of grazing lands, and ii) development of the agricultural sector and cultivation of grasslands.

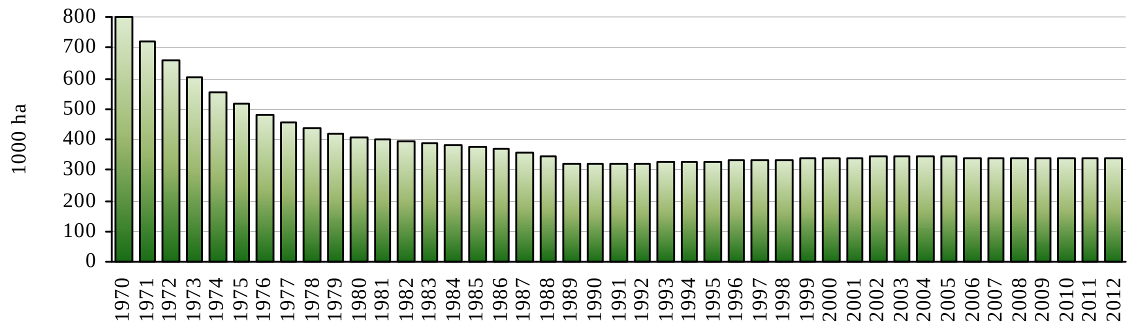

Figure 7.21. Grassland area in Estonia in 1970–2012, 1000 ha (SE, NFI)

The 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. Non-CO_2 emissions from biomass burning have also been estimated.

Grasslands have been both a net sink and source of GHG-s throughout the accounting period (Figure 7.22), depending mostly on the changes of living biomass. In the beginning of the 2000s, fast biomass increase characterized grasslands, mostly caused by abandonment of old croplands. Due to natural succession, when the tree crown cover of grasslands exceeds 30%, the land is reallocated to the forest land category, which is the reason behind the decrease in grassland carbon uptake by biomass.

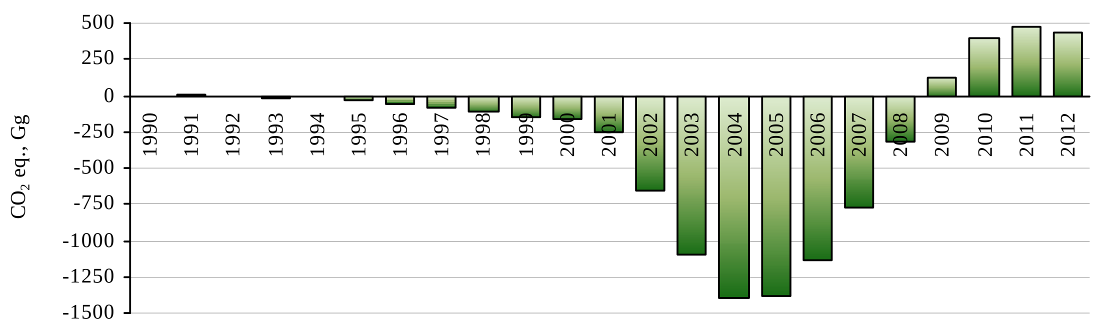

Figure 7.22. Annual CO_2 uptake(-)/emissions(+) from the Grassland category in 1990−2012, Gg

7.4.2. Methodological issues

The 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, the *Tier 2* approach and *Method 2* – the stock change method was used. The NFI provides annually updated data about the area and volume of growing stocks on grasslands. Biomass change is the difference between the biomass at year t_2 and year t_1 (see Equation 7.2). Parameters from IPCC 2006 (Table 7.23) were applied.

Table 7.23. Parameters used in Grassland living biomass estimations[156]

$BCEF_S$			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 $BCEF_S$[157]	GL rem GL	0.76	0.45
	to GL	0.69…0.96	0.41

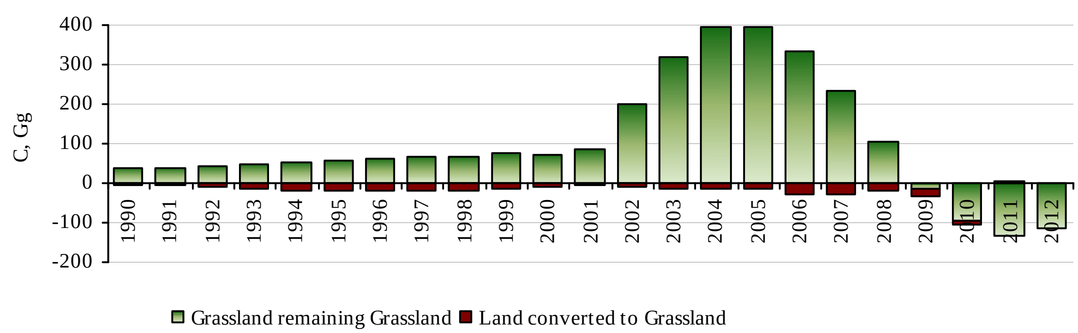

Figure 7.23. Carbon stock change in Grassland living biomass in 1990–2012, Gg C

Figure 7.23 illustrates the annual change in living biomass carbon pool in the 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 the forest land category.

[156] IPCC 2006, Vol 4 (AFOLU), Table 4.4 & 4.5.
[157] The weighted average $BCEF_S$ values are dependent on the distribution of tree species, age class and growing stock.

The 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

the same method (*Tier 2*, stock-change method) and parameters were used for estimating carbon stock changes in the dead wood pool on grasslands as for forest land, more information can be found in chapter 7.2.2.3. The 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.

Grassland dead wood carbon pool increased, reaching its peak in 2006 mostly due to storms that took place in 2001, 2002 and 2005 (Figure 7.24). After 2006, there is a declining trend in grassland dead wood stock, since accumulated dead wood is decomposing and also the area of grasslands has been decreasing in recent years.

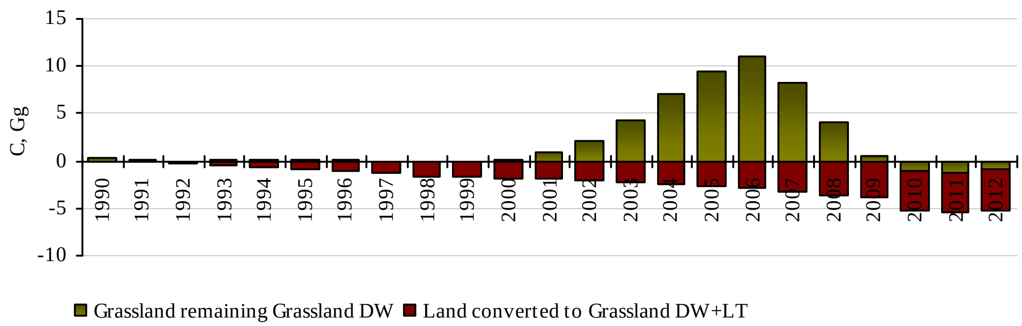

Figure 7.24. Annual change in Grassland dead organic matter pool in 1990–2012, Gg C

7.4.2.3. CO_2 emissions/removals from/by litter

Estonia does not have sufficient country specific data regarding forest and grassland litter stocks, thus under grassland remaining grassland, for the litter pool the *Tier 1* method was implemented, assuming that carbon stocks are in equilibrium so that the changes in the litter pool are assumed to be zero.

Under land conversion to grassland, the UNFCCC in-country review (2012) recommended the use of the litter emission factor from Sweden (Table 7.24) in order to avoid underestimation of emissions from deforestation (Forest land→Grassland) and assure consistency between the Convention and Kyoto Protocol reporting.

7.4.2.4. CO_2 emissions/removals from/by mineral soils

Reference soil organic carbon stock (Table 7.14) was calculated for grassland mineral soils based on national reasearch and published data. *Tier 1* method and relative stock change factors from IPCC 2006[158] were applied to estimate annual stock changes in the grassland remaining grassland category. Since grasslands are not actively managed in Estonia, nor are additional inputs added to grassland soil, all stock change

[158] IPCC 2006 (Vol 4), Table 6.2, p. 6.16.

factors (F_{LU}, F_{MG}, F_I) are equal to 1, hence no changes are assumed in the grassland remaining mineral soil pool.

Emission estimates for land conversion to grassland are based on corresponding Swedish EF-s (*Tier 2*) (Table 7.24), 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 (*Tier 1*).

Table 7.24. Cumulative land-use changes to Grassland in 2012, soil and litter emission factors[159]

Land-use	kha	%	EF mineral soil Mg C ha^{-1}	EF organic soil Mg C ha^{-1}	EF litter Mg C ha^{-1}
Grassland remaining grassland	286.1	-	-	-1.71	-
Forest Land→Grassland	5.8	11%	0.225	-1.60	-0.75
Cropland→ Grassland	40.9	81%	1.04	-1.60	NA
Wetlands→ Grassland	1.0	2%	0.21	-1.60	NA
Settlements→ Grassland	1.9	4%	0.21	-1.60	NA
Other Land→ Grassland	1.1	2%	0.21	-1.60	NA
Total to GL	50.6	100%			

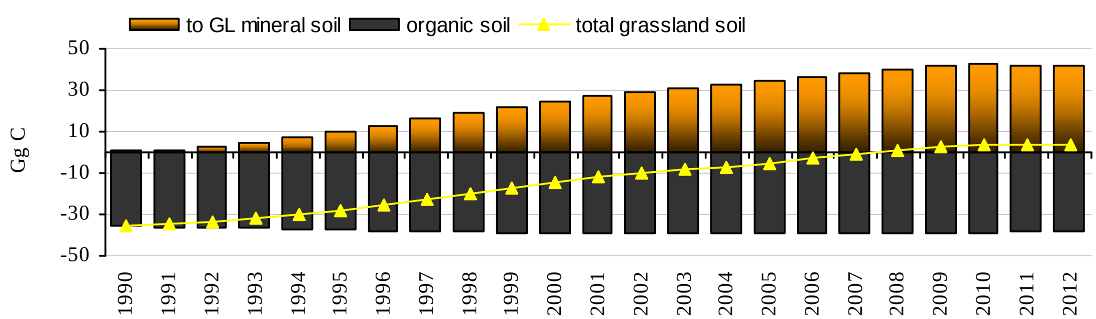

Figure 7.25. Annual stock change in Grassland mineral and drained organic soil pools 1990–2012, Gg C

7.4.2.5. CO_2 emissions from organic soils

Figure 7.25 illustrates annual changes in grassland organic soils. *Tier 2* method and Equation 7.10 was implemented to estimate the loss of carbon from drained grassland soils. The emission factor from Sweden (Table 7.24) was implemented due to lack of country-specific data.

The total area of grassland organic soils and the sub-area of drained soils are obtained from the NFI database. The proportion of drained organic soils is about 56%. All organic soils falling under land converted to grassland are considered drained.

[159] Sweden NIR 2013, Annexes, Table A 3:2.9, p. 85

Equation 7.10[160]

$$\Delta C_{GGOrganic} = \sum_c (A \bullet EF)_c$$

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 6% 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 7.25.

Table 7.25. Uncertainties in the Grassland category.

IPCC Source Category		Uncertainties %		EF References
		Activity data[161]	Emission factors	
5.C.1	Grassland remaining Grassland – living biomass	9.74	46.95	IPCC 2003 & 2006
5.C.1	Grassland remaining Grassland – organic soils	16.85	35.00	Sweden NIR 2013, Table 7.5, p. 296
5.C.1	Grassland remaining Grassland – dead wood	19.19	12.89	Sandström *et al*. 2007
5.C.2.1	Forest Land converted to Grassland - living biomass	40.58	46.95	IPCC 2003 & 2006
5.C.2	Land converted to Grassland – living biomass (excl. FL)	16.30	46.95	IPCC 2003 & 2006
5.C.2	Land converted to Grassland – mineral soils	14.03	35.00	Sweden NIR 2013, Table 7.5, p. 296
5.C.2	Land converted to Grassland – organic soils	45.67	35.00	Sweden NIR 2013, Table 7.5, p. 296
5.C.2.1	Forest Land converted to Grassland - dead wood	40.59	30.07	Sandström *et al*. 2007
5.C.2	Land converted to Grassland – dead wood (excl. FL)	23.21	30.07	Sandström *et al*. 2007

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 chapter 1.3.3.

[160] GPG-LULUCF 2003, Equation 3.4.10., p. 3.114.
[161] All activity data references are obtained from NFI.

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 inventory. The QC check list is used during the inventory.

Country-specific Grassland reference soil organic carbon stocks (SOC_{REF}) for mineral soils were compared with the estimates following IPCC 2006 methodology (Table 7.14) for verification purpose.

7.4.5. Source-specific recalculations

Activity data as well as growing stock and dead wood stock volumes are being updated and if necessary, corrected, each year.

The grassland organic soil emission factor from Sweden was updated.

In Table 7.26 changes in applied to parameters and in Table 7.27 a quantitative overview of recalculations are shown.

Table 7.26. Parameters used in the Grassland category recalculations (15.04.2013 submission and 15.04.2014 submission)

Land use category	Parameter	2013 Submission		Source	2014 Submission		Source
Grassland remaining Grassland	EF organic soil [Mg C ha^{-1} yr^{-1}]	EF Sweden	-1.60	National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84	EF Sweden	-1.71	Sweden 2013, CRF (1990-2011 average)

7.4.6. Source-specific planned improvements

A project titled „Applied research of greenhouse gases in the LULUCF sector in the framework of UNFCCC and Kyoto protocol reporting“ was launched in June 2013, funded by the Environmental Investment Centre. One of the objectives of the project is to determine changes in grassland soil organic carbon stocks. Project activities include conducting fieldwork, resampling previous sample plots and estimating carbon stock changes in natural and semi-natural grassland soils. The aim is to develop country-specific emission factors for grassland soils.

Table 7.27. Quantitative overview of recalculations, Gg C (15.04.2013 submission/15.04.2014 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	6.9	39.4	**82.5**	52.9	55.5	**4.7**	97.0	70.8	**-37.0**	380.3	393.6	**3.4**	-32.9	-94.7	**65.2**
	Dead organic matter	0.3	0.3	**-2.6**	0.2	0.2	**-3.0**	0.2	0.2	**-1.0**	9.5	9.5	**-0.2**	-2.2	-1.10	**-100**
	Organic soil	-32.5	-35.1	**7.5**	-31.8	-34.4	**7.6**	-31.3	-33.8	**7.4**	-30.4	-33.1	**8.2**	-29.0	-31.4	**7.5**
Land converted to Grassland	Living biomass	-4.0	-4.29	**6.8**	-19.4	-18.92	**-2.5**	-8.9	-10.39	**14.3**	-8.7	-16.54	**47.4**	-8.2	-10.85	**24.4**
	Dead organic matter	0.02	0.02	**8.7**	-0.9	-0.82	**-9.8**	-1.8	-1.81	**0.6**	-2.5	-2.59	**3.5**	-3.7	-4.08	**9.3**
	Mineral soil	0.7	0.46	**-52.2**	11.2	9.60	**-16.7**	24.7	24.55	**-0.6**	33.2	34.40	**3.6**	38.5	42.34	**9.0**
	Organic soil	-0.6	-0.47	**-27.7**	-4.1	-3.11	**-31.8**	-6.3	-5.14	**-22.6**	-6.3	-6.30	**0**	-6.3	-7.60	**17.1**
	TOTAL Grassland net CO_2	106.9	-1.3	**8 619**	-29.7	-29.4	**-1.3**	-269.8	-163.0	**-65.5**	-1 374.9	-1 389.1	**1.0**	160.6	393.6	**59.2**

7.5. Wetlands (CRF 5.D)

7.5.1. Source category description

The area of wetlands cover 11% of Estonia's territory. Wetlands (including peatland and inland water bodies) decreased until the beginning of 1990s, since then the area has remained stable (Figure 7.26). A 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 sites and land conversion to wetlands/peatlands.

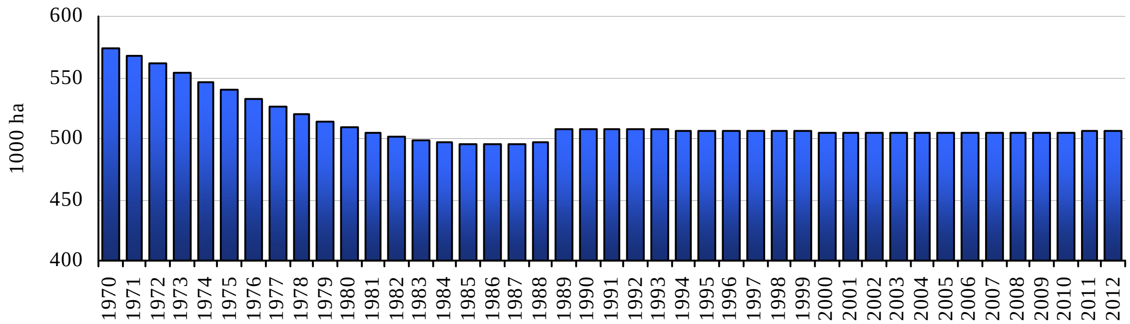

Figure 7.26. Area of Wetlands (including inland water bodies and peat extraction sites) in Estonia in 1970–2012, 1000 ha

In Estonia, peat is the third most-important indigenous fuel after oil shale and wood. A more detailed overview of usage of peat for energy production is provided under Energy sector (Chapter 3).

Activity data for the estimation of emissions related to peat extraction was obtained from NFI and the Estonian Peat Association. In 2012, the total area of managed peat extractions fields was 18 593 ha (Figure 7.27 & Figure 7.28). Peat extraction usually proceeds on the same production area during several years. After extraction the area is restored

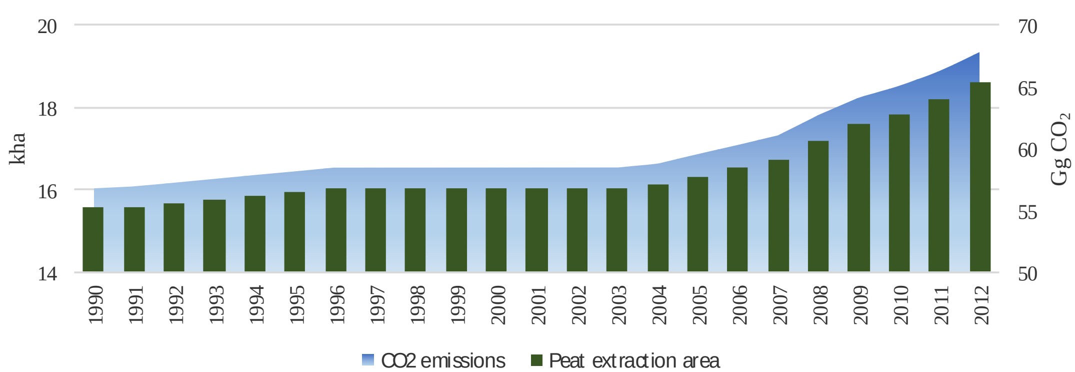

Figure 7.27. Total peatland area (kha) and emissions (Gg CO_2) related to peat extraction

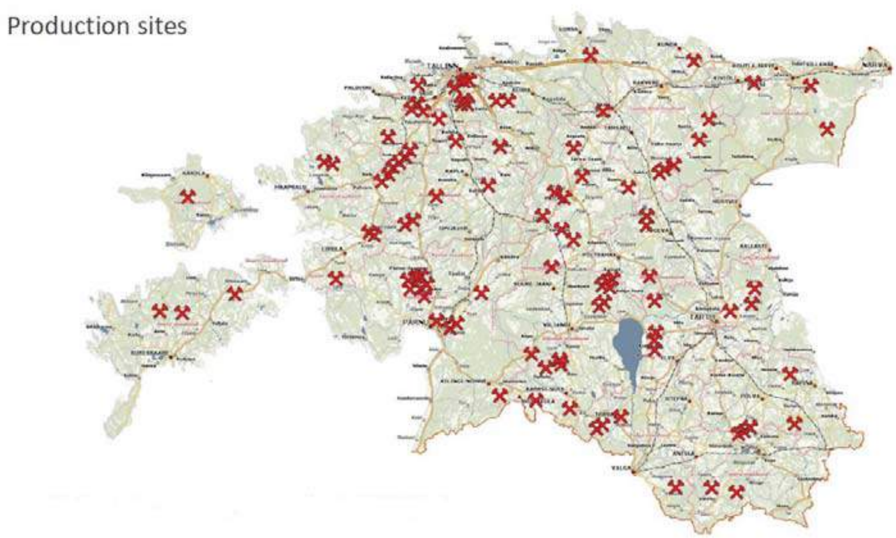

Figure 7.28. Peat production sites in Estonia

7.5.2. Methodological issues

7.5.2.1. Change in carbon stocks in living biomass and dead wood

Carbon loss in living biomass and dead organic matter pools after land conversion to Wetlands/Peat extraction sites (Table 7.28) was estimated using the *Tier 2*. It was assumed that all biomass will be lost after land use change. Average growing stock and dead wood volumes (NFI) in corresponding land remaining (eg land remaining forest land) categories were applied. Carbon loss from living biomass and DOM were 18 Gg and 0.5 Gg respectively in 2012 (Figure 7.29). Land change to wetlands and peat extraction sites has intensified since 2004, leading to growing emissions in the recent years.

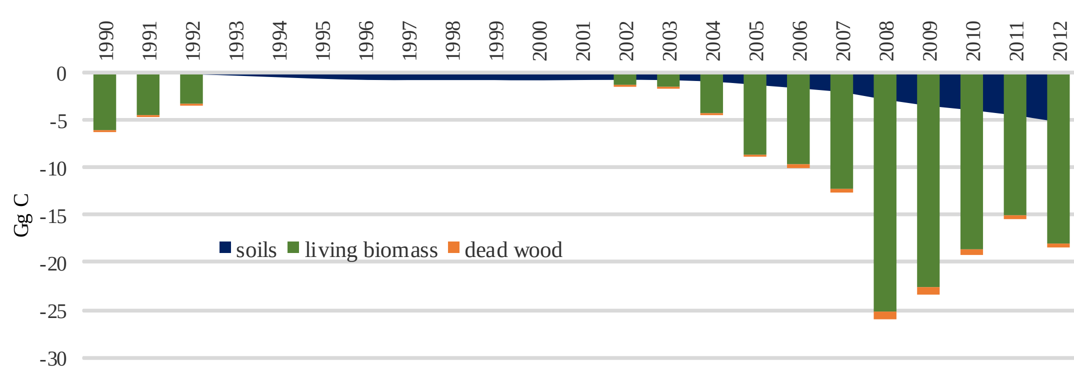

Figure 7.29. Carbon loss in living biomass, dead organic matter and soil after land conversion to wetlands and peat extraction sites in 1990–2012, Gg C

7.5.2.2. Emissions from organic soils

In Table 7.28 land use changes to wetlands and peat extraction sites and applied emission factors are presented. Emission estimates are illustrated in Figure 7.27 and Figure 7.29.

Table 7.28. Cumulative land-use changes to Wetlands and peat extraction sites in 2012, soil and litter emission factors

Land-use change	kha	EF organic soil Mg C ha^{-1}	EF litter [162] Mg C ha^{-1}
Forest Land→Wetlands	0.9	no emissions, soil C is not considered lost after LUC to <u>unmanaged</u> wetlands	-1.20
Grassand→Wetlands	0.3		NA
Other land→Wetlands	1.3		NA
Total to WL	2.4		
Forest Land→Peat extraction	2.6	-1.741	-1.20
Wetlands→ Peat extraction	0.4		NA
Total to WL_{Peat}	3.0		

Tier 2 and Equation 7.11 was implemented for estimating CO_2 emissions from organic soils managed for peat extraction.

Equation 7.11[163]

$$\Delta C_{WWpeat\_Soil,extraction} = A_{peatland} \bullet EF_{CO2}$$

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 7.29).

Country-specific emission factors (Table 7.29) were applied for estimating emissions from peatland management.

[162] Since there are no country-specific EF-s nor Swedish EF-s for land converted to Wetlands, the same litter emission factors as under land converted to Settlements was applied.
[163] GPG-LULUCF, 2003, Equation 3a.3.6, p. 3.279.

Table 7.29. Emission factors for CO_2–C, N_2O–N and CH_4-C for active peatland management[164]

	Annual soil efflux, median value [kg ha^{-1} yr^{-1}]
CO_2-C	1741
N_2O-N	0.19
CH_4-C	0.12

Equation 7.12 (*Tier 2*) was implemented for estimating CH_4 emissions from organic soils managed for peat extraction.

Equation 7.12[165]

$$\text{Direct } CH_4 \text{ emissions}_{WWpeat} = \left(A_{peatland} \bullet EF_{CH4}\right) \bullet 16/12 \bullet 10^{-6}$$

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 7.29).

CH_4 emissions associated with changes in soil carbon during peat extraction are showed in Figure 7.30. Emissions have increased by 19% compared to the base year due to the enlargement of peat extraction sites.

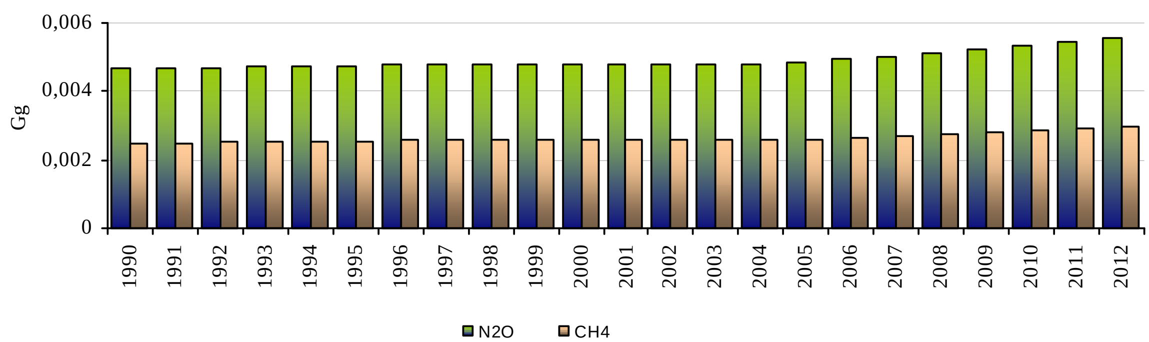

Figure 7.30. CH_4 and N_2O emissions from peat extraction in 1990–2012, Gg

Equation 7.13 (*Tier 2*) was used for estimating N_2O emissions from drained peatlands. Results are illustrated in Figure 7.30.

[164] 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.
[165] Equation adjusted after Equation 3a.3.7 in GPG-LULUCF, 2003, p. 3.283

Equation 7.13[166]

$$\text{Direct } N_2O \text{ emissions}_{WWpeat} = \left(A_{peatland} \bullet EF_{N2O}\right) \bullet 44/28 \bullet 10^{-6}$$

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 7.29).

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 7.30.

Table 7.30. Uncertainties in the Wetlands category

IPCC Source Category		Uncertainties %		EF References
		Activity data[167]	Emission factors	
5.D.1	Wetlands remaining Wetlands\Peatland - organic soils managed for peat extraction CO_2	22.76	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
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	102.78	46.95	IPCC 2003 & 2006
5.D.2.1	Forest Land converted to Wetlands - organic soils managed for peat extraction	74.07	50.00	Salm *et al*. 2012
5.D.2.1	Forest Land converted to Wetlands - dead wood	51.23	12.89	Sandström *et al*. 2007
5.D.2.5	Wetlands converted to Peatland - organic soils	74.07	50.00	Salm *et al*. 2012

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 the IPCC *Tier 1* method. The activities are carried out every year during the inventory. The QC check list is used during inventory.

Country-specific peat extraction soil emission factors were compared with GPG-LULUCF 2003 default factors (Table 7.31).

[166] GPG-LULUCF, 2003, Equation 3a.3.7, p. 3.283.
[167] All activity data references are obtained from the NFI.

Table 7.31. Comparison of country-specific and IPCC 2003 drained peatland soil emission factors

EF (kg ha^{-1} yr^{-1})	CO_2-C	N_2O-N	CH_4-C
country-specific (Salm *et al*. 2012)	1741	0.19	0.12
IPCC 2003 default	200 … 1100[168]	0.1 … 1.8[169]	NA

7.5.5. Source-specific recalculations

Updated activity data, growing stocks and dead wood volumes from the NFI was used for estimating carbon losses due to land conversion to wetlands and peatlands (Table 7.32).

Table 7.32. Quantitative overview of recalculations, (15.04.2013 submission/ 15.04.2014 submission)

Wetlands TOTAL emissions, Gg		**CO_2**	**CH_4**	**N_2O**
1990	Previous submission	129.2	0.003	0.005
	Current submission	122.3	0.003	0.005
	Difference %	**-5.7**	**-3.2**	**-3.2**
1995	Previous submission	102.6	0.003	0.005
	Current submission	101.7	0.003	0.005
	Difference %	**-0.9**	**-0.9**	**-0.9**
2000	Previous submission	102.6	0.003	0.005
	Current submission	102.3	0.003	0.005
	Difference %	**-0.3**	**-0.3**	**-0.3**
2005	Previous submission	148.2	0.003	0.005
	Current submission	136.5	0.003	0.005
	Difference %	**-8.6**	**-1.0**	**-1.0**
2010	Previous submission	155.1	0.003	0.005
	Current submission	184.3	0.003	0.005
	Difference %	**15.8**	**1.6**	**1.6**

[168] GPG-LULUCF 2003, Table 3a.3.2, p 3.280
[169] GPG-LULUCF 2003, Table 3a.3.4, p 3.284

7.5.6. Source-specific planned improvements

Updated NFI activity data will be used.

7.6. Settlements (CRF 5.E)

7.6.1. Source category description

Settlements, including all built-up areas, cover about 7% of Estonia's territory. The area of settlements has been increasing continuously in Estonia (Figure 7.31) mainly on behalf of forest lands (Table 7.4). Carbon flows related to Settlements remaining Settlements have not been calculated in the current submission due to lack of detailed data. Furthermore, it is not mandatory for Parties to report estimates for the category contained in appendix 3a.4 (Settlements remaining Settlements) of the IPCC good practice guidance for LULUCF.

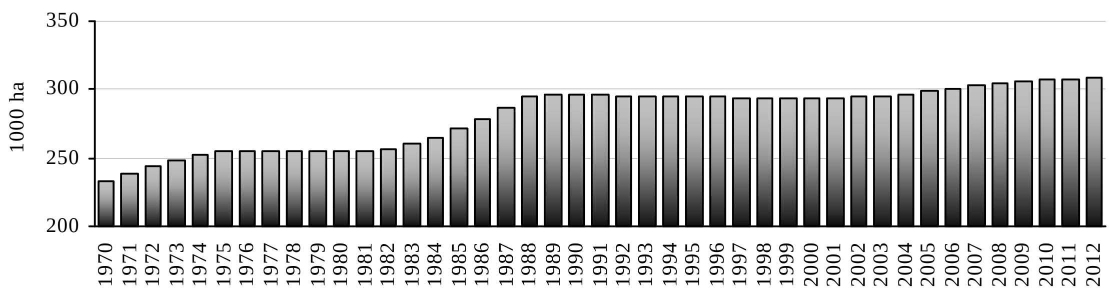

Figure 7.31. Area of Settlements in Estonia in 1970–2012, 1000 ha (SE, NFI)

7.6.2. Methodological issues

Emissions estimates were provided for forest land, cropland, grassland and other land conversion to Settlements (Figure 7.32). Total CO_2 emissions after land conversion to settlements were 264 Gg in 2012.

Change in carbon stocks in living biomass and dead wood due to land conversion is estimated (using Equation 7.14) by multiplying the area converted annually to settlements by the difference in carbon stocks between biomass in the system prior to conversion and that in the settlements after conversion, assuming that all biomass will be lost (B_{AFTER}=0). Forest land and grassland living biomass and dead wood stocks prior the land-use change were obtained from the NFI.

Equation 7.14[170]

$$\Delta C_{CONVERSION} = \sum_i \{(B_{AFTER_i} - B_{BEFORE_i}) \bullet \Delta A_{TO\_OTHERS_i}\} \bullet CF$$

Where:
$\Delta C_{CONVERSION}$ – initial change in biomass carbon stocks on land converted to another land category, tonnes C yr^{-1};
B_{AFTERi} – biomass stocks on land type i immediately after the conversion, tonnes d.m. ha^{-1};
$B_{BEFOREi}$ – biomass stocks on land type i before the conversion, tonnes d.m. ha^{-1};
$\Delta A_{TO\_OTHERSi}$ – area of land use i converted to another land-use category in a certain year, ha yr^{-1};
CF – carbon fraction of dry matter, tonne C (tonnes d.m.)$^{-1}$;
i – type of land use converted to another land-use category

Due to missing country-specific soil emission factors, EFs from Sweden were implemented (Table 7.33). Since there were no EFs for land converted to Settlements for organic soils, mineral soils EF-s were applied.

Table 7.33. Cumulative land-use changes to Settlements in 2012, soil and litter emission factors[171]

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→Settlements	8.8	-1.30	-	-1.20
Cropland→Settlements	4.5	-2.50	-	NA
Grassland→Settlements	3.3	-2.75	-	NA
Other Land→ Settlements	0.8	-1.30	-	NA
Total	17.4			

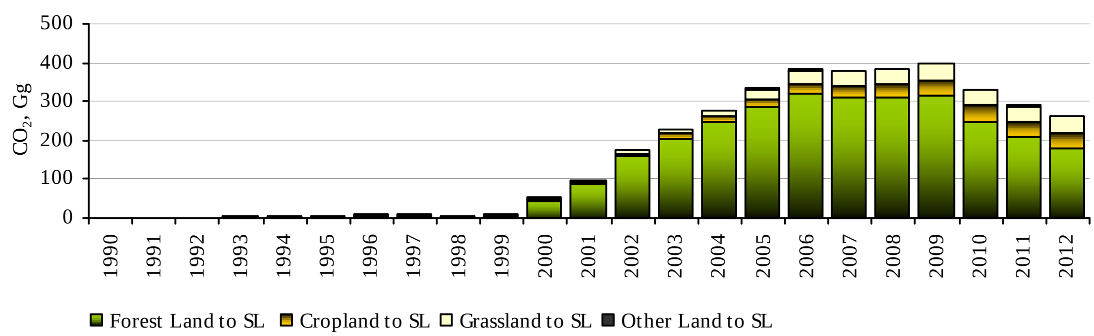

Figure 7.32. CO_2 emissions related to land conversion to Settlements, 1990–2012

[170] IPCC 2006 (Vol 4), Equation 2.16, p. 2.20
[171] Emission factors were obtained from Sweden National Inventory Report 2013, Annexes, Table A3:2.9, p.85

7.6.3. Uncertainty and time series consistency

The uncertainty rates related to activity data and emission factors in the Settlements catyegory are presented in Table 7.34.

Table 7.34. Uncertainties in the land converted to Settlements category.

IPCC Source Category		Uncertainties %		EF References
		Activity data[172]	Emission factors	
5.E.2	Land converted to Settlements – living biomass	62.81	46.95	IPCC 2003 & 2006
5.E.2	Land converted to Settlements – soils	24.31	35.00	Sweden NIR 2013, Table 7.5, p. 296
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 the LULUCF 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 Chapter 1.6.1.

7.6.5. Source-specific recalculations

Updated activity data, growing stocks and dead wood volumes from the NFI were used for estimating carbon losses due to land conversion to Settlements. Swedish litter emission factor was updated (-1.25 Mg C ha^{-1} yr^{-1} in 2013; -1.20 Mg C ha^{-1} yr^{-1} in 2014 submission).

[172] All activity data uncertainty estimates are obtained from the NFI.

Table 7.35. Quantitative overview of recalculations in the Settlements category (15.04.2013 submission/15.04.2014 submission)

to Settlements TOTAL emissions, Gg		CO_2		CO_2
1990	Previous submission	NE,NO	**2005**	346.50
	Current submission	0.56		333.39
	Difference %	**100**		**-3.9**
1995	Previous submission	6.91	**2010**	323.84
	Current submission	5.57		331.58
	Difference %	**-24.2**		**2.3**
2000	Previous submission	67.06		
	Current submission	53.73		
	Difference %	**-24.8**		

7.6.6. Source-specific planned improvements

Updated data from the NFI for land-use changes will be used.

7.7. Other Land (CRF 5.F)

7.7.1. Source category description

The 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 2014 submission, emissions from forest land, cropland, grassland and wetlands to the Other land category were estimated (Figure 7.33) implementing Equation 7.14 and emission factors from the Sweden annual submission 2013 (Table 7.36). Conversion to other land has occurred since 2003 according to the NFI. Total emissions from land converted to Other land were estimated at 43 Gg CO_2 in 2012.

Table 7.36. Cumulative land-use changes to Other Land in 2012, soil and litter emission factors

Land-use change	kha	EF mineral soil Mg C ha^{-1} [173]	EF organic soil Mg C ha^{-1}	EF litter Mg C ha^{-1}
Forest Land→Other Land	2.4	-1.30	-	-1.20
Cropland→Other Land	0.5	-2.50	-	NA
Grassland→Other Land	0.1	-2.75	-	NA
Wetlands→Other land	0.1	-3.73	-	NA
Total	3.1			

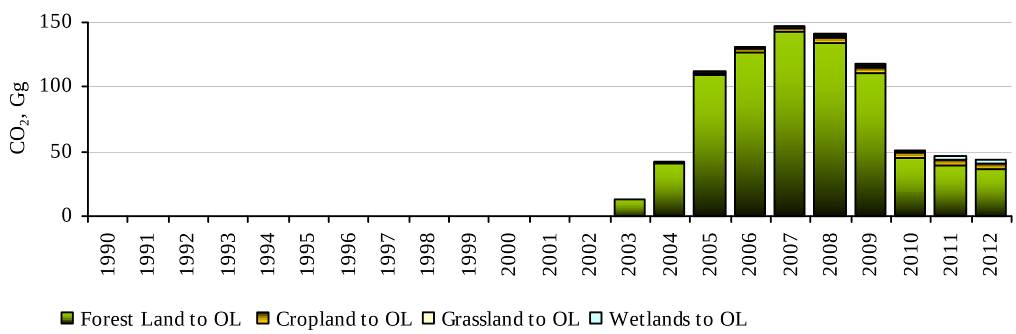

Figure 7.33. CO_2 missions related to land-use changes to Other land, 1990–2012

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 7.37.

Table 7.37. Uncertainties used in the land converted to Other Land category

IPCC Source Category		Uncertainties % Activity data[174]	Uncertainties % Emission factors	EF References
5.F.2	Land converted to Other Land – living biomass (excl FL)	72.75	46.95	IPCC 2003 & 2006
5.F.2.1	Forest Land converted to Other Land – living biomass	62.81	46.95	IPCC 2003 & 2006
5.F.2	Land converted to Other Land – soils	55.34	35.00	Sweden NIR 2013, Table 7.5, p. 296
5.F.2	Land converted to Other Land – dead wood	78.78	12.89	Sandström *et al*. 2007
5.F.2.1	Forest Land converted to Other Land – dead wood	62.82	12.89	Sandström *et al*. 2007

[173] Since there are no Swedish EFs for land converted to Other Land, the same emission factors as under land converted to Settlements were applied. The same EFs were implemented for mineral and organic soils.
[174] All activity data uncertainty estimates are obtained from the NFI.

7.7.4. Source specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for the LULUCF sector according to the IPCC *Tier 1* method. The quality objectives and the QA/QC plan for the Estonian GHG inventory at the national level are presented in 1.6.1.

7.7.5. Source-specific recalculations

Updated activity data, growing stocks and dead wood volumes from the NFI were used for estimating carbon losses due to land conversion to Other Land. The Swedish litter emission factor was updated (-1.25 Mg C ha^{-1} yr^{-1} in 2013; -1.20 Mg C ha^{-1} yr^{-1} in 2014 submission).

Table 7.38. Quantitative overview of recalculations in the Other Land category (15.04.2013 submission/15.04.2014 submission)

to Settlements TOTAL emissions, Gg		**CO_2**		**CO_2**
1990/1995	Previous submission	NO	**2005**	98.56
	Current submission	NO		111.58
	Difference %	**-**		**11.7**
2000	Previous submission	NO	**2010**	68.98
	Current submission	NO		50.95
	Difference %	**-**		**-35.4**

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 after wildfires. CO_2 emissions caused by wildfires are included in living biomass emission estimates due to the stock change (stock-difference) method used for calculations, thus CO_2 emissions are not reported under the 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 forest fires, and according to the Estonian Fire Safety Act, it is forbidden to burn dead grass through the year.

7.8.1. Methodology, data availability and sources, emission factors

Information about wildfires is acquired from the Estonian Rescue Service (ERS), which reports the location and type of fire occurred. With the objective to improve and verify data and emissions related to wildfires, the Estonian Environment Agency started to inventory reported wildfires. Exact location (georeference, area), land use and affected biomass are determined during fieldwork. Wildfires reported by the Estonian Rescue Service in 2012 are indicated in Figure 7.34.

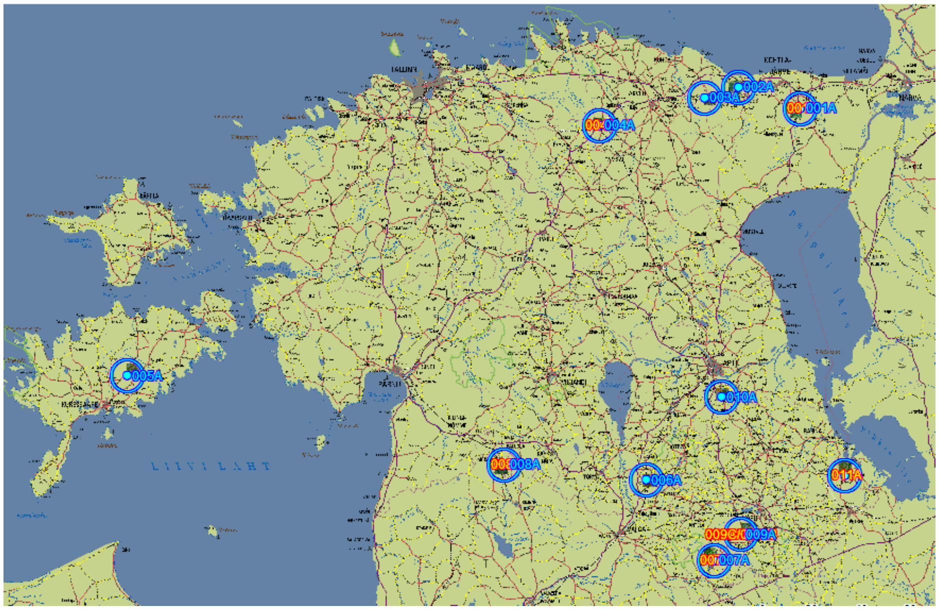

Figure 7.34. Reported wildfires in Estonia in 2012

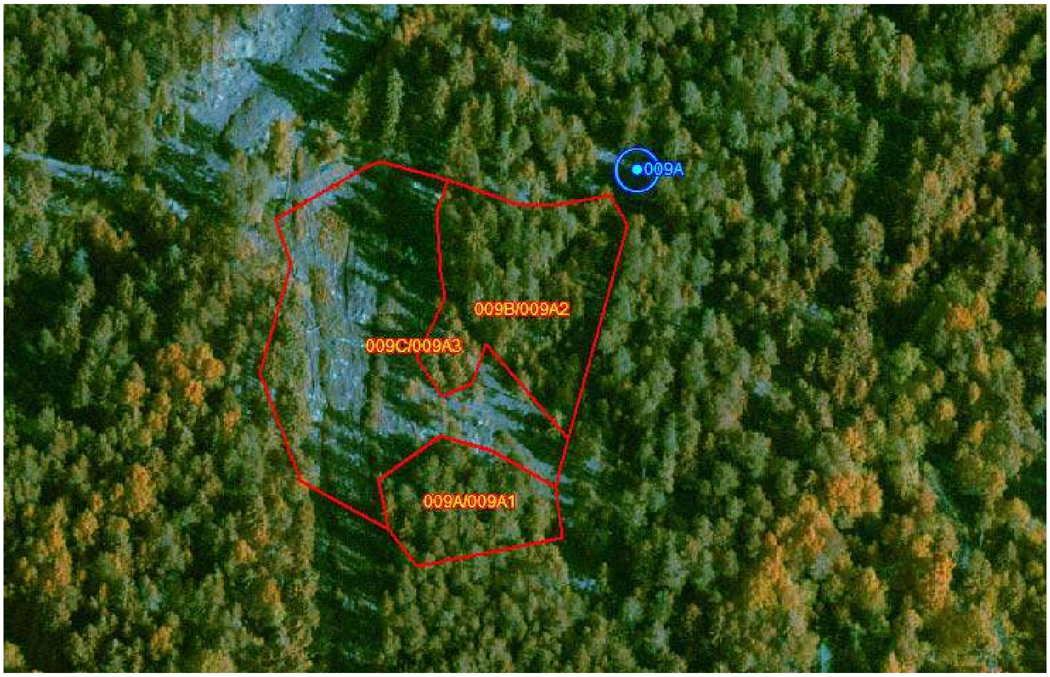

Figure 7.35. Reported fire location (blue circle), actual location (red border) and data analyses

Sometimes the location of wildfire reported by the ERS is imprecise, in which case EtEA field workers examine the nearby area and try to locate the place of fire (Figure 7.35). Detected burned area is separated into several land use categories if necessary.

The *Tier 2* method and Equation 7.15 was used to estimate the emissions of non-CO_2 greenhouse gases. Mass of available fuel and combustion efficiency is determined during fieldwork starting from 2013.

Equation 7.15[175]

$$L_{fire} = A \bullet B \bullet C \bullet D \bullet 10^{-6}$$

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};[176]
C – combustion efficiency (or fraction of the biomass combusted), dimensionless; from 1990–2011 applied value 0.15[177], starting from 2012 C is estimated during field inventory;
D – emission factor, g (kg dry matter.)$^{-1}$.

Emission factors used for biomass burning emission calculations are shown in Table 7.39.

[175] GPG-LULUCF 2003, Equation 3.2.20, p. 3.49.
[176] from 1990-2011 year specific average forest biomass growing stock was used as basis for B
[177] GPG 2003; Table 3A.1.12, p. 3.179 (Boreal) Surface fire

According to ERS and EtEA wildfires occurred only on 1.33 ha of forests and 0.88 ha of grasslands in 2012 (Figure 7.36). Fluctuations in area burned are caused mainly by the weather conditions in different years (e.g. extremely hot and dry summers).

Table 7.39. Factors used for estimation of non-CO_2 greenhouse gas emissions from fires

	CH_4 Emission factor, D[178]	N_2O Emission factor, D[179]
Forest Land	9	0.11
Grassland and Wetlands	2	0.1

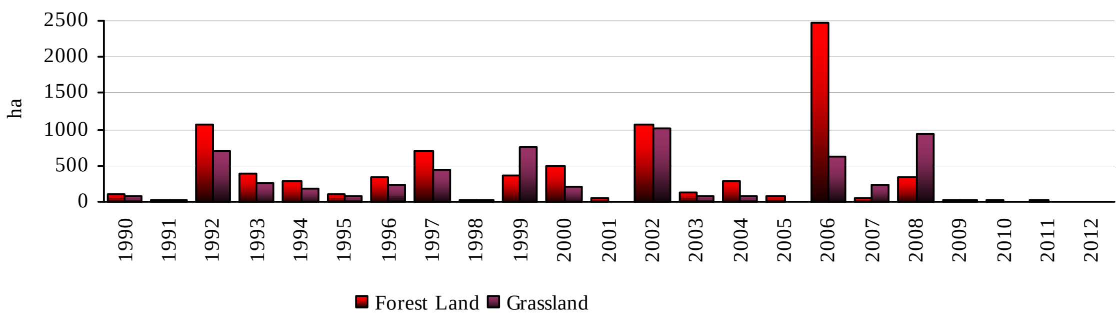

Figure 7.36. Annual area of forest land, grassland and wetlands affected by fires in 1990−2012, ha

Emissions of CH_4 and N_2O from land burnings are illustrated in Figure 7.37 and Figure 7.38. The total amount of CH_4 and N_2O released after wildfires was 333 kg and 6.3 kg respectively in 2012. 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.

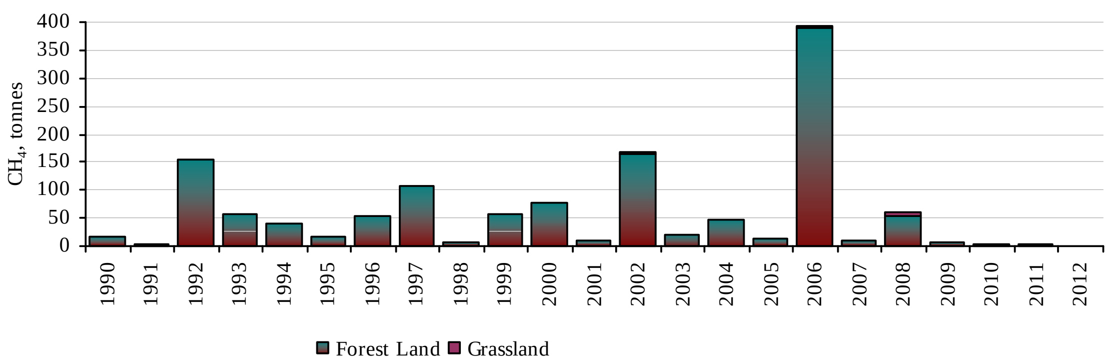

Figure 7.37. CH_4 emissions from wildfires in Estonia in 1990–2012, t

[178] GPG-LULUCF 2003, Table 3A.1.16, p. 3.185, Forest fires (Delmas *et al.* (1995)).
[179] GPG-LULUCF 2003, Table 3A.1.16, p. 3.185, Moist-infertile grassland (Scholes (1995)).

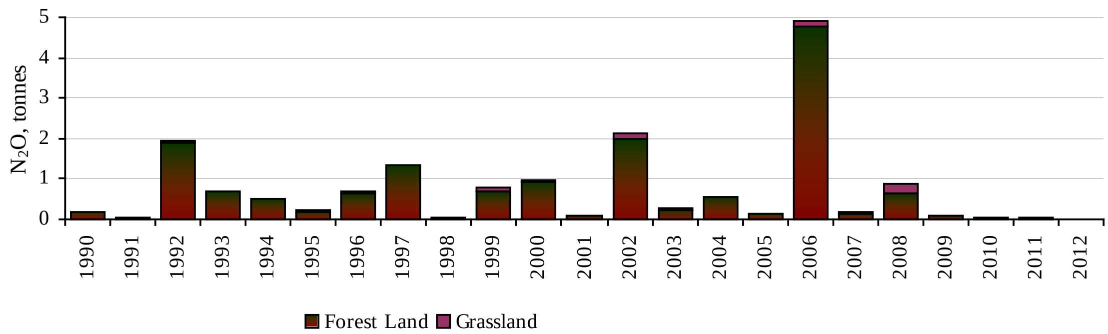

Figure 7.38. N_2O emissions from wildfires in Estonia in 1990–2012, t

7.8.2. Uncertainties and time series consistency

Uncertainty estimates of CH_4 and N_2O emissions from wildfires were carried out based on LULUCF GPG (2003) guidelines. Activity data concerning area burnt was obtained from the Estonian Rescue Service and the Estonian Environment Agency. The uncertainty rates are shown in Table 7.40.

Table 7.40. Uncertainties of non-CO_2 emission estimates from biomass burning

IPCC Source Category	Uncertainties %		EF References
	Activity data[180]	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

7.8.3. Source specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for the LULUCF 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 Chapter 1.6.

Activity data obtained from the Estonian Rescue Service is verified and corrected if necessary during field inventory carried out by the Estonian Environment Agency.

7.8.4. Source-specific recalculations

No recalculations were made in the 2014 submission.

[180] All activity data uncertainty estimates are obtained from the NFI.

7.8.5. Source-specific planned improvements

Starting from October 2013, forest fires are inventoried by the Estonian Environment Agency, which determines the area and type of fire and estimates the fire damage on biomass (trees, dead organic matter) and soils.

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[181]. 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. In addition to prior requirement, development of municipal waste management system was put into practice due to enlarged pollution fees attended with waste disposal on land.

According to the local waste management rules, 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 from wastewater treatment. The waste sector also covers GHG emissions from waste incineration, biological treatment, landfill gas treatment and wastewater handling including domestic and commercial, and industrial wastewater. Emissions from wastewater handling basically do not occur in Estonia, as all wastewater is mostly treated using aerobic processes. However in wastewater treating plants anaerobic and anoxic zones for wastewater treating are used as well.

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 relies on the decision trees in IPCC Guidelines and therefore *Tier 1* and Tier 2 (The FOD) methods are applied. The choice of activity data to calculate emissions depends on formulas used.

[181] 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 Agency (EtEA) 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 of data on population and product production in Estonia
Estonian Environment Agency -Waste Bureau -Water Bureau -Air Bureau	www.keskkonnainfo.ee	EtEA	- Collection of data on solid waste generation, disposal, and recovery, incl. waste incineration and biological treatment - Collection of data on waste water generation - Collection of data on methane recovery

8.1.2. Quantitative overview of the waste sector

CO_2 equivalent emissions from waste sector in 2012 were 307.13 Gg. It made up 1.6% of the total GHG emission in 2012 (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 2012.

Due to recalculations in estimations of emissions from biological treatment the time series since 1990 was updated (Table 8.3).

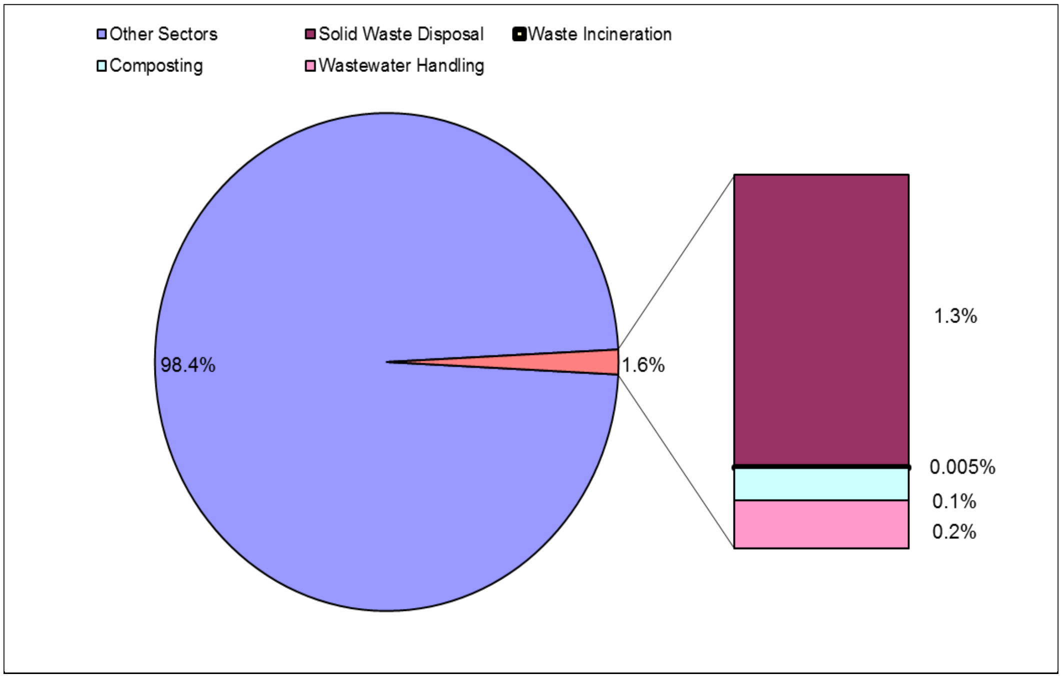

Figure 8.1. CO_2 equivalent emissions from the waste sector compared to the total GHG emissions in Estonia in 2012

The total CO_2 equivalent emission from waste sector in 2012 decreased 10.6% compared to the base year, although the emission from solid waste landfilled increased 33.7% and emission from waste composting processes increased from 1.20 Gg to 26.2 Gg in 2012 (Figure 8.2).

As seen from the table (Table 8.3) the lowest value of GHG emissions from waste management occurred in 1995, mainly caused by decreased CH_4 emissions from paper and sludge disposal on land. The highest CO_2 equivalent emission in 2001 is related to significant increase in emissions also from solid waste disposal. Emissions from waste incineration have been marginal during the whole period compared to other activities involved. For example, in 2007–2011 non-biogenic emissions did not occurred, as no organic wastes were incinerated, moreover in 2008 and 2011 no wastes were incinerated without energy recovery at all which resulted in no emerged emissions. The total CO_2 equivalent in 2012 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 and disposal.

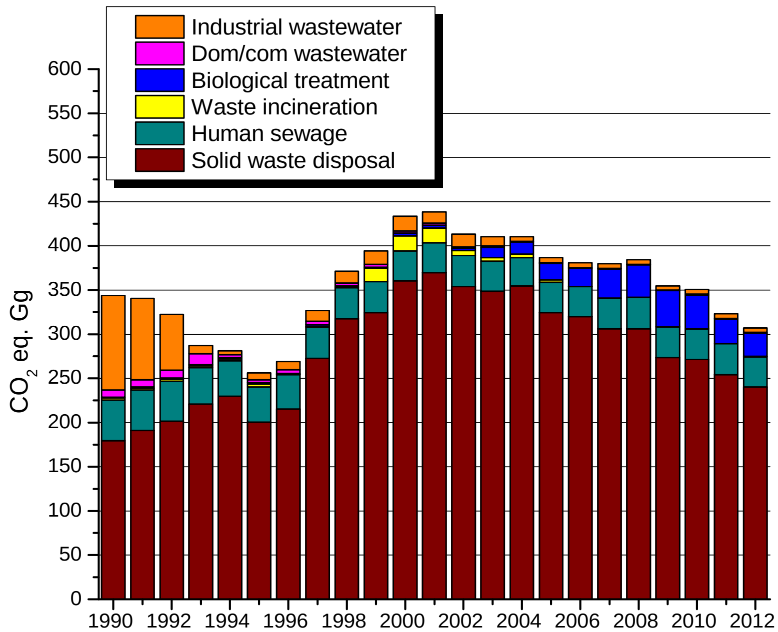

Figure 8.2. Trends of GHG emissions in the waste sector by source categories in 1990–2012**,** Gg CO_2 eq.

Table 8.3. GHG emissions from waste sector in Estonia in 1990–2012, 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[182]	*0.0082*[183]	0.0016	0.0050	0.027	0.002	0.148	0.387	5.082	NO	NO	343.65
1991	9.103	0.034	*0.0082*	0.0016	0.0050	0.028	0.002	0.148	0.386	4.379	NO	NO	340.33
1992	9.592	0.034	*0.0082*	0.0016	0.0050	0.030	0.002	0.146	0.426	3.017	NO	NO	322.51
1993	10.517	0.034	*0.0082*	0.0016	0.0050	0.031	0.002	0.133	0.579	0.449	NO	NO	287.16
1994	10.940	0.034	*0.0082*	0.0016	0.0050	0.033	0.002	0.130	0.162	0.198	NO	NO	281.09
1995	9.543	0.025	*0.0237*	0.0048	0.0061	0.036	0.003	0.128	0.159	0.375	NO	NO	256.41
1996	10.259	0.013	*0.0078*	0.0008	0.0004	0.024	0.002	0.125	0.195	0.442	NO	NO	269.03
1997	12.985	0.034	*0.0012*	0.0008	0.0007	0.045	0.003	0.114	0.192	0.584	NO	NO	326.86
1998	15.118	0.057	*0.0001*	0.0009	0.0048	0.008	0.001	0.113	0.153	0.645	NO	NO	371.41
1999	15.453	0.041	*0.0002*	0.0373	0.0126	0.026	0.002	0.112	0.151	0.717	NO	NO	394.23
2000	17.166	0.062	*0.00004*	0.0069	0.0473	0.076	0.006	0.109	0.113	0.790	NO	NO	433.47
2001	17.606	0.045	*0.0003*	0.0099	0.0443	0.072	0.005	0.108	0.112	0.608	NO	NO	438.48
2002	16.846	0.016	*0.0396*	0.0035	0.0140	0.065	0.005	0.113	0.075	0.689	NO	NO	413.31
2003	16.600	0.013	*0.0381*	0.0023	0.0105	0.269	0.020	0.110	0.074	0.483	NO	NO	410.17
2004	16.892	0.013	*0.0942*	0.0026	0.0106	0.304	0.023	0.103	0.037	0.250	NO	NO	410.24

[182] 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.
[183] 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.

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.
2005	15.446	0.008	*0.0517*	0.0015	0.0072	0.421	0.032	0.111	0.037	0.267	NO	NO	386.61
2006	15.234	0.0002	*0.0117*	0.0003	0.0001	0.461	0.035	0.110	0.037	0.268	NO	NO	380.80
2007	14.578	NO	*0.0041*	0.0002	NO	0.742	0.056	0.112	0.037	0.255	NO	NO	379.87
2008	14.582	NO	*NO*	NO	NO	0.829	0.062	0.115	0.037	0.241	NO	NO	384.35
2009	13.023	NO	*0.00004*	0.00002	NO	0.923	0.069	0.112	0.037	0.210	0.00055	0.000011	354.38
2010	12.919	NO	*0.00005*	0.0002	NO	0.871	0.065	0.112	0.037	0.250	0.00055	0.000011	350.53
2011	12.110	NO	*NO*	NO	NO	0.629	0.047	0.113	0.037	0.249	0.00056	0.000011	323.22
2012	11.440	0.003	*NO*	0.0001	0.003	0.592	0.044	0.109	0.035	0.245	0.00055	0.000011	307.13

8.1.3. Key categories

Waste key categories in 2012 (without LULUCF) calculated with the *Tier 2* method[184] are:

6.A	Solid Waste Disposal on Land	L, T[185]
6.B.1	Industrial Wastewater (CH_4)	L, T
6.B.2.2	Domestic and Commercial Wastewater – human sewage (N_2O)	L, 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[186]:

$$Utotal = \sqrt{U1^2 + U2^2 + \cdots Un^2}$$

The combined uncertainties of activity data and emission factor related to the Waste Sector in 2012 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

[184] GHG emissions/removals of LULUCF sector are not included.
[185] L-Level Assessment method; T-Trend Assessment method.
[186] 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 2012, 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. In addition there are several mechanical-biological treatment (MBT) facilities. The residue (sorting fraction) of these MBT facilities is landfilled or used as covering material for landfills.

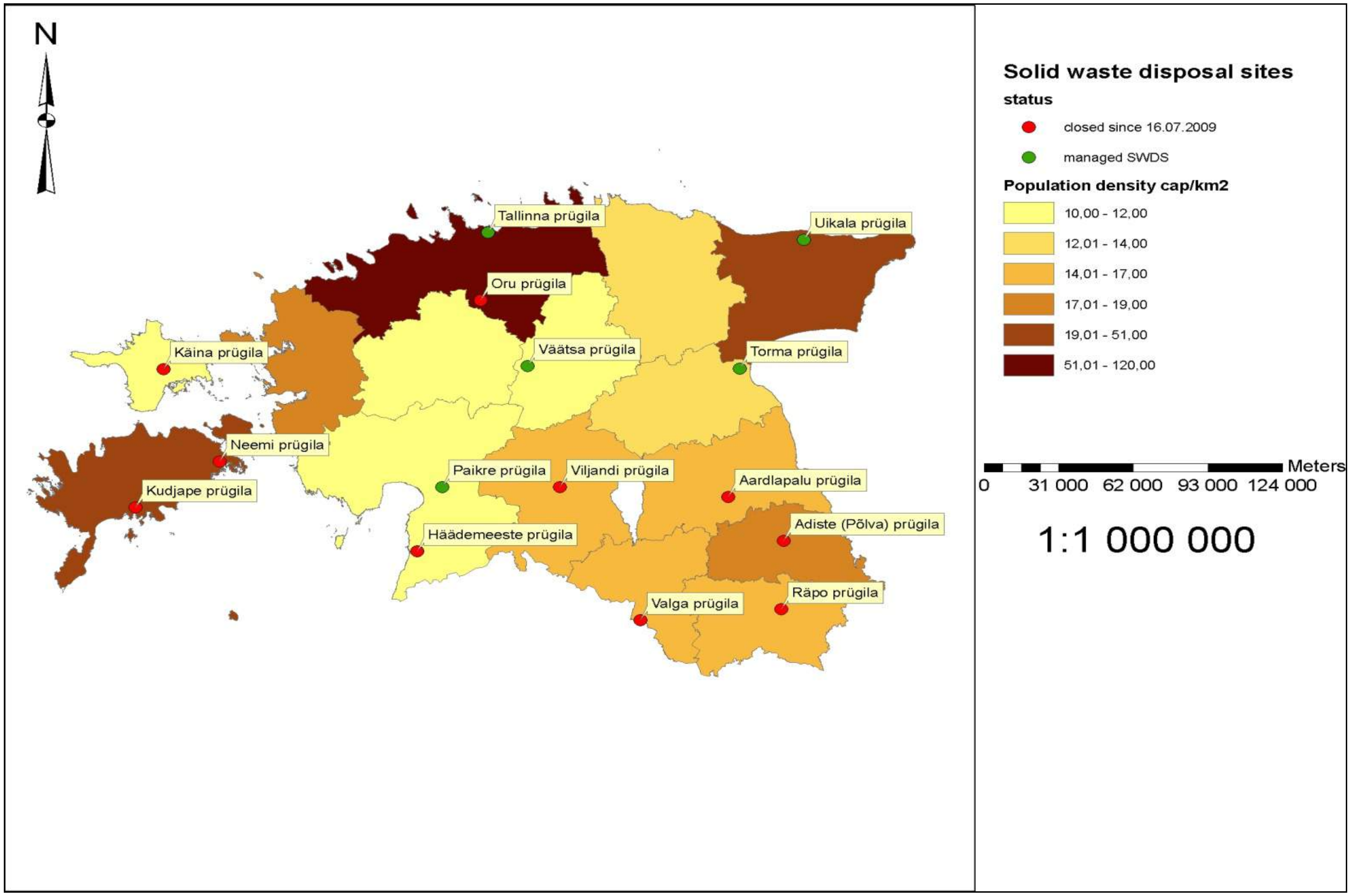

Figure 8.3. The map of Estonia's population, population density and operating landfills of municipal wastes in 2012

The annual trend of inert[187] and degradable waste generated in Estonia in 1990–2012 is presented in Figure 8.4. Since 1992 the EtEA (former 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[188]. As seen from the figure, amount of inert and degradable waste generated in 2012 has increased compared to 2011. The quantity of waste generation in 2012 was about 22.2 mln tonnes, in contrast with 2011 it has risen 2.5% due to increase in production of shale oil and electricity and to a small extent 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 2012 is accordingly 7% and 93%.

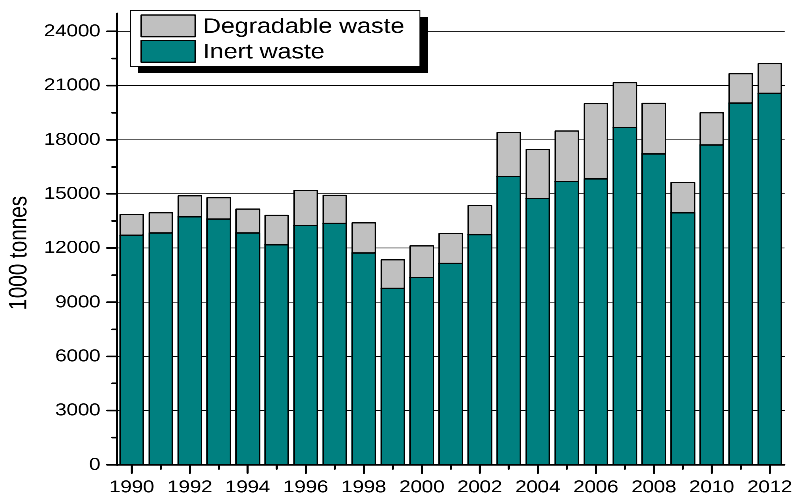

Figure 8.4. Amounts of waste generated in Estonia in 1990**–**2012, 1000 tonnes

As seen from the Figure 8.5 the quantity of DOC[189] generated has increased 2 times in 2012, compared to the base year. In comparison with the year 2011 the amount of DOC generated in 2012 has decreased 0.5% and the ratio of DOC landfilled to DOC generated has made fallout from 10.5% to 5.5%.

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

[187] 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.).
[188] 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.
[189] DOC-Degradable Organic Carbon.

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 in 2010 in the quantity of DOC generated is reasoned by an increase in generation of industrial wood waste.

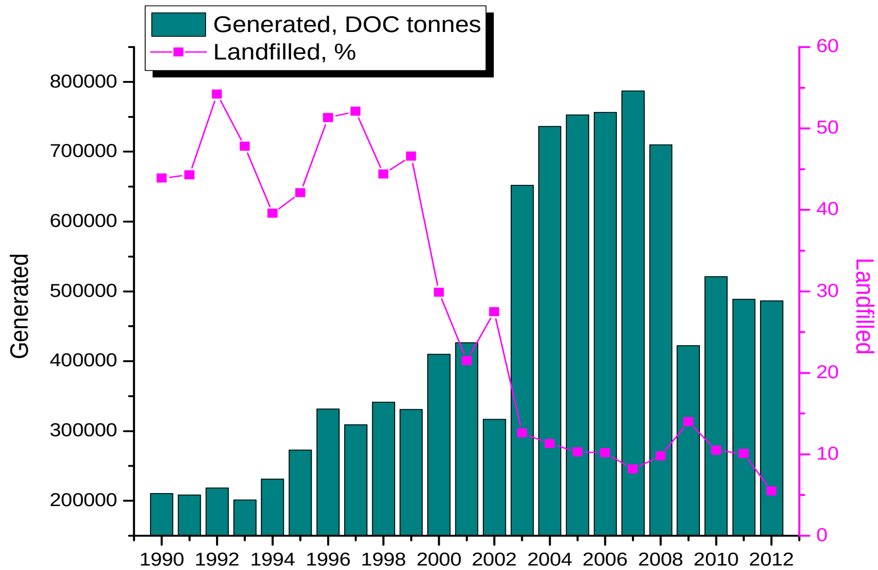

Figure 8.5. Quantity of DOC generated (tonnes) and ratio of DOC landfilled to DOC generated (%) in 1990–2012

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 (incl. biogas burnt in a flare) is obtained from EtEA 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 2012 was 4.38 Gg (Figure 8.6). Emissions derived from flaring process are reported separately and considered as net emissions.

In 1995–2006[190] 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 in the current report 4 landfills in Estonia where biogas is collected and then recovered or flared are considered, although there are 4 additional landfills in Estonia where landfill gas collection system is already installed or planned to install in the future, but no relevant data about CH_4 recovery was reported for 2012 or previous years. The quantity of collected methane in biogas is presented in the following table (Figure 8.6).

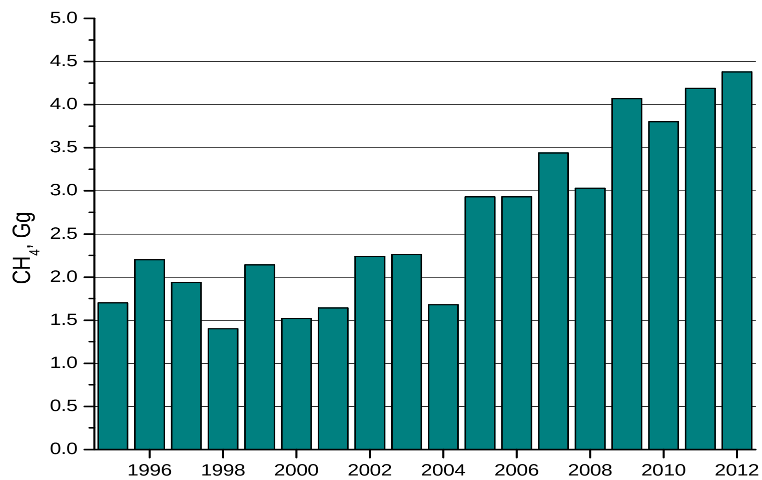

Figure 8.6. CH_4 recovered from landfills 1995–2012, Gg

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 2012 (collected from Estonian Environment Agency (EtEA)) and amount of methane recovered (obtained from the EtEA Air bureau) are used as activity data.

In 2012 22.2 million tonnes of waste was generated in Estonia. About 83% of the waste generated was produced by oil shale industry (wastes from mining and physical-chemical treatment, thermal processes, and other oil shale wastes[191]). Wastes from oil shale industries are not taken into account in the estimations of GHG emissions from solid waste disposal. The quantity of mixed municipal waste generated in 2012 was about 294 189 tonnes in addition to separately collected fractions, which summed up about 45 thousand tonnes. The total amount of municipal waste generated was about 1,4% of the total waste generation. The

[190] Since 1995 CH_4 is collected and recovered in Estonia.
[191] Wastes from the treatment of the oil shale and coal, e.g a pitch.

total amount of waste disposed onto landfills was 8.2 millions of tonnes, about 127 thousand tonnes of it comprised municipal waste and 8 million tonnes industrial wastes (Table 8.5, Table 8.6).

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
2012	35.4	4.8	17.1	2.5	6.5	0.03	62.0	126.5

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
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

	Organic	Textile	Wood	Paper	Leather	Rubber	Sludge	Inert
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
2012	1.0	0.5	1.2	0.01	-	-	2.3	8 029.0

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.

$$CH_4\text{, Gg/year} = \sum_x [A \bullet k \bullet MSW_{T(W)} \bullet MSW_{F(X)} \bullet L_0(x) \bullet e^{-k(t-x)}] \quad (8.1)$$[192]

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).

$$CH_4\text{, Gg/year} = [\, CH_4 \text{ generated in year } t - R(t)] \bullet (1 - OX) \quad (8.3)$$[193]

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 full agreement with the information and data ranges given in the *Good Practice Guidance* (IPCC 2000).

[192] Equation 5.1 of the IPCC, 2000, pp 5.6.
[193] Equation 5.2 of the IPCC 2000, pp 5.7.

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)[194]

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 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).

[194] Table 2.4 and Table 2.5 of the 2006 IPCC Guidelines, pp 2.14-2.16.

In the FOD model country-specific data on waste composition of solid municipal waste is used in the estimates. There have been three research made in Estonia about waste composition in municipal waste, the first one in 2000, the second one in 2008 and last one in 2013. 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. In 2008–2011 composition data employed in the FOD model derived from the second research made in 2008 and since 2012 new composition data is applied (Table 8.9, Table 8.10).

Calculations made under solid waste disposal comprise managed as well as uncategorized disposal sites. CH_4 emissions in 1990–1994 derive from uncategorized disposal sites, emissions occurring since 2009 derive only from managed disposal sites, meanwhile CH_4 emissions in 1995–2008 are generated both in managed and uncategorized waste disposal sites. Managed disposal site in 1995 –2008 is considered as a landfill recovering landfill gas, which was Pääsküla landfill in Tallinn. Uncategorized waste management type was chosen, as there is no accurate data available and research made in Estonia about distribution of waste by waste management type (unmanaged shallow or unmanaged deep). CH_4 emissions from both landfill types are reported together in the NIR, as the waste model used for calculations doesn't afford separately reported emissions.[195]

Table 8.9. The waste composition of solid municipal waste, %

	1950-1999[196]	**2000-2007**[12]	**2008-2011**[197]	**2012-onward**[198]
Organic household waste and non-defined non separated waste	42.1	42.1	36.65	31.8
Paper and cardboard	25.3	25.3	17.53	13.5
Wood	3.3	3.3	0.44	2.0
Textiles	0.9	0.9	4.43	5.1

Table 8.10. DOC content of mixed municipal waste in Estonia in 1950–2012

	1950-1999	**2000-2007**	**2008-2011**	**2012-onward**
DOC content in MSW	0.201	0.201	0.156	0.138

8.2.3. Quantitative overview - CH_4 emissions from solid waste disposal (CRF 6.A)

In 2012 the total CH_4 emission from solid waste disposed onto landfills in Estonia was 11.4 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 2012 a light decrease has taken place in the

[195] Information about the uncategorized disposal sites was added as a recommendation by ERT 2013.
[196] The data on waste composition of 2000 was taken from (Olmejäätmete koostise… 2000).
[197] The data on waste composition of 2008 was taken from (Eestis tekkinud olmejäätmete… 2008).
[198] The data on waste composition of 2012 was taken from (Eestis tekkinud segaolmejäätmete…2013).

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 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 1990–2012, 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
2012	5.49	0.45	7.84	1.47	0.38	0.15	0.041	-4.38	11.440

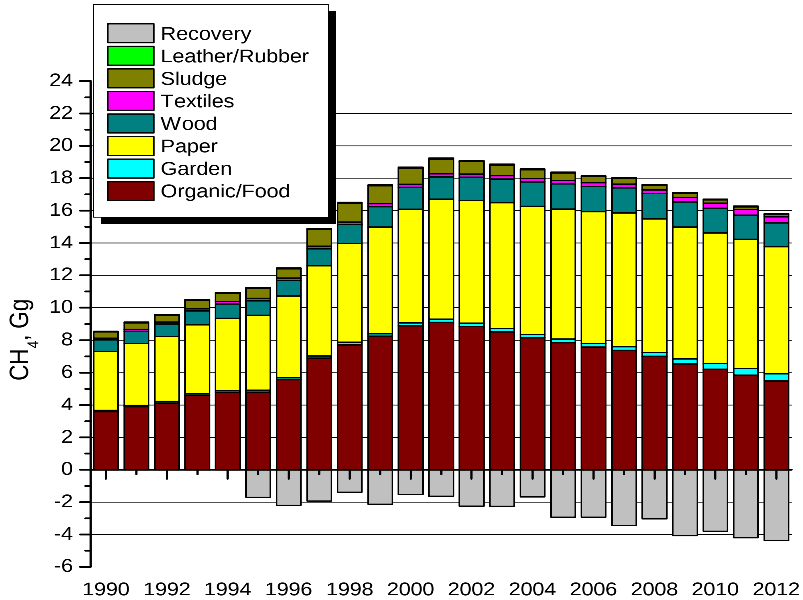

Figure 8.7. CH_4 emissions and recovery from landfills in Estonia in 1990–2012, Gg

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.[199]

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		

[199] In some cases (methane recovery, waste composition) 2006 IPCC is used for uncertainties, as in GPG 2000, no values were available for these parameters.

Input	Uncertainties	Reference
=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

No source-specific recalculations were carried out.

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 domestic and industrial wastewater is usually treated as follows:

At first wastewater from households and commercial institutions is collected by drains and canalized to the wastewater treatment plant, where at first primary mechanical clearance take place during which physical barriers remove larger solids from water as well as greases, oils and sand. During biological treatment, including biodegradation by microorganisms in aerobic environment, and activated sludge processes, organic compounds, like phosphor and nitrogen are removed from wastewater. Chemical phosphour removal is used as well. Purified water is led into the environment.

Sludge treatment

In some wastewater treatment plants for sewage sludge handling anaerobic digestion is used. Usually 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.

The sludge separated in several processes of cleaning the wastewater, is treated as follows:

At first, the sludge is pumped to the methane tank, where it is fermented and after 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 in landscaping, recultivation or agriculture. 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 2012 was 1.7 billion m^3, out of which 1.3 billion m^3 was used as cooling water for the production of energy and therefore no water treatment was needed. 361.44 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 359.82 million m^3. As seen from the Figure 8.8, the decrease has taken place in the amounts of wastewater treated in Estonia in 1990–2012, 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 2012 is presented in Table 8.13 and Table 8.14.

Table 8.13. Wastewater generation by type, 1000 m^3

Year	Total	Cooling Water	Total wastewater, exp cooling water	Mining water	Sewage	Rainfall water
2012	1 698 545	1 313 655	384 890	230 552	125 055	29 283

Table 8.14. Wastewater generation by economic sectors in Estonia, 1000 m^3

Year	Energy	Cooling/industry	Other	Agriculture	Domestic	Industry
2012	7270	1 314 840	5 522	4 116	39 831	28 970

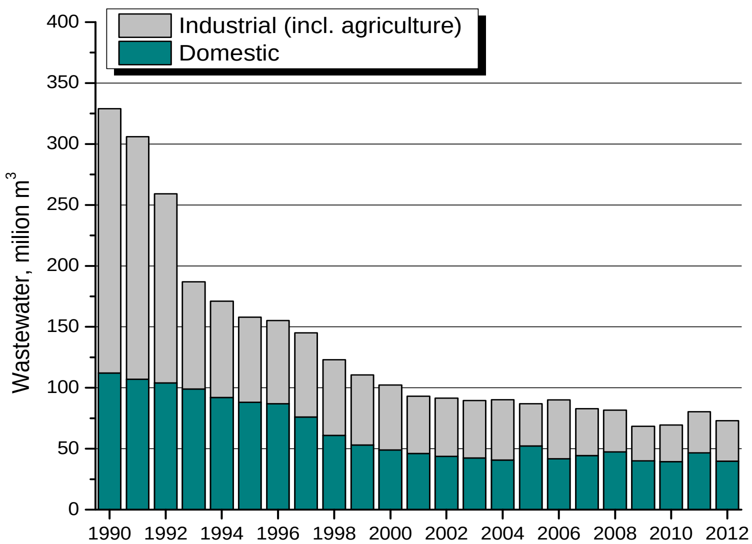

Figure 8.8. Amounts of wastewater treated in Estonia in 1990–2012, million m^3

8.3.2. Methodological issues

Activity data

The quantities of domestic and industrial wastewater generation and treatment were obtained from the datasets of the EtEA 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.

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.

$$CH_4 \text{ Emissions} = (TOW \bullet EF) - \text{Methane Recovery} \quad (8.4)$$ [200]

Domestic wastewater (CH_4):

$$TOW_{dom} = P \bullet D_{dom} \quad (8.5)$$ [201]

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.

[200] IPCC 1996, Waste, pp. 6.22, equation 12.
[201] IPCC 2000, Waste, pp. 5.18, equation 5.10.

Industrial wastewater (CH_4):

$$TOW_{ind} \text{ (kg COD/year)} = W \bullet O \bullet D_{ind} \bullet (1-DS_{ind}) \quad (8.6)$$ [202]

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.

$$EF_i = B_0 \bullet \sum (WS_{ix} \bullet MCF_x) \quad (8.7)$$ [203]

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 on the wastewater output data derived from CRF Reporter and default Wastewater generation rates[204]. 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.

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 8.15. The value of MCF is used as expert judgment from EtEA Water Bureau. According to the expert, there are factually no wastewater treatment systems in Estonia, where wastewater is treated only anaerobically. In wastewater treatment plants wastewater is treated aerobically, but there are some parts in the treatment process, where anaerobic treatment cycles are involved. It was recommended to use MCF value 0.6, as water treatment partly contains anaerobic cycles. As all wastewater, both industrial and domestic, is treated together in the same treatment plant (due to common drainage) MCF 0.6 is applied to both categories.[205] In addition the lower B_o value is used in the calculations, although according to the IPCC GPG 2000 the default value should be 0.6. The old assumption (IPCC 1996) is applied, as it was discussed with national experts, that the old value is more suitable for Estonia's

[202] IPCC 1996, Waste. pp 6.19, equation 8.
[203] IPCC 1996, Waste. pp 6.21, equation 10.
[204] IPCC 2000. Waste. Table 5.4, pp 5.22.
[205] Justification of used MCF value (0.6) was added as a recommendation by ERT 2013.

circumstances. The decision relies only on the expert judgement, because no researches have been carried out in Estonia to support the GPG 2000 value.[206]

Table 8.15. 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 2006, 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 2012 the total amount of CH_4 emission from domestic and commercial wastewater handling was 0.0354 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.

In 2012 the total amount of CH_4 emission from domestic and commercial wastewater handling was 0.0354 Gg (Figure 8.9). The quantity of CH_4 emission have been highest in 1990–1993, due to increasing population. After the collapse of the Soviet Union population of Estonia declined, number of households and commercial enterprises decreased and less wastewater from domestic and commercial units was produced. As seen from the figure, the trend of CH_4 emission from domestic and commercial wastewater has stabilized since 2004 due to more or less steady population in Estonia.

[206] Justification of used B_o value (0.25) was added as a recommendation by ERT 2013.

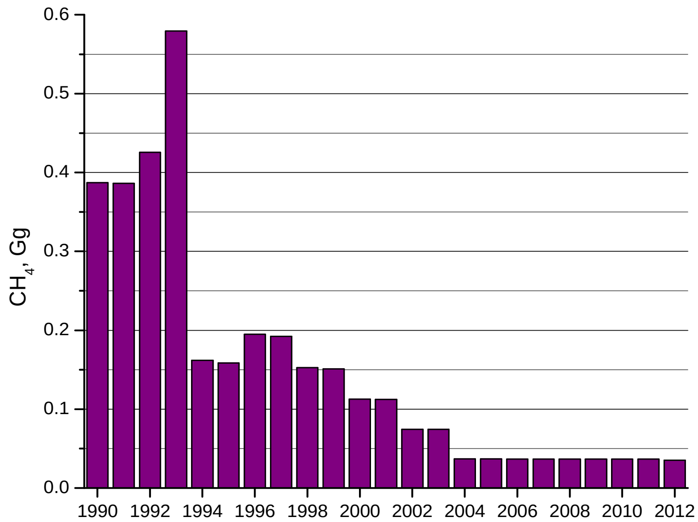

Figure 8.9. CH_4 emissions from domestic/commercial wastewater handling in 1990–2012, Gg

In 2012 the total amount of CH_4 emission from industrial wastewater handling was 0.245 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.

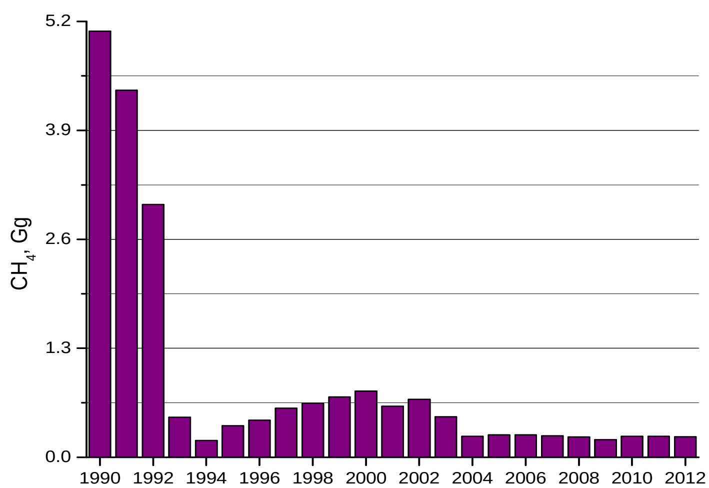

Figure 8.10. CH_4 emissions from industrial wastewater handling in 1990–2012, Gg

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 8.16[207].

Table 8.16. 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 emissions in 2009 and 2011 were recalculated respectively due to revision of fraction of degradable organic component (DOC) removed as sludge and update in activity data of production output in databases of Estonian Statistics in 2013 (Table 8.17).

Table 8.17. Total industrial output and CH_4 emissions from industrial wastewater handling in 2011

Industry type	Total industrial output in 2011 (t/year) (2013 Submission)	Reported emissions of CH_4 in 2011, Gg (2013 Submission)	Total industrial output in 2011 (t/year) (2014 Submission)	Recalculated emissions of CH_4 in 2011,Gg (2014 Submission)
Food/beverage	1 222 416	0.248	1 231 316	0.249

[207] 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.

Table 8.18. Fraction of DOC removed as sludge and CH_4 emissions from industrial wastewater handling in 2009, 2011

Year	Fraction of DOC removed as sludge (2013 Submission)	Reported emissions of CH_4 in 2009, Gg (2013 Submission)	Fraction of DOC removed as sludge (2014 Submission)	Recalculated emissions of CH_4 in 2009,Gg (2014 Submission)
2009	0.001	0.2103	0.002	0.2101
2011	0.001	0.248	0.002	0.249

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.

$$N_2O - N = [(PROTEIN \bullet Nr_{PEOLPE} \bullet Frac_{NPR}) - Nsewsludge] \bullet EF_6 \qquad (8.10)$$ [208]

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;
Nsewsludge – N that is applied to soils in form of sewage sludge.

Emission factors

Emission factors used in the calculations are default emission factors from IPCC 1996 and IPCC 2000 Agriculture chapter.

[208] 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
$Frac_{NPR}$	0.16 kg N/kg of protein[209]
EF_6	0.01 kg N_2O-N/ kg N discharged sewage effluent[210]

8.4.3. Quantitative overview – Human consumption followed by municipal sewage treatment

The total N_2O emission from human sewage in Estonia in 2012 was 0.109 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.

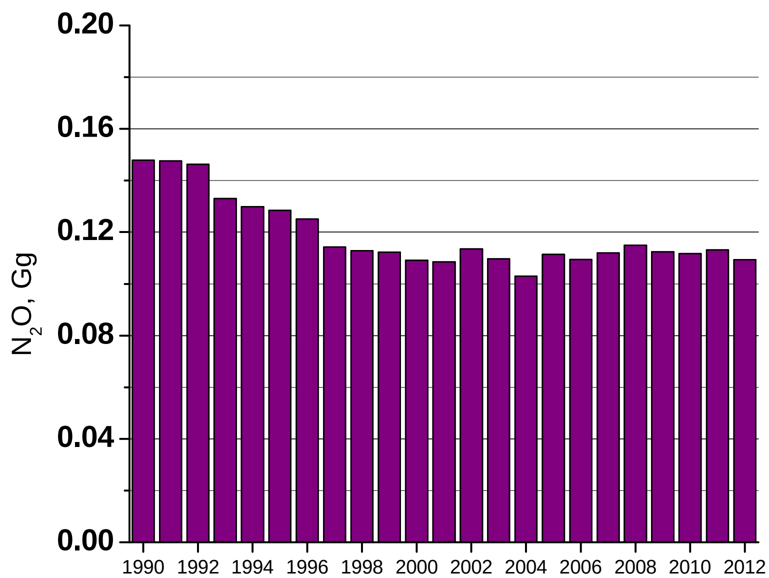

Figure 8.11. N_2O emissions from human sewage in Estonia in 1990–2012, Gg

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.

[209] IPCC 1996. Agriculture. Reference manual. Table 4-24 – Default values of parameters for indirect emissions. pp. 4.106.

[210] IPCC 1996. Agriculture. Reference Manual. Table 4-23 – Default emission factors for indirect emissions. pp. 4.105.

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.

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 years 2002, 2007, 2010 and 2011 due to update in Agriculture sector in values of nitrogen that is applied to soils in the form of sewage sludge (see Table 8.21).

Table 8. 21. Recalculated N_2O emissions from sewage sludge

Year	**2013 Submission**		**2014 Submission**	
	Nsewsludge	**N_2O emission**	**Nsewsludge**	**N_2O emission**
2002	55 784	0.1129	19 833	0.1135
2007	22 012	0.1135	119 032	0.1120
2010	102 130	0.1119	115 948	0.1117
2011	163 108	0.1110	21 155	0.1132

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 EtEA. The data on 1990–1994 was interpolated based on rough assumptions.

In 2012 the quantity of waste from waste incineration without energy recovery was 56 tonnes (Table 8.22). Waste incineration with energy recovery is part of the energy sector, therefore data and emissions occurred are reported under the energy sector.

Table 8.22. Amounts of waste incinerated without energy recovery in Estonia in 1990–2012, tonnes[211]

Year	Inert waste	Leather, Rubber	Municipal Waste	Petroleum -products and Oils	Organic Waste	Paper	Plastic	Sludge	Textiles	Wood	Clinical	Total
1990[212]	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

[211] D10 operation of the waste disposal activities – Incineration on land.
[212] The data of 1990–1994 was interpolated.

Year	Inert waste	Leather, Rubber	Municipal Waste	Petroleum -products and Oils	Organic Waste	Paper	Plastic	Sludge	Textiles	Wood	Clinical	Total
2005	63			106	0	2			176	10	9	366
2006					0				40		1	41
2007									14	7		21
2008												NO
2009						2						2
2010						3				18		21
2011												NO
2012	27			11						18		56

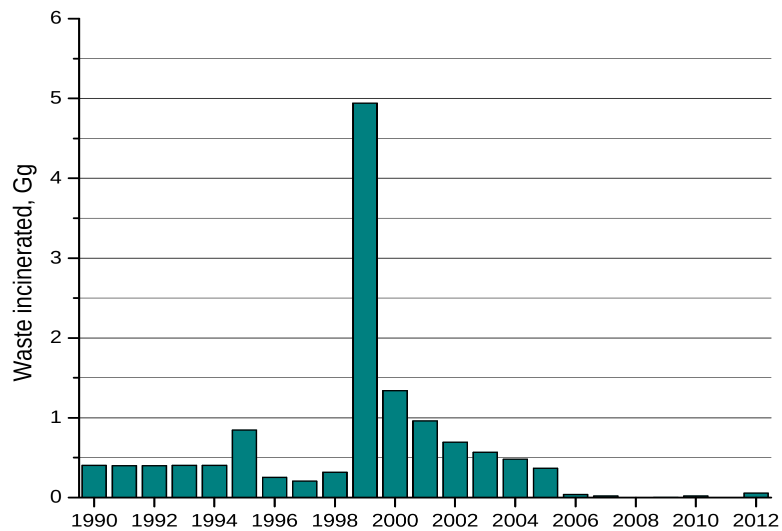

Figure 8.12. Amounts of waste incinerated without energy recovery in Estonia in 1990–2012, Gg

As seen from the previous figure there has been a sharp increase in the amounts of waste incinerated in 1995 and 1999. 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 56 tonnes in 2012. Reason for the marginal quantities of waste combusted without energy recovery, is that 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)[213]. 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.

$$CO_2 \text{ emissions, Gg/year} = \sum_i (SW_i \bullet dm_i \bullet CF_i \bullet FCF_i \bullet OF_i) \bullet 44/12 \qquad (8.11)$$[214]

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
- 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[215],[216],[217]

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			

[213] IPCC 2006 Guidelines was used instead of IPCC 1996 and 2000, as more detailed emission factors were available according to waste types.
[214] IPCC 2006, Waste. Chapter 5, pp. 5.7, equation 5.1.
[215] Table 2.4 of the 2006 IPCC Guidelines, pp. 2.14.
[216] Table 2.5 of the 2006 IPCC Guidelines, pp. 2.16.
[217] Table 2.6 of the 2006 IPCC Guidelines, pp. 2.16.

Waste component	Dry matter content in % of wet weight	Total carbon content in % of dry matter	Fossil carbon fraction in % of total carbon
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)[218]. 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.

$$N_2O \text{ emissions, Gg/year} = \sum_i (IW_i \bullet EF_i) \bullet 10^{-6} \quad (8.12)$$[219]

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'[220]

Waste category	Emission factor g N_2O/t waste incinerated	Weight basis
MSW	8[221]	Wet basis

[218] IPCC 2006 Guidelines was used instead of IPCC 1996 and 2000, as more detailed emission factors were available according to waste types
[219] IPCC 2006, Chapter 5, pp. 5.14, equation 5.5.
[220] Table 5.5 and 5.6 of the 2006 IPCC Guidelines, Chapter 5, pp. 5.21, 5.22.

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

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)[222]. The total CO_2 emission from non-biogenic waste incineration in 2012 was 0.003 Gg. (Figure 8.13).

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, and the minor emissions in 1998–2001 are related to the very small quantities of paper combustion. Since 2002 biogenic emissions have increased as considerable amounts of textile wastes were incinerated. In 2007-2011 no non-biogenic waste have been burned, so no CO_2 emissions occurred, also emissions from biogenic materials have been negligible in last years (Figure 8.13).

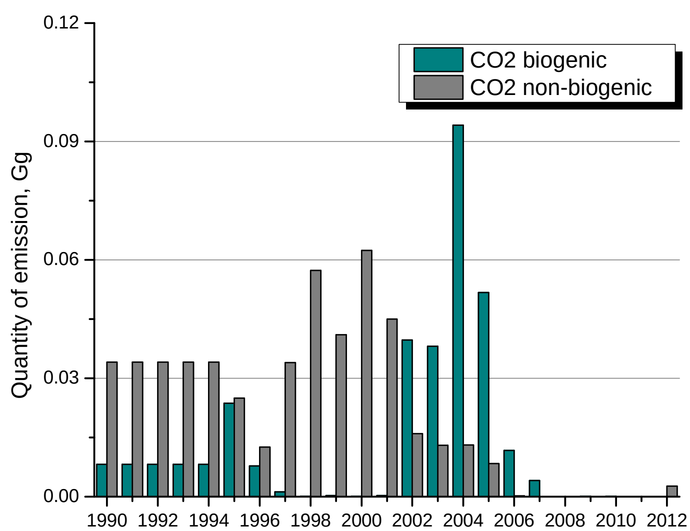

Figure 8.13. CO_2 emissions from waste incineration without energy recovery in Estonia in 1990–2012, Gg

[221] An experience of Germany.
[222] 2006 IPCC, Chapter 5, Waste, pp 5.5.

The total N_2O emission from waste incineration in 2012 was 0.003 Gg, 0.0001 Gg from combustion of biogenic waste and 0.0027 Gg from non-biogenic materials. 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).

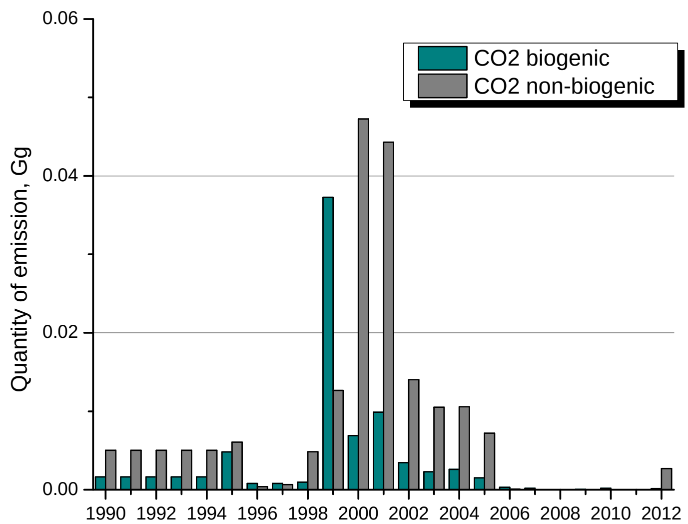

Figure 8.14. N_2O emissions from waste incineration without energy recovery in Estonia in 1990–2012, Gg

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

Input	Uncertainties	Reference
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

No source-specific recalculations were carried out.

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 2012 are used as activity data. The data is provided by EtEA. In 2012 148 086 tonnes of wastes were treated biologically (composted); it made up 1.8% of the total amount of waste disposed. Inert and petroleum product wastes consist of oils and stone, waste from the oil shale industry, and plastic waste are not taken into account in the estimates. As seen from the following table, sludge and wood waste contribute the most in composting in Estonia.

Table 8.26. Amounts of waste used for composting in Estonia in 1990–2012, tonnes[223]

Year	Leather and Rubber	Municipal Waste	Organic Waste	Paper	Sludge	Textiles	Wood	Total
1990	n.d.	n.d.	3 751	n.d	127	144	2 753	6 775
1991	n.d.	n.d.	3 948	n.d	127	144	2 898	7 117
1992	n.d.	n.d.	4 156	n.d	127	144	3 050	7 477
1993	n.d.	n.d.	4 375	n.d	127	144	3 211	7 857
1994	n.d.	n.d.	4 605	n.d	127	144	3 380	8 256
1995	1	1	4 847	0.8	127	366	3 558	8 901
1996	3		5 812			59	133	6 007
1997	11		9 051		102	72	1 993	11 229
1998	61		375		78	80	1 494	2 088
1999			2 635			319	3 480	6 434
2000			15 194		120	419	3 277	19 010
2001			5 156	0.04	10 283		2 498	17 937
2002			8 437	59	3 864	54	3 946	16 359
2003		12	23 149	10	35 875	83	8 211	67 339
2004		5	14 958	34	55 031	344	5 727	76 098
2005		5	20 311	37	64 971	52	19 839	105 216
2006		0	24 878	678	68 078	109	21 584	115 327
2007		0	11 109	628	137 963	29	35 800	185 529
2008		2 207	20 939	820	147 112		36 181	207 259
2009		10 172	52 014	7	134 947		33 671	230 810
2010		10 141	32 303	4	142 142		33 043	217 633
2011		13 728	22 831	35	93 115		27 456	157 165
2012		30	21 161	48	97 450		29 397	148 086

[223] The data of 1990–1994 were interpolated based on rough assumptions made.

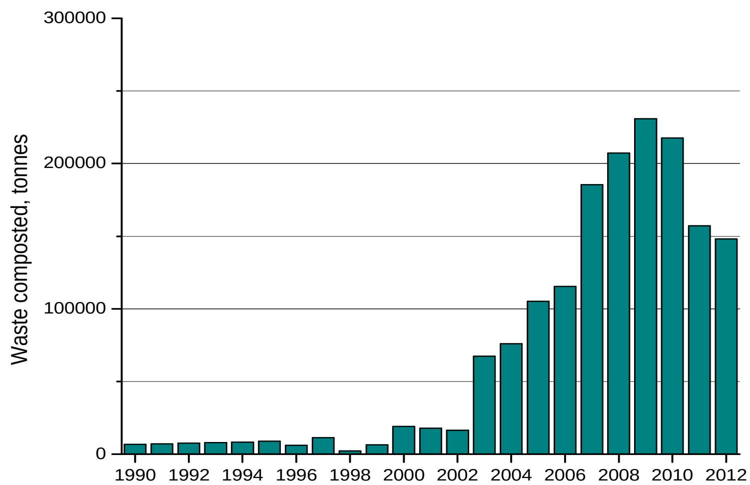

Figure 8.15. Amounts of organic waste used in biological treatment in Estonia in 1990–2012, tonnes

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 significantly – from 6 775 tonnes in 1990 to 148 086 tonnes in 2012. The volume of wastes for composting have enlarged significantly in recent years due to obligations stated with Waste Act in 2004[224], 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)[225], due to emission factors are IPCC default values.

$$CH_4, Gg = \sum_i (M_i \bullet EF_i) \bullet 10^{-3} - R \qquad (8.13)$$ [226]

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.

$$N_2O, Gg = \sum_i (M_i \bullet EF_i) \bullet 10^{-3} \qquad (8.14)$$ [227]

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.

[224] Estonian Waste Act.
[225] IPCC 2006 Guidelines is used, as no method available in earlier guidelines.
[226] IPCC 2006, Chapter 4, equation 4.1, pp. 4.5.
[227] 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 8.27).

Table 8.27. Default emission factors from 'Biological treatment'[228]

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 2012 the total N_2O emission from biological treatment of waste was 0.04 Gg and CH_4 emission 0.59 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 composted in these years. The emissions have been highest in 2009 due to considerable effect from organic waste on the amount of waste composted; sharp downfall in 2011 emissions is related to the total amount of waste biologically recycled which has significantly decreased compared to previous years.

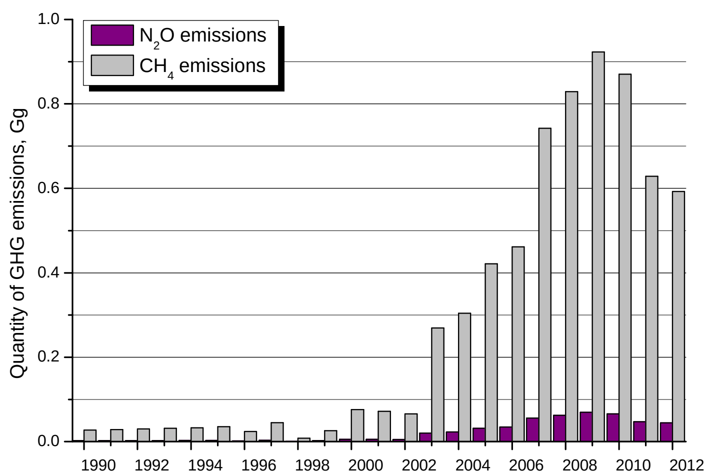

Figure 8.16. CH_4 and N_2O emissions from biological treatment in Estonia in 1990–2012, Gg

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

[228] IPCC 2006, Chapter 4, Table 4.1, pp. 4.6, on a wet basis.

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 8.28.

The combined uncertainty rates related to biological treatment sub-category are reported in Chapter 8.1.4.

Table 8.28. 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 were recalculated for whole time series due to revision of amounts of biological waste reported under R3 recovery activity. In co-operation with EtEA specialists all waste types reported as composting were examined and improper wastes were removed from the total annual amount composted. Under organic wastes, quantities of animal manure were removed and amounts of whey were revised. In addition amounts of paper, sludge and wood waste were reduced according to improper waste types reported under composting.

Table 8.29. CH_4 and N_2O emissions from biological treatment of waste in 1990–2011, Gg

	2013 Submission			**2014 Submission**		
Year	**Total annual amount composted (Gg)**	**N_2O emission (Gg)**	**CH_4 emission (Gg)**	**Total annual amount composted (Gg)**	**N_2O emission (Gg)**	**CH_4 emission (Gg)**
1990	7.139	0.002	0.029	6.775	0.002	0.027
1991	7.501	0.002	0.030	7.117	0.002	0.028
1992	7.881	0.002	0.032	7.477	0.002	0.030
1993	8.282	0.002	0.033	7.857	0.002	0.031
1994	8.703	0.003	0.035	8.256	0.002	0.033
1995	9.371	0.003	0.037	8.901	0.003	0.036
1996	31.523	0.009	0.126	6.007	0.002	0.024
1997	65.409	0.020	0.262	11.229	0.003	0.045
1998	6.618	0.002	0.026	2.088	0.001	0.008
1999	10.845	0.003	0.043	6.434	0.002	0.026

	2013 Submission			2014 Submission		
Year	**Total annual amount composted (Gg)**	**N_2O emission (Gg)**	**CH_4 emission (Gg)**	**Total annual amount composted (Gg)**	**N_2O emission (Gg)**	**CH_4 emission (Gg)**
2000	26.719	0.008	0.107	19.010	0.006	0.076
2001	35.682	0.011	0.143	17.937	0.005	0.072
2002	98.952	0.030	0.396	*16.359*	0.005	0.065
2003	297.903	0.089	1.192	*67.339*	0.020	0.269
2004	403.407	0.121	1.614	*76.098*	0.023	0.304
2005	479.924	0.144	1.920	*105.216*	0.032	0.421
2006	670.398	0.201	2.682	*115.327*	0.035	0.461
2007	769.653	0.231	3.079	*185.529*	0.056	0.742
2008	685.291	0.206	2.741	*207.259*	0.062	0.829
2009	667.721	0.200	2.671	*230.810*	0.069	0.923
2010	795.806	0.239	3.183	*217.633*	0.065	0.871
2011	542.693	0.163	2.171	*157.165*	0.047	0.629

8.6.7. Source-specific planned improvements

The activity data is kept under consideration and will be updated necessarily.

8.7. Biogas Burnt in a Flare (CRF 6.D)

8.7.1. Source category description

There are 4 landfills in Estonia, Väätsa, Paikre, Aardlapalu, Torma, where landfill gas is collected but instead of energy recovery it is burnt in a flare. Quantities of landfill gas from Torma and Aardlapalu landfills were not taken into account in 2012 calculation. Due to low methane content in Torma landfill gas, the gas was not collected and burnt in a flare in 2012, in Aardlapalu landfill the collection system is still in a start-up phase and therefore no permanent amount of gas was collected in 2012. 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).

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 EtEA Air bureau.

As seen from the Table 8.30, 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 8.30).

Table 8.30. Amount of biogas burned in a flare in 2009–2012, tonnes

Company	2009	2010	2011	2012
Väätsa Prügila AS	5 500 000	5 500 000	5 500 000	5 500 000
Paikre OÜ	-	17 130	97 520	19 383
Total (m^3)	5 500 000	5 517 130	5 597 520	5 519 383
Total (TJ)	0.11000	0.11034	0.11164	0.11041

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 ● Activity (8.15)[229]

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 8.31 are plant specific.

Table 8.31. Emission factors and parameters used in calculations of biogas burnt in a flare

NCV[230] (MJ/Nm^3) of biogas			
Company	2009	2010	2011
Väätsa Prügila AS	20	20	20
Paikre OÜ		20	16.8
Emission factors (kg/TJ)[231]			
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 2012 was 0.000552 Gg and N_2O emission 0.000011 Gg. As seen from the table below (Table 8.32), the emissions are marginal compared to other greenhouse gas emissions from Waste Sector.

Table 8.32. CH_4 and N_2O emissions from biogas burnt in a flare, Gg

Emission	2009	2010	2011	2012
CH_4	0.000550	0.000552	0.000558	0.000552
N_2O	0.000011	0.000011	0.000011	0.000011

[229] IPCC 1996, Energy, pp 1.35, pp 1.36.
[230] Net Calorific Value
[231] IPCC 1996, Energy, pp 1.35, pp 1.36.

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.

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 2014 inventory submission by the CRF category and their implications

SECTOR	SOURCE	RECALCULATION
ENERGY	International Bunkers	The activity data of fuel consumption in Aviation Bunkering has been revised: in 1993 – 747.7 TJ (was 735.3 TJ); in 1996 – 647.9 TJ (was 633.6 TJ); in 2007 – 2097.1 TJ (was 2096.1 TJ); in 2010 – 1549.7 TJ (was 1549.3 TJ); in 2011 – 1412.6 TJ (was 1412.8 TJ). The CEF of LTO cycle in Aviation Bunkering has been corrected to 73.3 C/TJ (was 74.8 tC/TJ). The CH_4 and N_2O emissions have been corrected in Aviation Bunkering. These corrections have resulted in recalculation of emissions for all years from 1990 to 2011 (see Chapter 3.2.2 – International Bunker Fuels).
	Feedstocks and Non-Energy Use of Fuels	The following activity data of fuel consumption has been revised: 1.Lubricants: in 2011 – 129.3 TJ (was 160.8 TJ) 2.Bitumen: in 2003 – 2049.7 TJ (was 1205.7 TJ); in 2004 – 2652.5TJ (was 1768.4 TJ); in 2005 – 3657.3 TJ (was 1647.8 TJ); in 2006 – 4220.0 TJ (was 2170.3 TJ); in 2007 – 4099.4 TJ (was 1406.7 TJ); in 2008 – 3697.5 TJ (was 1527.2 TJ); in 2009 – 3416.2 TJ (was 1348.1 TJ); in 2010 – 3054.4 TJ (was 1559.8 TJ); in 2011 – 2692.7 TJ (was 1571.4 TJ) 3.Oil Shale: the activity data has been revised for all years from 1990–2011 (see Chapter 3.2.3 Feedstocks and Non-Energy Use of Fuels).
	Energy Industries – Public Electricity and Heat Production (CRF 1.A.1.a)	In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG and Coal have been implemented. The implementation of these CEFs resulted in recalculations in all years from 1990–2011 (see Chapter 3.2.5.5).
	Energy Industries – Public Electricity and Heat Production (CRF 1.A.1.a)	The CEF of Narva semi-coke gas in 2011 is corrected to 18.70 tC/TJ (was 16.43 tC/TJ).
	Manufacturing Industries and Construction (CRF 1.A.2)	In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG, Coke and Coal have been implemented. The implementation of these CEFs resulted in recalculations in all years from 1990–2011 (see Chapter 3.2.5.5).
	Manufacturing Industries and Construction (CRF 1.A.2)	The consumption of Oil Shale in the CRF source-category 1.A.2.f has been revised for the year 2011 – 2201 TJ (was 3046 TJ).
	Transport - Railways (CRF 1.A.3.c)	In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG, Coke and Coal have been implemented. The implementation of these CEFs resulted in recalculations in all years from 1990–2011 (see Chapter 3.2.6.6).

SECTOR	SOURCE	RECALCULATION
	Transport – Domestic Navigation (CRF 1.A.3.d)	In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG, Coke and Coal have been implemented. The implementation of these CEFs resulted in recalculations in all years from 1990–2011 (see Chapter 3.2.6.6).
	Transport- Civil Aviation (CRF 1.A.3.a)	The CO_2 EF of LTO cycle has been corrected to 73.3 tC/TJ (was 74.8 tC/TJ).
	Other Sectors – Commercial/Institutional (CRF 1.A.4.a)	In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG, Coke and Coal have been implemented. The implementation of these CEFs resulted in recalculations in all years from 1990–2011 (see Chapter 3.2.7.3).
	Other Sectors – Residential (CRF 1.A.4.b)	In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG, Coke and Coal have been implemented. The implementation of these CEFs resulted in recalculations in all years from 1990–2011 (see Chapter 3.2.7.3).
	Other Sectors – Agriculture/Forestry/Fisheries (CRF 1.A.4.c)	In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG, Coke and Coal have been implemented. The implementation of these CEFs resulted in recalculations in all years from 1990–2011 (see Chapter 3.2.7.3).
	Other – Other mobile (CRF 1.A.5)	In current submission the country-specific CEFs of Diesel Oil, Light Fuel Oil, Residual Fuel Oil, LPG, Coke and Coal have been implemented. The implementation of these CEFs resulted in recalculations in all years from 1990–2011 (see Chapter 3.2.7.3).
	Oil Transport (CRF 1.B.2.a.3) and Oil Refining/Storage (CRF 1.B.2.a.4)	The CH_4 emissions from these categories have been changed to „NO“ according to the ERT recommendation.
INDUSTRIAL PROCESSES	Other Production (CRF 2.D)	NMVOC emissions from food and drink were corrected for year 2011. The recalculation in 2011 emission was 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.
	Commercial Refrigeration (CRF 2.IIA.F.1.2 Commercial Refrigeration)	Activity data in years 2010 and 2011 was recalculated due to more accurate data from companies installing and servicing refrigeration equipment for restaurants, canteens and similar institutions was available on the average charge of the equipment and on the share of different refrigerants. Activity data on vending machines was corrected for the year 2011 as updated information on the share of R-134a and R-404A was available from one company.
	Stationary Air-Conditioning (CRF 2.IIA.F.1.5)	Actual emissions from stocks in 2010 were corrected due to mistake in rounding.
	Fire Extinguishers (CRF 2.F.3)	Activity data in years 2005–2011 were recalculated due to more data from companies dealing with fire protecting systems was available.
	Electrical Equipment (CRF 2.F.8)	2011 emissions from stocks were recalculated due to mistake in activity data of one company.
SOLVENT AND OTHER PRODUCT USE	Paint Application (CRF 3.A) and Other Product Use (CRF 3.D.5)	NMVOC and indirect CO_2 emissions from paint application were corrected for the years 1990–1999 due to updates in statistical data and from other product use for the year 2011 due to corrections in NMVOC emission factor.
AGRICULTURE	Enteric Fermentation (CRF 4.A)	Activity data on horse and young cattle population were corrected for 2007 and 2008 due to an update made in the Statistics Estonia database resulting in recalculation of CH_4 emissions from enteric fermentation.
	Manure Management (CRF 4.B)	There were recalculations performed to estimate CH_4 emissions from manure management of horses and young cattle: data on livestock population were updated for 2007 and 2008 due to an update made in the Statistics Estonia database.

SECTOR	SOURCE	RECALCULATION
		Initial parameters used to estimate gross energy intake were recalculated (for cattle): data on weight of bovine cattle (aged between 1 and 2 years) were updated.
		There was a correction of a copy and paste omission in the reporting of N excretion values for dairy cattle and fur-bearing animals in CRF table.
		Nitrogen excretion rates of horses and young cattle were recalculated based on the updated data.
	Cultivation of Histosols (CRF 4 D.1.5)	Cultivation of organic soils – data on areas of organic soils cultivated were updated in the framework of the NFI.
	Sewage sludge applied on agricultural lands (CRF 4.D.1.5)	N_2O emissions from sewage sludge application on agricultural land were recalculated for 2002, 2007, 2010 and 2011, because the data on quantities of sewage sludge used in 2002–2011 for land treatment resulting in benefit to agriculture or ecological improvement were revised by the EtEA.
		The methodology of reporting direct N_2O emissions from sewage sludge application on agricultural soils was adjusted according to the 2012 ERT recommendation and the correct value (0.2; $Frac_{GASM}$) was used in the calculations.
	N_2O emissions from pasture, range and paddock (CRF 4.D.2)	An omission was amended in the reporting of activity data for pasture in CRF table 4.D for 2011.
	Indirect emissions from agricultural soils (CRF 4.D.3)	There were recalculations in 'Indirect N_2O emissions from agricultural soils' category were performed since the data on quantities of sewage sludge used in 2002-2011 for land treatment resulting in benefit to agriculture or ecological improvement were revised by the EtEA.
LULUCF	Forest Land (CRF 5.A)	Activity data and biomass stocks were updated by NFI. Mineral and organic soil emission factors were updated.
	Cropland (CRF 5.B)	Activity data and biomass stocks were updated by NFI.
	Grassland (CRF 5.C)	Activity data and biomass stocks were updated by NFI. Organic soil emission factor was updated.
	Wetlands (CRF 5.D)	Activity data and biomass stocks were updated by NFI.
	Settlements (CRF 5.E)	Activity data and biomass stocks were updated by NFI. Litter emission factor was updated.
	Other land (CRF 5.F)	Activity data and biomass stocks were updated by NFI. Litter emission factor was updated.
WASTE	Wastewater Handling (CRF 6.B)	Under industrial wastewater handling (CRF 6.B.1.) CH_4 emissions in 2009 and 2011 were recalculated respectively due to revision of fraction of degradable organic component (DOC) removed as sludge and update in activity data of production output in databases of Estonian Statistics in 2013.
	Biological Treatment (CRF 6.D)	CH_4 and N_2O emissions from biological treatment were recalculated for whole time series due to revision of amounts of biological waste reported under R3 recovery activity. In co-operation with EtEA specialists all waste types reported as composting were examined and improper wastes were removed from the total annual amount composted. Under organic wastes, quantities of animal manure were removed and amounts of whey were revised. In addition amounts of paper, sludge and wood waste were reduced according to improper waste types reported under composting.
	N_2O emission from human consumption followed by municipal sewage treatment (CRF 6.B.2.2)	N_2O emissions from human sewage were recalculated for years 2002, 2007, 2010 and 2011 due to update in Agriculture sector in values of nitrogen that is applied to soils in the form of sewage sludge.

10.1.2. KP-LULUCF inventory

Areas subject to afforestation/reforestation and deforestation are annually updated by the NFI, new data is integrated into overall activity data. Carbon stock changes in AR dead wood pool were estimated for the first time in current submission.

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 -2.25% (2011) and 0.19% (1993). Therefore, the implications of the recalculations on the level and on the trend, 1990–2011, 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 -0.38% (2004) and 13.78% (2009) (Table 10.2).

Table 10.2. Recalculation performed in year 2014 for 1990–2011. Differences in % between this submission and the April 2013 submission for Estonia

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total CO_2 equivalent emissions with LULUCF	0.32	0.33	0.45	0.60	0.81	1.14	1.66	2.19	3.17	4.02	3.95
Total CO_2 equivalent without LULUCF	0.18	0.18	0.13	0.19	0.16	0.13	0.13	0.09	0.14	0.13	0.09
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total CO_2 equivalent emissions with LULUCF	1.95	1.34	0.29	-0.38	-0.07	0.62	3.02	7.86	13.78	9.01	5.44
Total CO_2 equivalent without LULUCF	0.07	0.00	-0.15	-0.25	-0.31	-0.51	-0.47	-0.37	-0.45	-0.48	-2.25

10.2.2. KP-LULUCF inventory

Quantitative changes due to recalculations under ARD are shown in Table 10.3 and Table 10.4.

Table 10.3. AR: Changes in emission estimates due to recalculations, Gg C

	2008	**2009**	**2010**	**2011**
2013 submission				
Above-ground biomass	19.63	24.27	26.27	29.07
Below-ground biomass	7.72	9.54	10.33	11.43
Litter	7.84	7.95	8.07	8.19
Dead wood	NO	NO	NO	NO

Mineral soils	-5.58	-5.59	-5.59	-5.59
Organic soils	-2.90	-3.10	-3.33	-3.55
Total Gg CO_2 eq in 2013	-97.88	-121.26	-131.07	-145.01
2014 submission				
Above-ground biomass	19.29	23.50	27.81	31.18
Below-ground biomass	7.59	9.24	10.94	12.26
Litter	8.28	8.44	8.55	8.65
Dead wood	0.04	0.03	0.02	0.02
Mineral soils	-15.54	-15.65	-15.70	-15.72
Organic soils	-3.15	-3.38	-5.37	-3.74
Total Gg CO_2 eq in 2014	-60.49	-81.29	-102.87	-119.69
TOTAL change % 2014/2013	**-61.81**	**-49.17**	**-27.41**	**-21.15**

Table 10.4. D: Changes in emission estimates due to recalculations, Gg C

	2008	**2009**	**2010**	**2011**
2013 submission				
Above-ground biomass	-133.30	-111.95	-74.16	-50.872
Below-ground biomass	-31.38	-26.35	-17.46	-11.976
Litter	-16.88	-18.94	-20.29	-21.204
Dead wood	-0.32	-0.18	-0.01	-0.143
Mineral soils	-10.67	-11.98	-12.92	-13.479
Organic soils	-4.23	-4.71	-4.91	-5.177
Total Gg CO_2 eq in 2013	721.53	638.44	475.74	377.12
2014 submission				
Above-ground biomass	-139.15	-125.35	-84.37	-68.94
Below-ground biomass	-32.76	-29.51	-19.86	-16.23
Litter	-15.96	-18.30	-19.83	-21.13
Dead wood	-4.25	-4.02	-2.82	-2.38
Mineral soils	-8.91	-10.29	-11.09	-11.65
Organic soils	-4.23	-5.24	-5.97	-6.89
Total Gg CO_2 eq in 2014	752.61	706.58	527.79	466.49
TOTAL change % 2014/2013	**4.31**	**9.64**	**9.86**	**19.16**

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 2014 for 1990–2011. Differences in CO_2 equivalent (Gg) between this and the April 2013 submission for Estonia

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total National Emissions and Removals		**94.41**	**86.36**	**72.11**	**59.52**	**84.18**	**97.67**	**165.20**	**237.40**	**346.18**	**504.98**	**712.47**	**425.88**	**277.10**
1. Energy		**65.79**	**60.86**	**27.66**	**30.67**	**25.75**	**16.24**	**20.01**	**17.10**	**17.57**	**14.58**	**5.79**	**5.71**	**5.16**
1.A.	Fuel Combustion Activities	65.79	60.86	27.66	30.67	25.75	16.24	20.01	17.10	17.57	14.58	5.79	5.71	5.16
1.A.1.	Energy Industries	72.95	65.58	27.95	31.31	24.59	15.12	18.37	15.74	15.81	13.31	4.56	3.74	3.17
1.A.2.	Manufacturing Industries and Construction	1.10	1.82	0.97	0.56	1.89	0.69	0.77	0.71	0.83	0.47	0.08	-0.17	0.73
1.A.3.	Transport	-0.56	-0.55	-0.36	-0.38	-0.38	-0.03	0.09	0.05	0.06	0.04	0.06	-0.26	-0.36
1.A.4.	Other Sectors	-7.59	-5.86	-0.79	-0.80	-0.32	0.45	0.76	0.59	0.87	0.75	1.08	2.42	1.63
1.A.5.	Other	-0.11	-0.13	-0.10	-0.03	-0.03	0.00	0.02	0.01	0.01	0.01	0.01	-0.03	-0.02
3. Solvent and Other Product Use		**0.04**	**0.05**	**0.06**	**0.06**	**0.11**	**0.13**	**0.17**	**0.19**	**0.19**	**0.19**			
5. Land Use, Land-Use Change and Forestry (net) [(5)]		**28.58**	**25.46**	**44.39**	**28.79**	**58.31**	**81.30**	**145.02**	**220.11**	**328.41**	**490.21**	**706.68**	**420.17**	**271.94**
5.A.	Forest Land	92.80	50.77	36.72	17.76	19.01	26.50	59.10	124.39	227.50	387.56	564.42	315.76	212.91
5.B.	Cropland	50.35	53.90	56.99	60.83	59.63	56.64	54.39	48.65	41.90	44.28	49.18	43.11	39.09
5.C.	Grassland	-108.15	-74.45	-46.31	-46.74	-17.76	0.38	33.87	49.93	61.60	60.03	106.74	67.42	25.74
5.D.	Wetlands	-6.98	-5.07	-3.03	-1.97	-1.42	-0.87	-0.32	-0.32	-0.32	-0.32	-0.32	-0.32	-2.24
5.E.	Settlements	0.56	0.32	0.02	-1.08	-1.14	-1.35	-2.02	-2.54	-2.27	-1.34	-13.33	-5.80	-3.56
5.F.	Other Land													

		2003	2004	2005	2006	2007	2008	2009	2010	2011
Total National Emissions and Removals		**90.01**	**-14.26**	**50.17**	**159.88**	**489.27**	**983.71**	**1 302.81**	**1 364.74**	**973.84**
1. Energy		**4.01**	**2.13**	**2.26**	**0.45**	**0.10**	**7.84**	**0.09**	**1.83**	**-405.81**
1.A.	Fuel Combustion Activities	4.01	2.13	2.26	0.45	0.10	7.84	0.09	1.83	-405.81
1.A.1.	Energy Industries	2.44	1.54	1.78	0.94	0.94	1.21	1.01	1.00	-336.64

		2003	2004	2005	2006	2007	2008	2009	2010	2011
1.A.2.	Manufacturing Industries and Construction	0.47	0.39	0.40	-0.30	-1.14	5.53	-0.92	0.52	-68.63
1.A.3.	Transport	-0.27	-0.37	-0.44	-0.47	-0.32	-0.23	-0.32	-0.14	-0.27
1.A.4.	Other Sectors	1.39	0.63	0.61	0.37	0.67	1.35	0.38	0.48	-0.23
1.A.5.	Other	-0.02	-0.06	-0.09	-0.08	-0.05	-0.02	-0.06	-0.03	-0.04
3. Solvent and Other Product Use										**0.00**
5. Land Use, Land-Use Change and Forestry (net) *(5)*		**86.00**	**-16.39**	**47.92**	**159.43**	**489.17**	**975.87**	**1 302.72**	**1 362.91**	**1 379.64**
5.A.	Forest Land	41.14	-21.17	58.75	148.79	394.67	814.41	1 035.08	1 102.19	1 121.23
5.B.	Cropland	36.69	28.33	15.24	10.25	7.32	6.29	7.84	8.83	14.98
5.C.	Grassland	-8.64	-43.38	-14.22	37.62	87.85	170.64	242.84	233.01	190.07
5.D.	Wetlands	-0.95	-5.21	-11.76	-13.75	2.30	26.87	32.50	29.18	43.45
5.E.	Settlements	4.19	0.30	-13.10	-34.07	-11.25	-36.42	2.33	7.74	28.66
5.F.	Other Land	13.57	24.75	13.02	10.59	8.28	-5.92	-17.87	-18.04	-18.75

Table 10.6. Recalculation for CH_4 performed year 2014 for 1990–2011. Differences in CO_2 equivalent (Gg) between this and the April 2013 submission for Estonia

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total National Emissions and Removals		**-3.58**	**-2.94**	**-1.71**	**-1.83**	**-2.09**	**-1.86**	**-3.78**	**-6.69**	**-2.45**	**-2.46**	**-1.63**	**-3.24**	**-8.08**
1. Energy		**-3.55**	**-2.90**	**-1.68**	**-1.79**	**-2.05**	**-1.82**	**-1.64**	**-2.14**	**-2.07**	**-2.09**	**-0.98**	**-1.75**	**-1.14**
1.A.	Fuel Combustion Activities													
1.A.1.	Energy Industries													
1.A.2.	Manufacturing Industries and Construction													
1.B.	Fugitive Emissions from Fuels	-3.55	-2.90	-1.68	-1.79	-2.05	-1.82	-1.64	-2.14	-2.07	-2.09	-0.98	-1.75	-1.14
1.B.2.	Oil and Natural Gas	-3.55	-2.90	-1.68	-1.79	-2.05	-1.82	-1.64	-2.14	-2.07	-2.09	-0.98	-1.75	-1.14

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
4. Agriculture														
4.A.	Enteric Fermentation													
4.B.	Manure Management													
5. Land Use, Land-Use Change and Forestry (net) *(5)*		**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.D.	Wetlands	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
6. Waste		**-0.03**	**-0.03**	**-0.03**	**-0.04**	**-0.04**	**-0.04**	**-2.14**	**-4.55**	**-0.38**	**-0.37**	**-0.65**	**-1.49**	**-6.94**
6.B.	Waste-water Handling													
6.D.	Other	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-2.14	-4.55	-0.38	-0.37	-0.65	-1.49	-6.94

		2003	2004	2005	2006	2007	2008	2009	2010	2011
Total National Emissions and Removals		**-21.24**	**-28.70**	**-32.66**	**-48.05**	**-51.28**	**-41.62**	**-38.32**	**-50.14**	**-34.07**
1. Energy		**-1.87**	**-1.21**	**-1.18**	**-1.43**	**-1.74**	**-1.50**	**-1.62**	**-1.57**	**-1.69**
1.A.	Fuel Combustion Activities						0.00	0.00		-0.14
1.A.1.	Energy Industries						0.00	0.00		
1.A.2.	Manufacturing Industries and Construction									-0.14
1.B.	Fugitive Emissions from Fuels	-1.87	-1.21	-1.18	-1.43	-1.74	-1.50	-1.62	-1.57	-1.55
1.B.2.	Oil and Natural Gas	-1.87	-1.21	-1.18	-1.43	-1.74	-1.50	-1.62	-1.57	-1.55
4. Agriculture						**-0.48**	**0.04**			
4.A.	Enteric Fermentation					-0.46	0.04			
4.B.	Manure Management					-0.02	0.00			
5. Land Use, Land-Use Change and Forestry (net) *(5)*		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
5.D.	Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. Waste		**-19.37**	**-27.49**	**-31.48**	**-46.63**	**-49.07**	**-40.15**	**-36.70**	**-48.57**	**-32.38**
6.B.	Waste-water Handling							0.00		0.01
6.D.	Other	-19.37	-27.49	-31.48	-46.63	-49.07	-40.15	-36.70	-48.57	-32,38

Table 10.7. Recalculation for N_2O performed year 2014 for 1990–2011. Differences in CO_2 equivalent (Gg) between this and the April 2013 submission for Estonia

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total National Emissions and Removals		**10.11**	**10.39**	**10.71**	**11.09**	**11.39**	**11.62**	**9.48**	**6.75**	**11.29**	**11.16**	**10.62**	**9.36**	**2.75**
1. Energy														
1.A.	Fuel Combustion Activities													
1.A.2.	Manufacturing Industries and Construction													
4. Agriculture		**10.19**	**10.47**	**10.78**	**11.16**	**11.45**	**11.67**	**11.86**	**11.79**	**11.71**	**11.57**	**11.34**	**11.02**	**10.29**
4.B.	Manure Management													
4.D.	Agricultural Soils (4)	10.19	10.47	10.78	11.16	11.45	11.67	11.86	11.79	11.71	11.57	11.34	11.02	10.29
5. Land Use, Land-Use Change and Forestry (net) (5)		**-0.05**	**-0.04**	**-0.04**	**-0.03**	**-0.02**	**-0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-0.04**
5.B.	Cropland													-0.03
5.D.	Wetlands	-0.05	-0.04	-0.04	-0.03	-0.02	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. Waste		**-0.03**	**-0.04**	**-0.04**	**-0.04**	**-0.04**	**-0.04**	**-2.37**	**-5.04**	**-0.42**	**-0.41**	**-0.72**	**-1.65**	**-7.51**
6.B	Waste-water Handling													0.18
6.D.	Other	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-2.37	-5.04	-0.42	-0.41	-0.72	-1.65	-7.68

		2003	2004	2005	2006	2007	2008	2009	2010	2011
Total National Emissions and Removals		**-11.45**	**-21.06**	**-26.55**	**-44.37**	**-47.74**	**-38.66**	**-35.44**	**-48.90**	**-32.31**
1. Energy										**-0.29**
1.A.	Fuel Combustion Activities									-0.29
1.A.2.	Manufacturing Industries and Construction									-0.29
4. Agriculture		**10.08**	**9.59**	**8.65**	**7.72**	**7.59**	**6.32**	**5.62**	**5.25**	**3.33**
4.B.	Manure Management					-0.13	0.01			

		2003	2004	2005	2006	2007	2008	2009	2010	2011
4.D.	Agricultural Soils [4]	10.08	9.59	8.65	7.72	7.72	6.31	5.62	5.25	3.33
5. Land Use, Land-Use Change and Forestry (net) [5]		**-0.08**	**-0.21**	**-0.36**	**-0.47**	**-0.54**	**-0.52**	**-0.43**	**-0.32**	**-0.18**
5.B.	Cropland	-0.08	-0.20	-0.35	-0.45	-0.50	-0.51	-0.44	-0.34	-0.24
5.D.	Wetlands	0.00	-0.01	-0.02	-0.02	-0.03	-0.02	0.00	0.03	0.06
6. Waste		**-21.44**	**-30.44**	**-34.85**	**-51.62**	**-54.80**	**-44.46**	**-40.63**	**-53.84**	**-35.16**
6.B	Waste-water Handling					-0.47			-0.07	0.69
6.D.	Other	-21.44	-30.44	-34.85	-51.62	-54.32	-44.46	-40.63	-53.77	-35.85

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	CH_4 from Natural Gas Distribution (CRF 1.B.2.b.4)	A project was implemented to develop country-specific CH_4 EF for natural gas distribution in Estonia. Data was received from AS Eesti Gaas, that in 2010, the total fugitive emissions from natural gas distribution was 0.629 Gg CH_4 and in 2011 – 2.679 Gg CH_4. Unfortunately, no data for the years 1990–2009 is available. According to the ERT recommendation in 2013, Estonia will collect data for more years, to use actual data for developing CH4 emissions for the period 1990–2009 (as often these emissions are related to maintenance work, accidents, etc.).
INDUSTRIAL PROCESSES	Glass Production (CRF 2.A.7.1)	Estonia investigates possibilities to develop 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	Field Burning of Agricultural residues (CRF 4.F)	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 soil and litter pools (CRF 5.A)	Estonian Environment Agency in cooperation with University of Tartu launched a project aimed to obtain data about below-ground carbon fluxes in coniferous forest soils. Estonian Environment Agency is conducting another project called „Applied research of greenhouse gases in LULUCF sector in the framework of UNFCCC and Kyoto protocol reporting", one of the objectives is to develop forest litter and mineral soil emission factors. Estonia will try to implement the Yasso07 model to estimate forest land mineral soil emissions.
	Carbon stock change in cropland mineral and organic soils (CRF 5.B)	Agricultural Research Centre of Estonia is conducting fieldwork and estimating carbon stock changes in croplands mineral and organic soils.
	Carbon stock change in grassland mineral and organic soils (CRF 5.C)	Agricultural Research Centre of Estonia is conducting fieldwork and estimating carbon stock changes in grasslands 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.

SECTOR	SOURCE	IMPROVEMENTS
	Biological Treatment (CRF 6.D)	The activity data is kept under consideration and will be updated necessarily.
	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 2013 inventory review report (FCCC/ARR/2013/EST).

Table 10.9. Response to the review of the 2013 inventory submission

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
Energy (Sectoral overview)	With regard to the EFs for CO_2 emissions from fuel combustion (all fuels), the NIR lists many EFs as country-specific, using the reference "CS, LT = D". In response to a question raised by the ERT during the review, Estonia explained that the IPCC default EF used by Lithuania was applied in Estonia and considered a country-specific EF. The ERT disagrees with this approach and recommends that Estonia update the references.	The references were updated.	Table 3.12	
Energy (Sectoral overview)	With regard to liquefied petroleum gas (LPG), Estonia uses the IPCC default CH_4 and N_2O EFs for gaseous fuels. The ERT agrees that the emission properties of LPG are closer to those of natural gas than to oil products. However, the ERT noted that Estonia used the oxidation factor for liquid fuels rather than for gaseous fuels. The ERT considers that the oxidation factor for gaseous fuels is more applicable, considering the physical properties of LPG. In response, Estonia indicated that this will be changed in the next annual submission. The ERT recommends that Estonia change the oxidation factor for LPG and recalculate the entire time series.	The CS emission factor of LPG was developed and therefore the oxidation factor of 1 was taken into use.	Table 3.12	
Energy (Comparison of the RA with the SA and international statistics)	During the previous review, the ERT recommended that Estonia improve the consistency between the data reported to the International Energy Agency (IEA) and the data reported in the CRF tables. During the review of the 2013 annual submission, a number of discrepancies were identified. In response to questions raised by the ERT, Estonia explained that the discrepancies were mainly in the CRF data and were caused by some values being updated in accordance with the results of a joint questionnaire by SE but not being updated in the CRF tables. The discrepancies are for different years of the time series prior to 2008. The ERT reiterates the recommendation made in the previous review report that Estonia improve the consistency between the data reported to IEA and the data gathered by SE.	The data was updated.	Recalculation chapters in the Energy section	

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
Energy (Country-specific issues)	The main domestic fuel in Estonia is oil shale. Oil shale is both combusted directly for the production of electricity and heat and as feedstock for the production of shale oil. Previous review reports have recommended that Estonia prepare carbon balances for shale oil production. The carbon balances were not included in the 2013 NIR due to confidentiality, but were provided to the ERT for the purposes of the review. Regarding the carbon balance, the normal procedure is to calculate the carbon inputs (oil shale) and outputs (shale oil, semi-coke, generator gas, etc.) and then to compare the two figures. In the carbon balance provided by Estonia, the carbon is calculated for most fuel streams, but for the last output fuel the carbon content is calculated as the input minus all other output carbon. This has the effect that the IEF for the last fuel stream for all three plants is highly variable and it also means that the output will always precisely match the input. The ERT considers that the process as described could lead to fugitive emissions that are not captured by the current approach. Therefore, the ERT recommends that Estonia collect data on the carbon content of all fuel streams and prepare the carbon balance to verify that no fugitive losses occur during the process. Furthermore, the ERT recommends that Estonia translate the first column of the carbon balance spreadsheet into English to facilitate the review.	The carbon balance was translated to english. The information about the Gaseous heat carrier process for Shale oil production is presented in NIR.	Chapter 3.2.5.2 section "Shale Oil"	
Energy (Key ctaegories – Stationary combustion: solid fuels – CO_2)	With regard to the EFs for CO_2 emissions from fuel combustion (solid fuels), the NIR states that a comparison of CO_2 EFs has been undertaken with corresponding plant-specific EFs reported under the EU ETS. Upon request from the ERT, Estonia provided the comparison. It showed rather large differences in the carbon content between the inventory data used and the EU ETS reporting, with the inventory having the higher values. Estonia explained that oil shale gases are chemically very uneven fuels and that it was probable that the data sent by the companies for inventory preparation are not exactly the same data that are used for the EU ETS calculations. The ERT acknowledges that these fuels will be uneven in composition over the year. The ERT recommends that Estonia provide information on the measurement	Information is provided in NIR 2014.	Chapter 3.2.5.4	

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
	requirements for the plants under the EU ETS and information on why the plants have reported different values to the inventory compilers and the EU ETS.			
Energy (Key categories – Road transportation: liquid fuels – CO_2)	During the review, the ERT requested to see the underlying data used to calculate the weighted CO_2 EFs for gasoline and diesel oil. When examining the data, the ERT noticed that there were unusual values regarding the carbon content for some countries, namely, Norway (diesel oil), Ukraine (gasoline) and Belarus (gasoline). While the EFs were correctly referenced at the time of the preparation of the annual submission, it is clear to the ERT that these EF values are incorrect. Since very small amounts were imported from the above-mentioned countries the significance for the emissions was negligible. The ERT recommends that Estonia in the future apply QC checks to the data and investigate any unusual values. Furthermore, the ERT recommends that Estonia provide in the NIR the information used to calculate the weighted EFs for the most recent year.	The values used in the calculation of country-specific CEFs are checked, if they differ significantly. Also, the information on the amounts of imported fuels are added in NIR 2014.	Table 3.29 and Table 3.30	
Energy (Non-key categories – Civil aviation: liquid fuels – CO_2)	Estonia reported different CO_2 EFs for aviation gasoline for landing and take-off cycles (LTOs) and cruise modes. It is unlikely that the CO_2 EF would vary significantly between flying modes. In response to a question raised by the ERT during the review, Estonia stated that the EFs are from the EMEP/EEA Guidebook. The ERT noted that the guidebook provides EFs in kg/LTO for LTOs and kg/t for cruise. When converting the LTO EFs using the fuel consumption per LTO reported in the guidebook, the guidebook provides the same EF in kg/t as for cruise. The ERT therefore considers that Estonia is overestimating emissions from LTOs. The ERT recommends that Estonia revise the CO_2 EF for LTOs.	The EF of LTO has been corrected.	Table 3.24	
Energy (Non-key categories – Road transportation: liquid fuels – CH_4 and N_2O)	The previous review report noted that there were significant inter-annual fluctuations in the implied emission factors (IEFs) for road transportation and recommended that Estonia improve its explanation of this in the NIR. In the 2013 annual submission, no improvements have been made in relation to this recommendation. The ERT considers that in general the description of the trends in the NIR related to the AD, IEFs and emissions could be improved. As examples, the ERT noted that	The information has been added in NIR 2014.	Chapter 3.2.6.3	

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
	the CH_4 IEF for diesel oil used in road transportation decreased significantly from 2010 (5.01 kg/TJ) to 2011 (2.67 kg/TJ) and that the number of vehicles increased between 1991 and 1992 by 8.6 per cent, while the kilometres driven decreased by 52.8 per cent. During the review, Estonia provided explanations for the different observed fluctuations. The ERT recommends that the Party improve the trend discussion in the NIR, focusing on the key categories.			
Energy (Non-key categories – Fugitive emissions: oil – CH_4)	Estonia estimates CH_4 emissions from transport and storage of oil. However, the IPCC default EFs used are for crude oil and it is not usually considered that CH_4 emissions occur from refined products. Since there is no oil refining in Estonia, it would be unusual for there to be transport and storage of crude oil. In response, the Party clarified that the AD used in the calculation were for refined oil products and not crude oil. Estonia also informed the ERT that a study is planned to investigate the possible emissions from this subcategory. The ERT noted that both the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as the Revised 1996 IPCC Guidelines) and the 2006 IPCC Guidelines consider CH_4 emissions from the distribution of refined oil products as not applicable. The EF currently used by Estonia is leading to a probable overestimation of emissions. The ERT recommends that Estonia report the notation key "NO" (not occurring) in CRF table 1.B.2 for oil transport (1.B.2.a.iii) and oil refining/storage (1.B.2.a.iv), since the transport, refining and storage of crude oil does not occur in Estonia. Furthermore, the ERT recommends that Estonia change the notation key for distribution of oil products (1.B.2.a.v) as it does occur in Estonia.	The notation keys have been changed.	Not applicable. The notation keys are only used in CRF tables.	

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
Energy (Non-key categories – Fugitive emissions: natural gas – CH_4)	Estonia uses an EF from Finland for the calculation of emissions from natural gas distribution. During the review, the ERT sought further clarification from the Party regarding the applicability of the Finnish EF in Estonia. In response, Estonia provided the ERT with data from the natural gas distribution company (Eesti Gaas) for 2010 and 2011, which showed that the Party currently overestimates the emissions. Estonia also informed the ERT that data were not available for the years 1990–2009. The ERT noted that emissions from natural gas distribution are often related to maintenance work, accidents, etc. This means that it will be unlikely that a trend extrapolation can be used. The ERT recommends that as data become available for future years, Estonia assess the possibility of revising the EF, taking into consideration the importance of time-series consistency.	The recommendation has been taken into account and the information is provided.	Chapter 3.3.2.6	
Industrial processes and solvent and other product use (Sectoral overview)	Estonia reported potential emissions of HFCs, PFCs and SF_6 as "NO" or "NE" (not estimated). In response to a question raised by the ERT during the review, Estonia indicated that it does not see a reason to report potential emissions because it reports actual emissions. In order to increase the transparency and comparability of the reporting, as well as to check actual estimates, the ERT again reiterates the encouragement made in the previous review report that Estonia provide estimates for the potential emissions of these gases.	Estonia has estimated actual emissions and therefore do not find it rational to estimate also potential emissions.		

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
Industrial processes and solvent and other product use (Non-key categories – Other (mineral products) – CO_2)	The ERT noted that emissions from the consumption of carbonates are determined using country-specific EFs under cement and lime production, while the 2006 IPCC Guidelines default values are used for glass production (for container glass the Revised 1996 IPCC Guidelines are used) as well as for bricks and tiles production and lightweight gravel production. Estonia indicated that the development of a country-specific EF was considered for glass production, but it did not see the rationale for developing country-specific EFs for bricks and tiles production as this category was not among the key categories. The ERT encourages the Party to pursue its consideration of developing a country-specific EF for glass production, particularly considering that only one production facility exists. Furthermore, the ERT encourages Estonia to assess available information on carbonate composition at the national level as well as in neighbouring Parties which could be considered for the development of a country-specific EF for bricks and tiles as well as lightweight gravel.	Estonia investigates possibilities to develop country-specific EFs for Glass Production (CRF 2.A.7.1) for future submissions. As bricks and tiles production is not a key category, Estonia does not find it rational to develop country-specific EFs.	4.2.5.6. Source-specific planned improvements	
Agriculture (Sectoral overview)	During the review, the ERT identified several small discrepancies without impacts on the calculations but due to incorrect reporting in the CRF tables (e.g. incorrect copy and paste). The ERT encourages Estonia to identify the actual reasons for this type of error in its reporting and encourages the Party to enhance its QC checks if this is recognized as responsible for these weaknesses.	The omissions have been corrected. Efforts are being made to avoid similar errors during the next submissions.	Throughout the NIR	
Agriculture (Sectoral overview)	The uncertainty estimates have been implemented according to the tier 1 method presented in the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (hereinafter referred to as the IPCC good practice guidance). In spite of the fact that tier 2 methods are used for the calculation of emissions from most of the key categories related to livestock, default uncertainty values have been used for most parameters. The ERT encourages Estonia to investigate the possibility of using more country-specific data for the uncertainty estimates in relation to the calculations that are actually implemented.	Estonia has taken notice of the encouragement to investigate the possibility of using more country-specific data for the uncertainty estimates and is considering to look into the matter in the following submissions.		Next submissions

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
Agriculture (Key categories – Enteric fermentation – CH_4)	Estonia reported CH_4 emissions from enteric fermentation for poultry as "NE". The ERT notes that although there is no methodology in the Revised 1996 IPCC Guidelines or in the IPCC good practice guidance, it encourages Estonia to estimate the emissions.	To date Estonia is not actively weighing the possibility to start reporting CH_4 emissions from enteric fermentation for poultry as no methodology in the Revised 1996 IPCC Guidelines or in the IPCC good practice guidance is available.		
Agriculture (Key categories – Enteric fermentation - CH_4)	For fur-bearing animals, Estonia has used an EF from Norway, since no IPCC default value is available; this value is used by different Nordic countries but can depend on the type of animal (mink, fox, etc.). The previous ERT encouraged the Party to examine the possibility of developing country-specific EFs for fur-bearing animals, but Estonia responded that due to the low level of emissions and the lack of resources this encouragement was not implemented in the 2013 annual submission. The ERT reiterates the previous encouragement that the Party develop country-specific EFs for fur-bearing animals but considers that this minor issue could be resolved by comparing the types of animals that were used to develop the Norwegian EF with the fur-bearing animals that are bred in Estonia.	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_2 eq 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
Agriculture (Key categories – Manure management – CH_4 and N_2O)	In response to a question raised by the ERT during the review regarding manure management allocation, Estonia recognized that there was an omission in the reporting of the allocation structure of manure management systems for swine in CRF table 4.B(a). However, the omission does not affect the calculation of emissions. The ERT recommends that Estonia amend this incorrect reporting.	The recommendation was implemented in the 2014 submission; the omission has been corrected	The omissions have been corrected in CRF table 4.B. However since the omission did not affect the calculation of emissions, the correction has not specifically been pointed out in the NIR.	
Agriculture (Key categories – Manure management – CH_4 and N_2O)	In response to a question raised by the ERT during the review regarding the nitrogen (N) excretion calculation, Estonia recognized that there was a copy and paste omission in the reporting of the N excretion values for dairy cattle and fur-bearing animals in CRF table 4.B(b). However, the omission does not affect the calculation of emissions. The ERT recommends that Estonia amend this incorrect reporting.	The recommendation was implemented in the 2014 submission; the omission has been corrected.	NIR Sub-section 6.4.2.7	

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
Agriculture (Key categories – Manure management – CH_4 and N_2O)	In response to a question raised by the ERT during the review regarding the sharp increase in N excretion for dairy cattle between 2007 and 2008, Estonia explained that this trend is due to the combined effect of the sharp increase in the milk yield between 2007 and 2008 and the use of milk yield dependent values for the N content in cattle feed. The N content in food values is based on an Estonian publication (Kaasik et al., 2002). According to this publication, the N content in cattle feed is about 2.3 per cent for cows producing less than 6,900–7,000 kg of milk per year; and 2.4 per cent for cows producing more than 6,900–7,000 kg of milk per year. The ERT considers that this explanation is satisfactory and commends Estonia for using a dynamic value for the N content in cattle feed, which is reliable information. However, the ERT also encourages Estonia to investigate the possibility of smoothing this effect, which appears to be a threshold effect and may not be in line with good practice. The ERT recommends that the Party increase the transparency of this issue by explaining the trend of N excretion for dairy cattle in the NIR. The ERT also recommends that Estonia report the fact there is dynamic N content in the feed of dairy cattle, which is not currently the case, in appendix A.3.3_V of the NIR.	The recommendation of increasing the transparency by explaining the trend of N excretion for dairy cattle in the NIR has been implemented in the 2014 submission. The encouragement made by the ERT for Estonia to investigate the possibility of smoothing the sharp increase in N excretion for dairy cattle between 2007 and 2008 has been taken under consideration.	NIR, Appendix A.3.3_V	
Agriculture (Key categories – Agricultural soils – N_2O)	In response to a question raised by the ERT during the review regarding N excretion on pasture, Estonia recognized that there was an omission in the reporting of AD for pasture in CRF table 4.D for 2011. However, the omission does not affect the calculation of emissions. The ERT recommends that Estonia amend this incorrect reporting.	The recommendation has been implemented in the 2014 submission; the omission has been corrected.	NIR Sub-section 6.6.4	
Agriculture (Key categories – Agricultural soils – N_2O)	Estonia plans to develop a more accurate value for the parameter fraction of total above-ground crop biomass that is removed from the field as a crop product (FracR). The ERT recommends that Estonia revise its estimate of FracR on the basis of national studies.	The work for developing a more accurate value for the parameter fraction of total above-ground crop biomass that is removed from the field as a crop product is in progress.		Next submissions

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
Land use, land-use change and forestry (Sectoral overview)	The reporting of the LULUCF sector is generally complete, with GHGs and land uses considered, as well as most carbon pools. With regard to the carbon pools, Estonia has not reported the losses from the carbon stock changes in living biomass except for forest land remaining forest land and other land converted to forest land. Gains and losses could be reported separately for above- and below-ground biomass for the sake of transparency when it is technically possible to separate information on gains and losses. The ERT encourages Estonia to separate gains and losses for all land uses, where possible.	Estonia has chosen Method 2 (also called the stock-change or stock-difference method) for estimating carbon stock changes in biomass for reporting. A net carbon stock change is the output of the stock-difference method, therefore gains and losses are not listed separately either in the CRF reporter nor in the NIR. The stock-difference method will provide more reliable estimates for relatively large increases or decreases of biomass (as it is in a small country like Estonia) or where very accurate forest inventories are carried out (Estonian National Forest Inventory). The choice of using default or stock change method is a matter for expert judgment, taking the national inventory systems into account. By the IPCC, carbon stock gains and losses should be listed separately except in cases where, due to the methods used, it is technically impossible to separate information on gains and losses. Encouragement to change the methodology is therefore not justified only for transparency reasons. In addition, the annual logging and increment data is always provided in the NIR.	7.2.2.1. Change in carbon stocks in living biomass	Estonia continues implementing the the stock-change method. More information will be provided, where possible, to verify the results.
Land use, land-use change and forestry (Sectoral overview)	The ERT identified an inconsistent use of the notation keys: "NE" was reported when the notation key "NA" (not applicable) would apply with regard to the reporting of land-use conversion to cropland. The ERT recommends that Estonia use the notation key "NA".	The notation key NA has been used in the 2014 submission CRF tables.		
Land use, land-use change and forestry (Sectoral overview)	The ERT noted that the transparency of the LULUCF reporting in the 2013 annual submission has been improved by the inclusion of information in the NIR on the assumptions, values and methodologies used. However, the ERT also noted that the transparency could be further enhanced by providing information on gains and losses for the carbon stock balances, and not only the net changes where technically possible. The ERT reiterates the recommendation made in the previous review report that Estonia provide more detailed information on the methodology used to estimate the carbon stock changes in	Estonia has chosen Method 2 (also called the stock-change or stock-difference method) for estimating carbon stock changes in biomass for reporting. A net carbon stock change is the output of the stock-difference method, therefore gains and losses are not listed separately either in the CRF reporter nor in the NIR. The stock-difference method will provide more reliable estimates for relatively large increases or decreases of biomass (as it is in a small country like Estonia) or where very accurate forest inventories are	7.2.2. Methodological issues (Forest Land) 7.3.2 Methodological issues (Cropland) 7.4.2 Methodological issues (Grassand) 7.5.2 Methodological issues	Estonia continues implementing the the stock-change method. More information will be provided, where possible, to verify the results. Land-use change

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
	any land converted to other land in the NIR.	carried out (Estonian National Forest Inventory). The choice of using default or stock change method is a matter for expert judgment, taking the national inventory systems into account. By the IPCC, carbon stock gains and losses should be listed separately except in cases where, due to the methods used, it is technically impossible to separate information on gains and losses. Recommendation to change the methodology is therefore not justified only for transparency reasons. In addition, the annual logging and increment data is always provided in the NIR. Estonia will provide more detailed information on the methodology used to estimate the carbon stock changes in any land converted to other land.	(Wetlands) 7.6.2 Methodological issues (Settlements) 11.2 Land-related information	emission estimation methodologies will be improved.
Land use, land-use change and forestry (Sectoral overview)	The ERT also noted that various forest definitions are referred to in the NIR. The ERT encourages Estonia to report only on the definition that is used in both the Convention and the KP-LULUCF reporting, and ensure that this definition is applied consistently.	Usage of forest definition has been clarified in the 2014 NIR. Forest definition has been applied consistently in the Convention and the KP reporting.	7.1.2.1. Forest land and definitions 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	
Land use, land-use change and forestry (Sectoral overview)	In response to a question raised by the ERT during the review, Estonia provided information on its capacity to detect the exact year of an occurrence of land-use change and its subsequent consistent representation in the time series. The ERT identified that this is achieved by combining NFI data with older maps and aerial photographs (see NIR chapter 7.1.3). The ERT recommends that Estonia include the information referred to above, and also report on any developments in identifying the exact year of the occurrence of land-use change.	More information about Estonia's capacity to detect the exact year of an occurrence of land-use change is provided in NIR 2014.	7.1.3. National Forest Inventory 7.2.6. Source-specific planned improvements 11.2 Land-related information	Methodology used to detect land-use changes will be improved.

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
Land use, land-use change and forestry (Sectoral overview)	The ERT noted that the NFI has an annual sampling area that could be deemed as insufficient to detect small deforested and afforested areas. The NIR states that there is no alternative source of information that can be used. The ERT encourages Estonia to explore available means to determine these areas and related parameters (such as country-specific EFs) that can increase the accuracy of the emission and removal estimates.	Estonia is exploring possibilities to increase the statistical significance of detecting AR and D areas.	11.3.1.6. Information on other methodological issues	Methodology used to detect ARD areas will be improved.
Land use, land-use change and forestry (Sectoral overview)	The ERT encourages Estonia to explore ways of estimating the impact of high harvest levels on forest soil emissions by initiating a national study or by validating current data by means of QA or verification checks, and that Estonia outline the progress made in this regard in the NIR.	Estonia is exploring possibilities to assess the impact of high harvest on forest soil emissions.	7.2.6. Source-specific planned improvements	
Land use, land-use change and forestry (Sectoral overview)	The ERT noted that the time-series consistency of some AD was raised as an issue in the previous review report. These data cover high inter-annual variations (as in the case of harvest volumes, deforestation or forest land converted to other land-use classes or mass of lime applied). The ERT recommends that the Party subject these data to further assessment by either QA or verification checks (or alternative means), and that Estonia report thereon in the NIR.	High inter-annual variations in AD have been explained in the NIR. In some cases, eg under Forest land category, data smoothing has been applied to decrease the fluctuation.	7.2.5. Source-specific recalculations 7.3.2.5. CO_2 emissions from liming (CRF 5(IV))	
Land use, land-use change and forestry (Sectoral overview)	The ERT noted that category-specific QA/QC and verification checks are referred to in the NIR and that Estonia applied tier 1 procedures. The ERT encourages Estonia to apply tier 2 QC, QA and verification procedures at least to those land uses identified as key categories and report the results in the NIR. Also, for QA/QC purposes, the ERT encourages the Party to include a summary table consisting of a comparison matrix of the Convention and KP-LULUCF reporting areas and explain any major differences.	Estonia has taken notice of the encouragement and is considering to improve the QA/QC and verification procedures according to available resources. A comparison matrix of the Convention and KP-LULUCF reporting areas as well as explanations are provided in NIR 2014.	7.2.4. Source specific QA/QC and verification 11.2.2. Methodology used to develop the land transition matrix	Estonia is considering to improve the QA/QC and verification procedures according to available resources.

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
Land use, land-use change and forestry (Key categories – Forest land remaining forest land – CO_2)	The ERT concurred with a finding in the previous review report (FCCC/ARR/2012/EST, para. 98) that the level of harvest volumes and wildfires cannot directly explain the observed large inter-annual variability in the carbon stock changes in living biomass. In response to a question raised by the ERT during the review, Estonia explained that the living biomass is calculated via the growing stock, with data obtained from the NFI. However, the NFI sample includes sampling errors that cause variations in the estimate. Smoothing is applied by Estonia to the carbon stock per hectare per year, resulting in the time series of carbon stock changes in biomass smoothed with multiple degree polynomials to reduce some differences (statistical errors) between successive years and in the estimates of the carbon stock changes. The ERT reiterates the recommendation in the previous annual review report that Estonia explore ways of reducing the inter-annual fluctuations and report thereon in its annual submission.	Large inter-annual variability in the carbon stock changes in living biomass has been dimished by data set smoothing (curve fitting) to create an approximating function that attempts to capture important patterns, while leaving out the noise. Algorithm of 5th degree polynomial was applied to NFI's actual data.	7.2.5. Source-specific recalculations	
Waste (Key categories – Solid waste disposal on land – CH_4)	In its 2013 annual submission, Estonia reported emissions from the category "uncategorized disposal site". However, the ERT found that information on this category and the reasons as to why this category is reported and its definition were missing. In response to a question raised by the ERT during the review, Estonia provided the necessary information. The ERT recommends that the Party include this information in the NIR.	The information is provided in NIR 2014.	NIR 2014, page 353 (footnote 195)	
Waste (Non-key categories – Wastewater handling – CH_4)	Estonia estimated CH_4 emissions from domestic and commercial wastewater using a tier 1 method and a maximum methane producing capacity (Bo) value from the Revised 1996 IPCC Guidelines, and country-specific EFs. In response to a question raised by the ERT during the review, the Party provided information on the country-specific methane conversion factor used to estimate the emissions. The ERT recommends that Estonia include this information in the NIR. The ERT also noted that Estonia has used a Bo value from the Revised 1996 IPCC Guidelines that is lower than the default value contained in the IPCC good practice guidance. In response to a question on this matter, the Party provided information in support of the use of the lower Bo value. The	The information is provided in NIR 2014.	NIR 2014, page 359-360 (footnotes 205 and 206)	

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
	ERT recommends that Estonia include this information in the NIR.			
Activities under Article 3, paragraph 3 and 4, of the Kyoto Protocol (Overview)	No information on factoring out was provided in the 2013 annual submission. In response to a question raised by the ERT during the review, this information was provided. Information was also provided to the ERT on the year of the onset of any activities, on the methodologies used for reporting land converted to other land uses, and on the units of afforestation/reforestation harvested since the beginning of the commitment period. The ERT recommends that Estonia include in its annual submission all information gaps in reporting listed.	Information on factoring out is provided in the 2014 annual submission. Other information gaps listed is provided in the 2014 annual submission.	11. KP-LULUCF	
Activities under Article 3, paragraph 3, of the Kyoto Protocol (Afforestation and reforestation – CO_2)	Estonia continues not to report the gains and/or losses in carbon stock changes for the carbon pools. The ERT encourages Estonia to report both gains and losses for all carbon pools and activities where technically possible.	Estonia has chosen Method 2 (also called the stock-change or stock-difference method) for estimating carbon stock changes in biomass for reporting. A net carbon stock change is the output of the stock-difference method, therefore gains and losses are not listed separately either in the CRF reporter nor in the NIR. The stock-difference method will provide more reliable estimates for relatively large increases or decreases of biomass (as it is in a small country like Estonia) or where very accurate forest inventories are carried out (Estonian National Forest Inventory). The choice of using default or stock change method is a matter for expert judgment, taking the national inventory systems into account. By the IPCC, carbon stock gains and losses should be listed separately except in cases where, due to the methods used, it is technically impossible to separate information on gains and losses. Encouragement to change the methodology is therefore not justified only for transparency reasons. In addition, the annual logging and increment data is always provided in the NIR.	11.3.1.1. Description of the methodologies and the underlying assumptions used	Estonia continues implementing the the stock-change method. More information will be provided, where possible, to verify the results.

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
Activities under Article 3, paragraph 3, of the Kyoto Protocol (Afforestation and reforestation – CO_2)	The ERT identified that the net carbon stock change in dead wood is reported as "NO" for units of A/R. In response to a request made by the ERT during the review to provide transparent and verifiable information to demonstrate that the pool is not a net source of emissions, Estonia replied that the NFI data reveal that no dead wood is present in afforested and reforested areas, and that the pool would be a sink with regard to tree growth. The ERT acknowledges this explanation but recommends that Estonia demonstrate this assumption through the provision of transparent and verifiable information showing that the pool is not a net source in its NIR.	Dead wood emission estimates are provided in NIR 2014.	11.3.1.1. Description of the methodologies and the underlying assumptions used	Estonia continues to report emissions from dead wood.
Activities under Article 3, paragraph 3, of the Kyoto Protocol (Afforestation and reforestation – CO_2)	The ERT identified that Estonia did not report units of land harvested in A/R activities since the beginning of the commitment period. In response to a question raised by the ERT during the review, the Party provided information (i.e. justification) stating that taking into account reasonable resources for tracking A/R units (NFI) and available data, there is no evidence of harvesting on A/R areas. Furthermore, the trees on A/R areas could be (a maximum of) 22 years old, hence it is not profitable (little stem volume) to harvest a forest of this age. The ERT recommends that Estonia include the information mentioned above in its NIR, including verifiable information that is sufficient (and transparent) in justifying that the carbon pool is not a net source of emissions.	Information is included in NIR 2014.	11.4. Article 3.3	More information will be provided, where possible, to verify the results.
Activities under Article 3, paragraph 3, of the Kyoto Protocol (Afforestation, reforestation and deforestation – CO_2)	In the previous review report, the ERT noted that since the values of the area of afforestation have 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 A/R or deforestation (D) may be actually higher. In response to a question raised by the ERT on this matter, Estonia agreed and explained that the NFI is the only current source of information, and that there are no alternative land-use statistics that can be used to detect deforestation areas. Further, the Party explained that harvesting permits do not differentiate between forest and other land, and the land cadastre data have been static since 1991. The ERT recommends that Estonia assess the impact of the application of different forest definitions,	Same forest definition is applied throughout the Convention and the Kyoto Protocol reporting. SE data has not been used under KP reporting after the 2012 submission. In the 2013 and 2014 submission AR areas are obtained from NFI, assuming that cropland/wetland/settlement conversion to forest land is direct human-induced activity, thus the sum of these land use changes is equal to AR area. All land use changes from forest land to other land uses are considered deforestation.	7.1.2.1. Forest land and definitions 11.1.1 Definition of forest and any other criteria 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 11.3.1.6 Source-specific QA/QC and verification	

Category	Comment	Estonia's response	Where in NIR 2014	Future plans
	specifically for afforested and reforested land, and utilize the results of this assessment to correct the area of ARD obtained from the SE data, and report thereon in the NIR.			
Changes to the national registry	The ERT concluded that, taking into account the confirmed changes in the national registry, including the additional information provided to the ERT during the review, Estonia's national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1 and continues to adhere to the technical standards for data exchange between registry systems in accordance with relevant decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP). With respect to the provision of information related to the database structure specifically, the ERT encourages the Party to provide additional information in the NIR. The ERT recommends that Estonia include all other additional information in response to the SIAR findings in its NIR in accordance with decision 15/CMP.1, annex, chapter I.G.	Additional information is provided in NIR 2014, Chapter 14.		

10.4.2. KP-LULUCF inventory

Planned improvements in the KP-LULUCF sector include following:

- improving the accuracy of D areas using old maps and conducting additional fieldwork;
- improving the accuracy of AR sites in the framework of the NFI;
- developing country-specific soil emission factors.

The Estonian Environment Agency has initialized in cooperation with the University of Tartu a project aimed to obtaining 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.

Estonia was selected to participate in the Specific Contract (SC) 12 taskforce on the harmonization of LULUCF inventories: modeling forest soil with Yasso. The Specific Contract 12 is a framework contract for the provision of forest data and services in support of the European Forest Data Centre. The general objective of SC 12 is to provide support to a limited number of member states on modeling carbon stock change of forest mineral soils implementing Yasso07.

A project titled „Applied research of greenhouse gases in the LULUCF sector in the framework of UNFCCC and Kyōto protocol reporting“ was launched in June 2013 and funded by the Environmental Investment Centre. The project covers several issues, i.e. acquiring missing country specific data related to the current and next Kyoto commitment period. Project activites and their description are presented in table Table 7.17.

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 of emissions and removals are prepared and reported consistently with the IPCC GPG LULUCF 2003 and Decisions 15/CMP.1 and 16/CMP.1 of the KP.

An overview of Article 3.3 activities' CO_2 emissions and removals are presented in Table ES.3. In 2012, net emissions from Article 3.3 activities were 306.59 Gg CO_2 eq. Uptake from afforestation and reforestation activities including emissions from biomass burning was estimated at -130.51 Gg CO_2 eq., whereas deforestation resulted in a net emission of 437.10 Gg CO_2 eq. Areas subject to AR and D were 29 165 and 20 805 ha, respectively by the end of 2012. Annual rates of afforestation and deforestation have declined continuously from 0.7 kha to 0.3 kha per year for AR and from 2.3 kha to 1.0 kha per year for D during the period 2008–2012 (Table 11.3).

11.1.1. Definition of forest and any other criteria

Under the Kyoto Protocol, Parties are requested to make national parameter choices for the forest definition within the ranges allowed by Decision 16/CMP.1. Estonia established the 'definition of forest in the context of the Kyoto Protocol' in 2006 with the main parameters of forest definition shown in Table 11.1. Estonia applies the same forest definition for both UNFCCC and KP reporting.

Table 11.1. Parameters for forest definition

Minimum tree crown cover	30%
Minimum land area	0.5 ha
Minimum tree height	2 m

In ARR2013, para.60 ERT noted that various forest definitions were referred in the 2013 NIR. Clarification has been provided as follows.

The definition of forest has been amended several times in the Estonian Forest Act during the last 20 years. Since 2009 it has stipulated forest land as land which meets at least one of the following requirements:

i) forest land use is included in land a cadastre;

ii) has an area of 0.1 hectares of land, growing woody plants with a minimum height of 1.3 meters and a tree crown cover of at least 30 percent.

To meet the requirements of UNFCCC and its Kyoto protocol reporting, the NFI is compiling statistical analyses based on both, the national and the Kyoto Protocol definition of a forest regarding the minimum area of a forest. The NFI has been recording information on forests, which remain in the area between 0.1 ha and 0.5 ha due to the fact that criterion of 0.5 ha has been a minimum forest area in one of the earlier redactions of the Forest Act. Thus there is activity data that is applicable for KP-LULUCF reporting. The same information is used for estimating forest area according to the FRA definition

The criterion of 1.3 m has caused some confusion in earlier greenhouse gas inventory reports; however it should be noted that it is not ‘the minimum tree height’ in context of the forest land definition. Actually, 1.3 m is the criteria for counting unstocked forest area to stocked forest. The minimum tree height *in situ* by the forest definition of the Forest Act is defined by tree species, the stand’s age and site index. Thus, there is not constant criteria for tree height in the national definition. As there are no forest-tree species in Estonia that could not reach the height of 2 m at the age of maturity, the height criterion of the Kyoto Protocol forest definition has been met in the NFI statistics.

All temporarily unstocked forest areas and regeneration areas which have yet to reach a crown density of 30 per cent and tree a height of 2 meters are also included as forest, as are areas 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.

All forest land is considered managed in Estonia – 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.

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) during the first commitment period as stated in the report “Report to facilitate the estimation of Estonia’s assigned amount under the Kyoto Protocol, 2007”.

Estonia has not elected any activities under article 3.4 during 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 report carbon flows related to afforestation (A), reforestation (R) and deforestation (D) activities for the first time in 2009, when the NFI started to report land-use changes.

In previous submissions, afforestation and reforestation areas were obtained from Statistics Estonia. Starting from the 2013 submission, a new approach was implemented. Now NFI field data about land-use changes are used, assuming that cropland, wetlands and settlements conversion to forest land reported under the Convention is direct human-induced land conversion, these areas are summed in order to get AR area (Table 11.2). Grassland and Other land conversion to forest land is considered not directly human induced. Grassland conversion to forest land occurs mainly due to natural succession after land abandonment, therefore these areas are 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 the NFI and consistency between UNFCCC and KP-LULUCF reporting is assured.

Data about deforestation is also acquired from the NFI. All land use changes from Forest Land to other land-use categories reported under the Convention are considered deforestation (Table 11.2).

With the new approach, all activity data (AR & D) is obtained from one source.

It should be noted that, starting from the 2013 submission, the area of land-use changes under the Convention and Kyoto LULUCF reporting do not have a full match. Once the time period for UNFCCC reporting of converted lands has elapsed (i.e. 20 years) the land is reported in the land remaining category, whereas under Kyoto reporting, this displacement is not applied.

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. Estonia did not choose any Article 3.4 activities for the first commitment period.

11.2. Land-related information

Estonia implements *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 from the National Forest Inventory.

The NFI is a sampling-based inventory system that covers the whole country and all land-use categories (Figure 7.5). During fieldwork, land categories are determined (Table 7.6), whereby the “LULUCF former land category” is registered if there are signs of land category change after the base point (31.12.1989). The year of change is being estimated first directly in the field, mainly based on the age of trees and characteristics of the surrounding landscape. Older maps and aerial photographs are used afterwards as supporting material to determine the exact year more accurately.

In ARR2013 para.61 the ERT recommended that Estonia include the information on its capacity to detect the exact year of an occurrence of land-use change and its subsequent consistent representation in the time series.

An illustrative example of how land-use changes are verified with maps and relevant materials are presented as follows.

In the cluster in Figure 11.1, Figure 11.2 and Figure 11.3, there are identified 6 land use changes on the NFI sample plots since 1990:

1. *N02* - grassland to forest land, LUC in 1995
2. *E06* - cropland to forest land, LUC in 1999
3. *S02* - cropland to forest land, LUC in 2009
4. *W04* - cropland to forest land, LUC in 2005
5. *W06* and W08 - cropland to forest land, LUC in 2008.

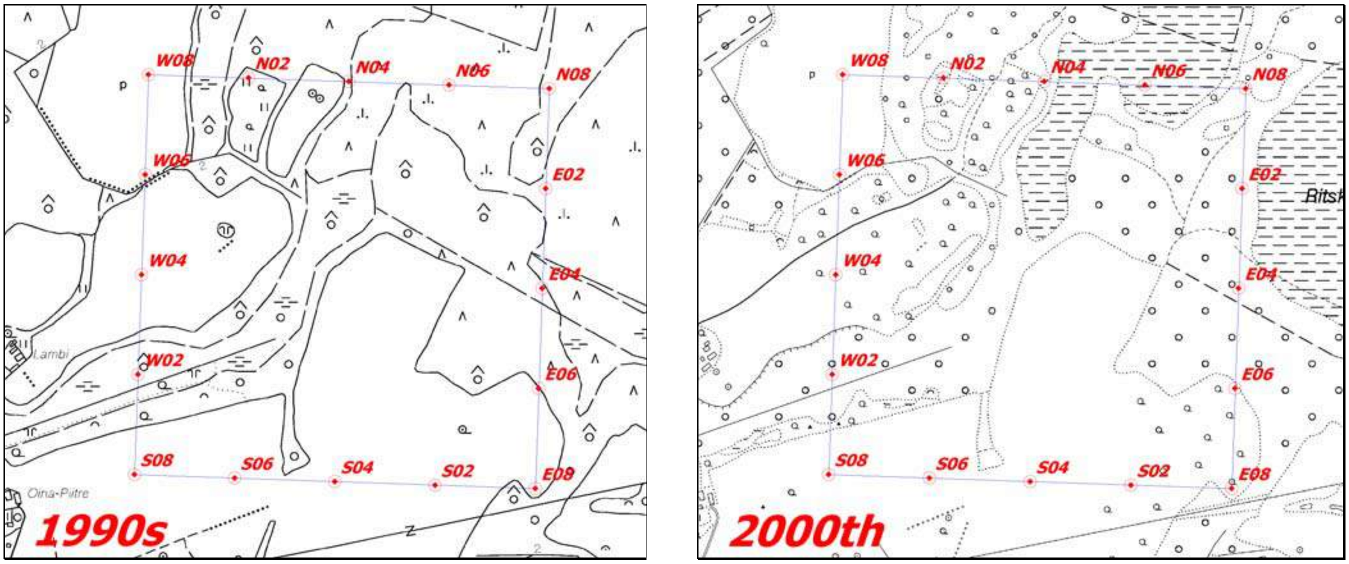

Figure 11.1. Base maps of 1990 and 2000

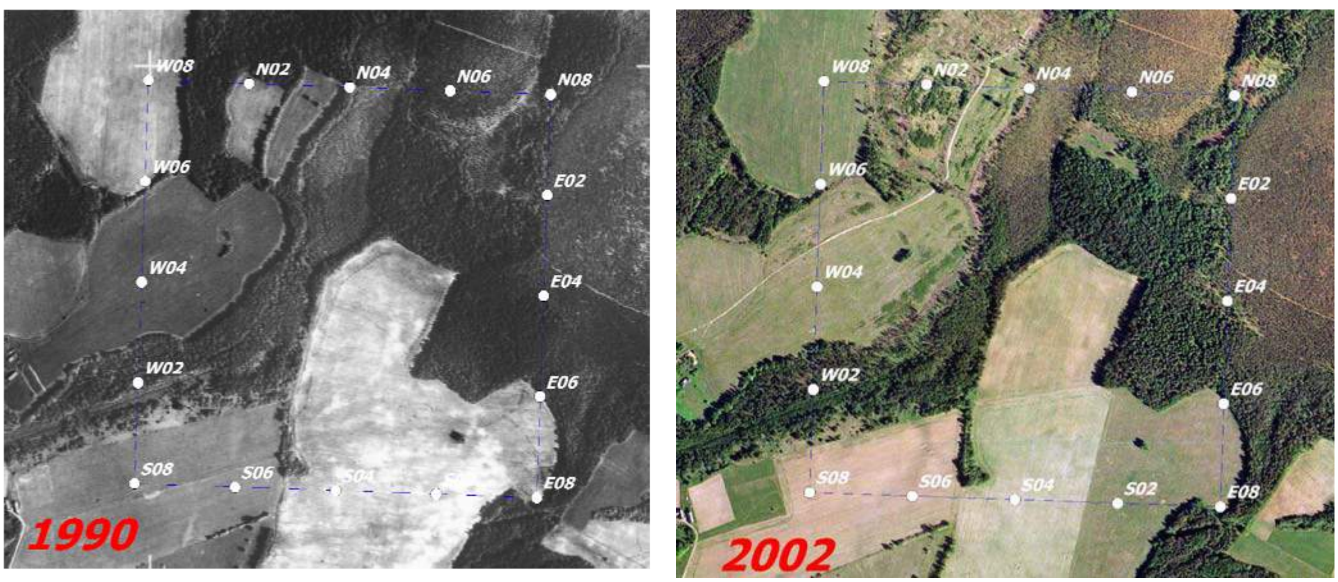

Figure 11.2. Ortophotos of 1990 and 2002

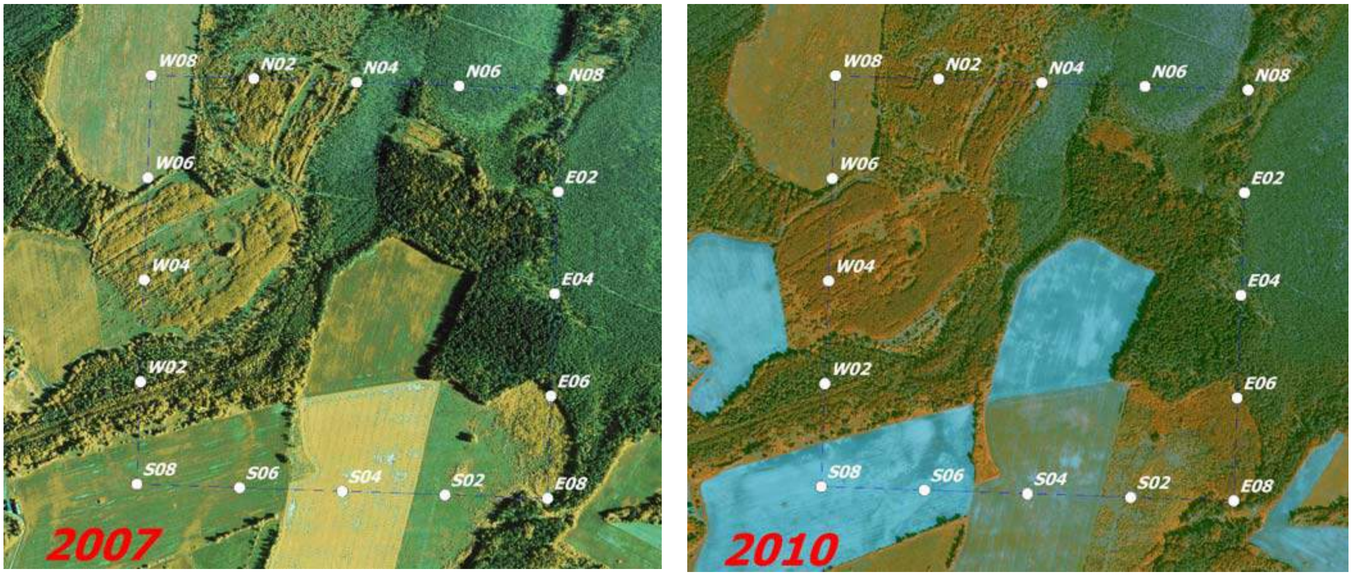

Figure 11.3. Ortophotos of 2007 and 2010

All permanent sample plots, that may also include detected land-use changes, are reinventoried in every 5 years (more information 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. In order to collect data about land-use transitions, NFI started additional field studies in 2009. Collected data provides information on different land-use classes (origins retrospectively 20 years), the year of changes and also soil type. During field inventory, "LULUCF former land category" is registered on every sample plot if the 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 land use matrix is compiled based on obtained NFI data.

In ARR2013 para.65, the the ERT encouraged the inclusion of a summary table consisting of a comparison matrix of the Convention and KP-LULUCF reporting areas for QA/QC purposes. Reported land-use changes under the Convention and respective ARD areas are presented in Table 11.2

The area of land-use changes under the Convention and Kyoto LULUCF reporting do not have a full match. Once the time period for UNFCCC reporting of converted lands has elapsed (i.e. 20 years) the land is reported in the land remaining category, whereas under Kyoto reporting, this displacement is not applied.

Table 11.2. Comparison of the Convention and KP-LULUCF cumulative areas

	the Convention		KP-LULUCF	
Land-use change	kha	%	kha	%
			Afforestation/reforestation	
Cropland→Forest Land	16.7	30%	19.1	65%
Grassland→Forest Land	22.0	40%		
Wetlands→ Forest Land	5.9	11%	6.2	21%
Settlements→ Forest Land	3.1	6%	3.8	13%
Other Land→ Forest Land	7.2	13%		
Total	54.8	100%	29.2	100%
			Deforestation	
Forest Land→Grassland	5.8	28%	5.9	29%
Forest Land→Wetlands	3.5	17%	3.6	17%
Forest Land→ Settlements	8.8	43%	8.8	42%
Forest Land→ Other Land	2.4	12%	2.4	12%
Total	20.5	100%	20.8	100%

11.2.3. Maps and/or database to identify the geographical locations, and the system of identification codes for 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 are used for reporting LULUCF under the KP as for reporting under UNFCCC.

The activity data subject to afforestation/reforestation and deforestation areas is presented in Table 11.3.

Table 11.3. Annual areas subject to afforestation/reforestation (AR) and deforestation (D) activities, ha (NFI)

Year	Afforestation/ Reforestation	Deforestation	Year	Afforestation/ Reforestation	Deforestation
1990	1 750	166	2002	1 047	788
1991	1 761	184	2003	932	1 045
1992	1 662	199	2004	1 063	1 351
1993	1 926	216	2005	1 009	1 887
1994	2 065	316	2006	933	2 227
1995	2 110	317	2007	909	2 200
1996	1 999	318	2008	735	2 330
1997	1 973	318	2009	525	2 079
1998	1 846	300	2010	392	1 389
1999	1 463	249	2011	331	1 130
2000	1 233	353	2012	322	989
2001	1 180	454	**Total**	**29 165**	**20 805**

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 methodology as under the UNFCCC reporting of land converted to Forest land. Activity data and growing stocks are obtained from the NFI.

Living biomass is calculated as follows, taking into account 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 11.5)

$\beta_{ij(u)}$ − $BCEF_S$ of tree species, tonnes m^{-3} (Table 11.4)

i − index of tree species (Table 11.4, Table 11.5)

$$j(u) = \begin{cases} 1, \textbf{\textit{if}}\ 0 \le u < 10 \\ 2, \textbf{\textit{if}}\ 11 \le u \le 16 \\ 3, \quad \textbf{\textit{if}}\ u > 16 \end{cases}$$

where

$j(u)$ − index of growing stock level by stand age (Table 11.6)

$$u = \sum_{k=1990}^{t}(t-k)$$

Table 11.4. $BCEF_S$ [t biomass/m^3 wood volume]

Species	Growing stock level [m^3/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 11.5. Distribution of main tree species and applied R ratio on AR areas

Main tree species	Proportion	Root-shoot ratio[232]
Pine	0.43	0.39
Spruce	0.53	0.39
Others (mainly birch)	0.05	0.46
Weighted average		0.39

Table 11.6. Input $BCEF_S$[233] for above-ground AR biomass calculations

Age of AR yr	Growing stock m^3/ha	$BCEF_S$ weighted average
1...6	< 20	1.17
7...13	21-50	0.67
14...22	51-100	0.58

Equation 7.2 and the same parameters as under 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 are calculated as under the Convention applying areas from Table 11.2 (Emission factors - AR: Table 7.12, D: Table 7.24, Table 7.28, Table 7.33, Table 7.36).

Carbon stock changes in litter and dead wood

Changes in the litter pool were estimated using the same approach as under land converted to Forest land for AR and Forest Land converted to other land uses for D. Applied litter emission factors can be found in Table 7.12 (AR) and Table 7.24, Table 7.28, Table 7.33, Table 7.36 (D).

[232] IPCC 2006, Vol 4 (AFOLU), Table 4.4, p. 4.49
[233] IPCC 2006, Vol 4 (AFOLU), Table 4.5, p. 4.50

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 after deforestation.

Dead wood on AR was reported as not occurring in previous submissions, since the NFI did not detect a significant amount of DW in afforestated/reforested lands. In ARR2013, para.77, ERT recommended that Estonia demonstrate that the pool is not a net source. Therefore, during forest inventory, the amount of dead wood present on AR lands was measured and carbon stocks changes were estimated following the methodology described in Chapter 7.2.2.3.

An overview of afforestation/reforestation and deforestation activities emissions and removals by carbon pools during the first Kyoto commitment period is presented in Figure 11.4 and Figure 11.5.

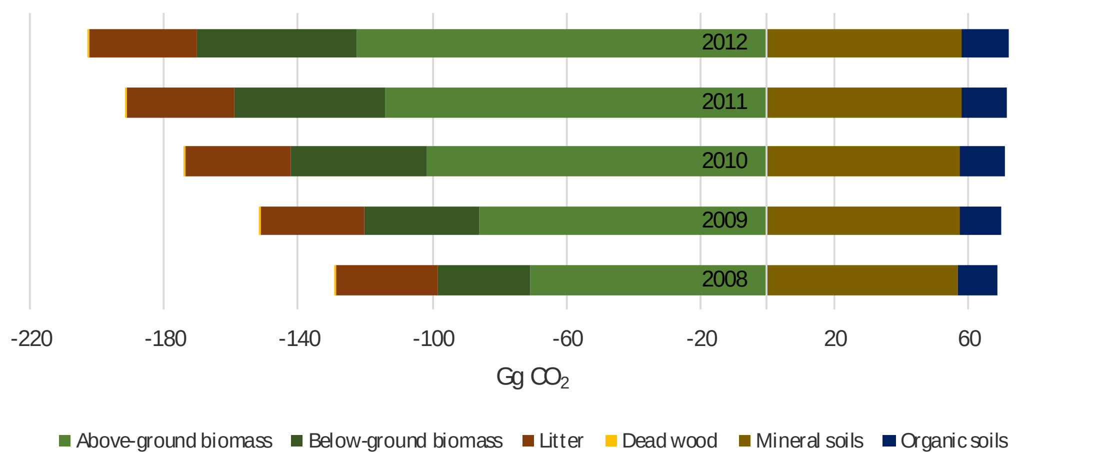

Figure 11.4. Afforestation/reforestation emissions (+) and removals (-) in 2008-2012, Gg CO_2

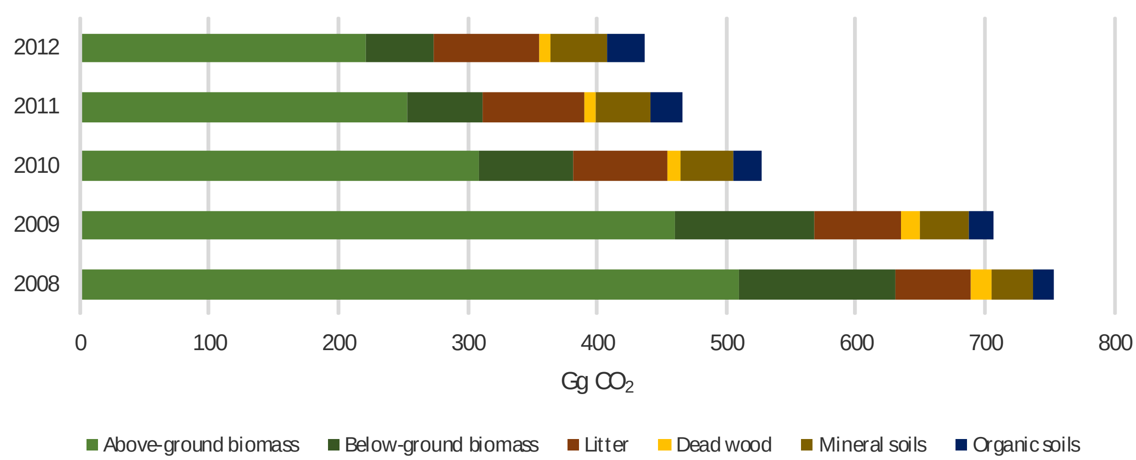

Figure 11.5. Deforestation emissions in 2008-2012, Gg CO_2

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 Chapter 7.8 Equation 7.15 and parameters indicated in Table 11.7 were used. Data regarding forest growing stock (biomass burnt) was obtained from the 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 [234]	CH_4 emission factor [235]	N_2O emission factor [236]
AR	0.76	9	0.11

Instant oxidation is assumed for all living biomass under deforestation, therefore it is reported that burning does not occur under D areas.

Other GHG emissions

Emissions from N fertilization and from lime applications are not estimated, for 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 2014 submission. Missing country-specific data is replaced with emission factors obtained from the Sweden 2013 submission. This approach has been approved by the ERT as an interim measure.

11.3.1.3. Information on whether or not indirect and natural GHG emissions and removals have been factored out

Estonia has not factored out emissions and removals from elevated carbon dioxide concentrations, indirect nitrogen deposition or the dynamic effects of the age structure. The IPCC does not give methods for factoring them out.

11.3.1.4. Changes in data and methods since the previous submission (recalculations)

Areas subject to afforestation/reforestation and deforestation are updated annually by NFI, new data is integrated to overall activity data. Carbon stock changes in the AR dead wood pool were estimated for the first time in the current submission.

[234] GPG-LULUCF 2003, Table 3A.1.12, p. 3.179, upper limit of All Boreal Forest, NFI expert opinion, EEIC.
[235] GPG-LULUCF 2003, Table 3A.1.16, p. 3.185, Forest fires (Delmas *et al.* (1995)).
[236] GPG-LULUCF 2003, Table 3A.1.16, p. 3.185, Forest fires (Delmas *et al.* (1995)).

In Table 10.3 and Table 10.4 an overview of the quantitative impact of ARD recalculations has been provided.

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.

Table 11.8. Uncertainties of ARD activities

IPCC Source Category		Uncertainties %		EF References
		Activity data[237]	Emission factors	
KP.A.1.1	Afforestation and Reforestation - living biomass	19.26	46.95	IPCC 2003 & 2006
KP.A.1.1	Afforestation and Reforestation - dead wood	91.00	12.89	Sandström *et al.* 2007
KP.A.1.1	Afforestation and Reforestation - litter	18.64	50.00	Sweden NIR 2013, Table 7.5, p. 296
KP.A.1.1	Afforestation and Reforestation - mineral soil	21.43	35.00	Sweden NIR 2013, Table 7.5, p. 296
KP.A.1.1	Afforestation and Reforestation - organic soil	37.98	35.00	Sweden NIR 2013, Table 7.5, p. 296
KP.A.1.1	Afforestation and Reforestation - biomass burning (CH_4)	22.09	70.00	LULUCF, 2003, p. 3.50
KP.A.1.1	Afforestation and Reforestation - biomass burning (N_2O)	22.09	70.00	LULUCF, 2003, p. 3.50
KP.A.2	Deforestation - living biomass	22.06	46.95	IPCC 2003 & 2006
KP.A.2	Deforestation - litter	25.69	50.00	Sweden NIR 2013, Table 7.5, p. 296
KP.A.2	Deforestation - dead wood	22.09	12.89	Sandström *et al.* 2007
KP.A.2	Deforestation - mineral soil	25.04	35.00	Sweden NIR 2013, Table 7.5, p. 296
KP.A.2	Deforestation - organic soil	46.72	35.00	Sweden NIR 2013, Table 7.5, p. 296

11.3.1.6. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for the LULUCF sector according to the IPCC *Tier 1* method. The activities are carried out every year during inventory. The QC check list is used during inventory.

According to ARR2013 para.65, a summary table consisting of a comparison matrix of the Convention and KP-LULUCF reporting areas has been added (Table 11.2) for QA/QC purposes in the current NIR.

ERT has recommended several times to verify the area of deforestation in Estonia[238], since detection of small and scattered events such as A/R or deforestation (D) may be underestimated due to the density of the NFI sampling grid (5km x 5km). In Table 11.9 the

[237] All activity data uncertainty estimates are obtained from NFI.
[238] ARR2013, para. 62 & para.79

comparison of deforestation areas and harvested (merchantable) volumes according to submitted harvesting permits and the NFI is shown.

The harvesting permits show on average 21% lower deforestation area and a 57% lower amount of deforested biomass compared to the NFI. The main reason is that harvesting permits do not represent realised activities, but only planned harvest and deforestation. It is also important to note that the definition of deforestation is not identical according to the forest notifications (i.e. harvesting permits) and the IPCC guidelines. In addition to forest land-use changes, clear-cuttings on grasslands, under powerlines and road ditches are sometimes regarded as deforestation according to the harvesting permits, which is an indication that the system of forest notifications, including harvesting permits is not unequivocal and transparent. Therefore, when reporting and accounting land use changes from Forest Land to other land-use categories and deforestation, NFI data is implemented. On the other hand, the NFI does not provide exact biomass loss on deforested areas, but the average growing stock of forest stands is the basis for calculating biomass loss due to deforestation, which may lead to overestimating of emissions.

Table 11.9. Comparison of deforestation area and harvested volume according to harvesting permits and the NFI

Deforestation	**area, ha**		**volume, m^3**	
year	harvesting permits	NFI	harvesting permits	NFI
2012	2 168	989	177 731	207 381
2011	2 460	1 130	231 493	236 148
2010	1 280	1 389	143 354	288 995
2009	1 567	2 079	145 284	429 359
2008	1 685	2 330	188 015	476 617
2007	1 398	2 200	171 593	445 243
2006	1 013	2 227	132 911	445 679
2005	593	1 887	75 207	374 313
2004	463	1 351	74 694	266 361
2003	874	1 045	119 338	205 780
2002	319	788	43 553	155 794
Total	**13 819**	**17 413**	**1 503 173**	**3 531 671**
Difference harv. permits/NFI (Σ2002-2012)	**21%**		**57%**	

11.3.1.7. Information on other methodological issues

A more accurate assessment of AR and D 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.

11.3.1.8. The year of the onset of an activity, if after 2008

Accounting of anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from land use, land-use change and forestry activities under Article 3.3 and 3.4, shall begin with the onset of the activity or the beginning of the commitment period, whichever comes later (*Marrakesh Accords*).

All 3.3 activities occurred before 2008, therefore the accounting of these activities began in 2008.

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 Chapter 11.2 – the cumulative sum of areas afforested/reforested and deforested since 1990.

11.4.1. Information that demonstrates that activities under KP.A.1.2 Units of land harvested since the beginning of the commitment period do not occur

In ARR2013, para. 78, the ERT identified that Estonia did not report units of land harvested in A/R activities since the beginning of the commitment period. Justifications are as follows:

- Rules of Forest Management (under the Forest Act) enacts harvest, reforestation/afforestation and forest protection activities. According to the Rules of Forest Management, clear-cutting is not allowed in stands with the dominant tree species (*Pinus sylvestris, Picea abies, Betula, Populus tremula, Alnus glutinosa* and hardwoods), when stand age is less than 30 … 130 years, depending on the site index class.
- Taking into account reasonable resources for tracking A/R units (NFI) and available data, there is no evidence of harvesting on A/R areas.
- Trees on A/R areas could be (a maximum of) 23 years old, hence it is not profitable (little stem volume) to harvest a forest of this age.

11.4.2. 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 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. The planting of new forest is the main human-induced reforestation activity directed towards the increase of forest area in Estonia. Afforestation activities have been implemented mainly on agricultural lands and exhausted quarries.

Changes in deforested areas are detected on NFI sample plots. The land-use category at the end of 1989 was assessed during field measurements, supporting maps and aerial photos were used where necessary.

11.4.3. Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

According to Estonian legislation, the land category change by humans is allowed only with orders from local authorities and/or the environmental minister. This must be preceded by the reassignment of the land (e.g. 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, the forest owner is obliged to implement reforestation techniques to the extent that within five years after logging or forest death a renewed forest is ensured. Re-establishment of a forest usually starts within 2 years after harvesting.

11.4.4. 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. Estonia did not elect any Article 3.4 activities for the first Kyoto commitment period.

11.6. Other information

The 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 to an 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 the 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 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_2014_1_11-27-54 13-1-2014.xls.

The SEF report for 2013 has been submitted to the UNFCCC Secretariat electronically and the contents of the report can 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 2013. Also the SEF includes information on transfers of the units during the year 2013.

12.2. Summary of information reported in the SEF tables

The total number of units in the NR at the beginning of the year 2013 was: 131 081 678 AAU, 3 758 479 ERU and 290 551 CER. In the end of the year the total balance of units was: 132 642 010 AAU, 2 463 976 ERU and 457 584 CER.

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 is also included in Estonian Standard Independent Assessment Report (hereinafter as SIAR) 2013 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 2013.

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/1170489 (selecting the headline "*Ühisrakendusprojektide ülevaade / JI projects overview*");

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 2012. This would mean that five times the emissions from the total inventory of 2012 will be lower, than 90% of the assigned amount. This would give an estimated commitment period reserve of **95 942 143 tonnes CO_2 equivalents.**

19 188 428.598 x 5 = 95 942 143 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.

Table 12.1. 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	2012	Total(6)		
	(Gg CO_2 equivalent)								
A. Article 3.3 activities									
A.1. Afforestation and Reforestation									-494,85
A.1.1. Units of land not harvested since the beginning of the commitment period(2)		-60,49	-81,29	-102,87	-119,69	-130,51	-494,85		-494,85
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		NA,NO
A.2. Deforestation		752,61	706,58	527,79	466,49	437,10	2 890,57		2 890,57
B. Article 3.4 activities									
B.1. Forest Management (if elected)		NA	NA	NA	NA	NA	NA		NA
3.3 offset(3)								2 395,72	NA
FM cap(4)								1 833,33	NA
B.2. Cropland Management (if elected)	0,00	NA	NA	NA	NA	NA	NA	0,00	0,00
B.3. Grazing Land Management (if elected)	0,00	NA	NA	NA	NA	NA	NA	0,00	0,00
B.4. Revegetation (if elected)	0,00	NA	NA	NA	NA	NA	NA	0,00	0,00

13. INFORMATION ON CHANGES IN NATIONAL SYSTEM

As a result of the merger of the Estonian Meteorological and Hydrological Institute (EMHI) and the Estonian Environment Information Centre (EEIC), the Estonian Environment Agency (EtEA) was formed in 2013. The agency is the legal successor to its predecessors. The Forest Monitoring Department of the Estonian Environment Agency is responsible for LULUCF ja KP LULUCF estimates.

For preparing the estimates of agriculture sector in the 2014 submission, Estonian Environmental Research Centre (EERC) did not subcontract Tallinn University of Technology (TUT).

14. INFORMATION ON CHANGES IN NATIONAL REGISTRY

Table 14.1. The following changes to the national registry of Estonia have occurred in 2013

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	No change of name or contact occurred during the reported period. National administrator is: Mr Mihkel Visnapuu khgregister@envir.ee tel. +372 6262 829
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	An updated diagram of the database structure is attached as Annex A. Iteration 5 of the national registry released in January 2013 and Iteration 6 of the national registry released in June 2013 introduces changes in the structure of the database. Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. However, each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex B). Annex H testing was carried out in February 2014 and the successful test report has been attached. No other change in the registry's conformance to the technical standards occurred for the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No change of security measures occurred during the reporting period
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex B. Annex H testing was carried out in February 2014 and the successful test report has been attached.

Table 14.2. Previous Annual Review recommendation and response

	Recommendation	**Response**
ARR 2013 para 87	The ERT concluded that, taking into account the confirmed changes in the national registry, including the additional information provided to the ERT during the review, Estonia's national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1 and continues to adhere to the technical standards for data exchange between registry systems in accordance with relevant decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP). With respect to the provision of information related to the database structure specifically, the ERT encourages the Party to provide additional information in the NIR. The ERT recommends that Estonia include all other additional information in response to the SIAR findings in its NIR in accordance with decision 15/CMP.1, annex, chapter I.G.	An updated diagram of the database structure is submitted together with the NIR. This separate document (Annex A – CSEUR_DB_model.pdf) shall not be published.

15. INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

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 12.11.2012 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. The decision was approved in April 2013 and as such it would cover obligations arising in respect of emissions in 2010, 2011 and 2012.

In October 2013 the ICAO Assembly agreed to develop a global MBM addressing international aviation emissions by 2016 and apply it by 2020. Until then countries or groups of countries, such as the EU, can implement interim measures. In response to the ICAO outcome and to give further momentum to the global discussions, the European Commission has proposed amending the EU ETS so that the requirements set out in Directive 2003/87/EC of the European Parliament and of the Council are temporarily considered as satisfied for the period until and including 2016 in respect of flights to and from aerodromes in countries outside the EEA.

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 2013.

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.

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 796 972 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.

Let’s do it! – World Cleanup 2012

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 Sixth 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 2012 excluding LULUCF
- Tier 2 level assessment year 2012 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 7 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
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	478.96	0.012	415.98%	0.049	0.298	0.298
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO_2	21 886.83	0.539	4.07%	0.022	0.133	0.431
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N_2O	394.80	0.010	85.59%	0.008	0.051	0.482
4.B	Manure Management - Solid Storage and Dry Lot	N_2O	303.38	0.007	103.56%	0.008	0.047	0.529
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CO_2	791.47	0.019	39.04%	0.008	0.046	0.575
4.A	Enteric Fermentation - Dairy Cattle	CH_4	583.68	0.014	50.99%	0.007	0.045	0.619
1.A.4.b	Other Sectors/Residential - Solid Fuels	CO_2	667.08	0.016	39.04%	0.006	0.039	0.658
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	CO_2	620.74	0.015	39.04%	0.006	0.036	0.695
4.D.2	Pasture, Range and Paddock Manure	N_2O	202.30	0.005	103.56%	0.005	0.031	0.726
4.A	Enteric Fermentation - Non-Dairy Cattle	CH_4	389.02	0.010	50.99%	0.005	0.030	0.756
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N_2O	247.95	0.006	80.00%	0.005	0.030	0.785
4.D.1.2	Direct Soil Emissions - Animal Manure Applied to Soils	N_2O	186.36	0.005	93.41%	0.004	0.026	0.811
6.A	Solid Waste Disposal on Land	CH_4	179.67	0.004	83.67%	0.004	0.022	0.834
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	CO_2	4 900.29	0.121	2.48%	0.003	0.018	0.852
6.B.1	Industrial Wastewater	CH_4	106.73	0.003	107.35%	0.003	0.017	0.869
4.D.3.1	Indirect Emissions - Atmospheric Deposition	N_2O	92.63	0.002	115.11%	0.003	0.016	0.885
4.D.1.5	Direct Soil Emissions - Cultivation of Histosols	N_2O	99.13	0.002	80.00%	0.002	0.012	0.897

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
5.A.1	Forest Land remaining Forest Land - living biomass	CO_2	-8 510.49	8 510.49	0.164	46.98%	0.077	0.331	0.331
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	478.96	478.96	0.009	415.98%	0.038	0.165	0.496
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO_2	21 886.83	21 886.83	0.421	4.07%	0.017	0.074	0.570
5.B.1	Cropland remaining Cropland - organic soils	CO_2	466.36	466.36	0.009	92.51%	0.008	0.036	0.606
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N_2O	394.80	394.80	0.008	85.59%	0.006	0.028	0.634

	IPCC Source Category	Gas	Emissions 1990	Absolute value	Lxt	Uxt	Tier 2 level assessment	Normalised Tier 2 level assessment	Cumulative total of column I
5.A.1	Forest Land remaining Forest Land - mineral soils	CO_2	-931.71	931.71	0.018	35.05%	0.006	0.027	0.661
4.B	Manure Management - Solid Storage and Dry Lot	N_2O	303.38	303.38	0.006	103.56%	0.006	0.026	0.687
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CO_2	791.47	791.47	0.015	39.04%	0.006	0.026	0.713
4.A	Enteric Fermentation - Dairy Cattle	CH_4	583.68	583.68	0.011	50.99%	0.006	0.025	0.737
1.A.4.b	Other Sectors/Residential - Solid Fuels	CO_2	667.08	667.08	0.013	39.04%	0.005	0.022	0.759
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	CO_2	620.74	620.74	0.012	39.04%	0.005	0.020	0.779
4.D.2	Pasture, Range and Paddock Manure	N_2O	202.30	202.30	0.004	103.56%	0.004	0.017	0.796
4.A	Enteric Fermentation - Non-Dairy Cattle	CH_4	389.02	389.02	0.007	50.99%	0.004	0.016	0.813
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N_2O	247.95	247.95	0.005	80.00%	0.004	0.016	0.829
5.B.1	Cropland remaining Cropland - mineral soils	CO_2	-354.20	354.20	0.007	50.08%	0.003	0.015	0.844
4.D.1.2	Direct Soil Emissions - Animal Manure Applied to Soils	N_2O	186.36	186.36	0.004	93.41%	0.003	0.014	0.858
5.A.1	Forest Land remaining Forest Land - organic soils	CO_2	479.39	479.39	0.009	35.26%	0.003	0.014	0.872
6.A	Solid Waste Disposal on Land	CH_4	179.67	179.67	0.003	83.67%	0.003	0.012	0.885
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	CO_2	4 900.29	4 900.29	0.094	2.48%	0.002	0.010	0.895
6.B.1	Industrial Wastewater	CH_4	106.73	106.73	0.002	107.35%	0.002	0.009	0.904

Table A.1.3. Tier 2 level assessment year 2012 excluding LULUCF

	IPCC Source Category	Gas	Emissions 2012	Lxt	Uxt	Tier 2 level assessment	Normalised Tier 2 level assessment	Cumulative total of column H
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	209.85	0.011	415.98%	0.045	0.268	0.268
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO_2	11 396.09	0.594	4.07%	0.024	0.142	0.410
6.A	Solid Waste Disposal on Land	CH_4	240.23	0.013	83.67%	0.010	0.062	0.472
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CO_2	396.91	0.021	39.04%	0.008	0.048	0.520
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N_2O	180.73	0.009	85.59%	0.008	0.047	0.567
1.A.4.b	Other Sectors/Residential - Biomass	CH_4	102.14	0.005	150.33%	0.008	0.047	0.614
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CO_2	352.89	0.018	39.04%	0.007	0.042	0.656
4.A	Enteric Fermentation - Dairy Cattle	CH_4	266.63	0.014	50.99%	0.007	0.042	0.698

	IPCC Source Category	Gas	Emissions 2012	Lxt	Uxt	Tier 2 level assessment	Normalised Tier 2 level assessment	Cumulative total of column H
4.B	Manure Management - Solid Storage and Dry Lot	N_2O	98.34	0.005	103.56%	0.005	0.031	0.729
4.D.2	Pasture, Range and Paddock Manure	N_2O	75.98	0.004	103.56%	0.004	0.024	0.754
4.D.1.2	Direct Soil Emissions - Animal Manure Applied to Soils	N_2O	81.06	0.004	93.41%	0.004	0.023	0.777
4.D.1.5	Direct Soil Emissions - Cultivation of Histosols	N_2O	88.18	0.005	80.00%	0.004	0.022	0.798
1.A.2	Manufacturing Industries and Constructions - Other Fuels	CO_2	115.35	0.006	60.21%	0.004	0.021	0.820
4.A	Enteric Fermentation - Non-Dairy Cattle	CH_4	133.35	0.007	50.99%	0.004	0.021	0.841
1.A.3.B	Road Transport - Liquid Fuels	CO_2	2 148.00	0.112	2.48%	0.003	0.016	0.857
4.D.3.1	Indirect Emissions - Atmospheric Deposition	N_2O	39.90	0.002	115.11%	0.002	0.014	0.871
1.A.1.a	Energy Industries/Electricity and Heat Production - Gaseous Fuels	CO_2	908.83	0.047	3.86%	0.002	0.011	0.882
6.B.2.2	Domestic and Commercial Wastewater - human sewage	N_2O	33.89	0.002	100.12%	0.002	0.010	0.892
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N_2O	40.05	0.002	80.00%	0.002	0.010	0.902

Table A.1.4. Tier 2 level assessment year 2012 including LULUCF

	IPCC Source Category	Gas	Emissions 2012	Absolute value	Lxt	Uxt	Tier 2 level assessment	Normalised Tier 2 level assessment	Cumulative total of column I
5.A.1	Forest Land remaining Forest Land - living biomass	CO_2	-2 240.46	2 240.46	0.088	46.98%	0.041	0.168	0.168
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	209.85	209.85	0.008	415.98%	0.034	0.139	0.307
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO_2	11 396.09	11 396.09	0.446	4.07%	0.018	0.074	0.382
5.B.1	Cropland remaining Cropland - organic soils	CO_2	402.01	402.01	0.016	92.51%	0.015	0.059	0.441
5.A.1	Forest Land remaining Forest Land - mineral soils	CO_2	-926.95	926.95	0.036	35.05%	0.013	0.052	0.493
5.C.1	Grassland remaining Grassland - living biomass	CO_2	423.29	423.29	0.017	47.95%	0.008	0.032	0.525
6.A	Solid Waste Disposal on Land	CH_4	240.23	240.23	0.009	83.67%	0.008	0.032	0.557
5.A.1	Forest Land remaining Forest Land - organic soils	CO_2	475.50	475.50	0.019	35.26%	0.007	0.027	0.584
5.B.1	Cropland remaining Cropland - mineral soils	CO_2	-312.10	312.10	0.012	50.08%	0.006	0.025	0.609
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CO_2	396.91	396.91	0.016	39.04%	0.006	0.025	0.634
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N_2O	180.73	180.73	0.007	85.59%	0.006	0.025	0.659
1.A.4.b	Other Sectors/Residential - Biomass	CH_4	102.14	102.14	0.004	150.33%	0.006	0.025	0.683

	IPCC Source Category	Gas	Emissions 2012	Absolute value	Lxt	Uxt	Tier 2 level assessment	Normalised Tier 2 level assessment	Cumulative total of column I
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CO_2	352.89	352.89	0.014	39.04%	0.005	0.022	0.705
4.A	Enteric Fermentation - Dairy Cattle	CH_4	266.63	266.63	0.010	50.99%	0.005	0.022	0.727
4.B	Manure Management - Solid Storage and Dry Lot	N_2O	98.34	98.34	0.004	103.56%	0.004	0.016	0.743
5.E.2	Land converted to Settlements - living biomass	CO_2	102.06	102.06	0.004	78.42%	0.003	0.013	0.756
4.D.2	Pasture, Range and Paddock Manure	N_2O	75.98	75.98	0.003	103.56%	0.003	0.013	0.768
4.D.1.2	Direct Soil Emissions - Animal Manure Applied to Soils	N_2O	81.06	81.06	0.003	93.41%	0.003	0.012	0.780
5.D.2.1	Forest Land converted to Wetlands - living biomass	CO_2	65.85	65.85	0.003	112.99%	0.003	0.012	0.792
4.D.1.5	Direct Soil Emissions - Cultivation of Histosols	N_2O	88.18	88.18	0.003	80.00%	0.003	0.011	0.804
1.A.2	Manufacturing Industries and Constructions - Other Fuels	CO_2	115.35	115.35	0.005	60.21%	0.003	0.011	0.815
4.A	Enteric Fermentation - Non-Dairy Cattle	CH_4	133.35	133.35	0.005	50.99%	0.003	0.011	0.826
5.C.2	Land converted to Grassland - mineral soils	CO_2	-151.73	151.73	0.006	37.71%	0.002	0.009	0.835
5.D.1	Wetlands remaining Wetlands\Peatland - organic soils managed for peat extraction	CO_2	99.53	99.53	0.004	54.93%	0.002	0.009	0.843
1.A.3.B	Road Transport - Liquid Fuels	CO_2	2 148.00	2 148.00	0.084	2.48%	0.002	0.008	0.852
5.E.2	Land converted to Settlements - soils	CO_2	120.18	120.18	0.005	42.61%	0.002	0.008	0.860
5.A.2.2	Grassland converted to Forest Land - living biomass	CO_2	-91.18	91.18	0.004	51.76%	0.002	0.008	0.868
4.D.3.1	Indirect Emissions - Atmospheric Deposition	N_2O	39.90	39.90	0.002	115.11%	0.002	0.007	0.875
5.A.1	Forest Land remaining Forest Land - dead wood	CO_2	-342.71	342.71	0.013	13.04%	0.002	0.007	0.882
5.C.1	Grassland remaining Grassland - organic soils	CO_2	114.27	114.27	0.004	38.85%	0.002	0.007	0.889
1.A.1.a	Energy Industries/Electricity and Heat Production - Gaseous Fuels	CO_2	908.83	908.83	0.036	3.86%	0.001	0.006	0.895
6.B.2.2	Domestic and Commercial Wastewater - human sewage	N_2O	33.89	33.89	0.001	100.12%	0.001	0.005	0.900

Table A.1.5. Tier 2 trend assessment excluding LULUCF

	IPCC Source Category	Gas	Emissions 1990	Emissions 2012	Txt	Uxt	Tier 2 trend assessment	Normalised Tier 2 trend assessment	Cumulative total of column I
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CO_2	65.20	396.91	0.040	39.04%	0.016	0.104	0.104
6.A	Solid Waste Disposal on Land	CH_4	179.67	240.23	0.017	83.67%	0.014	0.095	0.199
1.A.4.b	Other Sectors/Residential - Biomass	CH_4	33.67	102.14	0.010	150.33%	0.014	0.094	0.293
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	CO_2	620.74	0.00	0.032	39.04%	0.013	0.083	0.377
1.A.4.b	Other Sectors/Residential - Solid Fuels	CO_2	667.08	38.56	0.031	39.04%	0.012	0.079	0.456
1.A.2	Manufacturing Industries and Constructions - Other Fuels	CO_2	0.00	115.35	0.013	60.21%	0.008	0.051	0.506
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	478.96	209.85	0.002	415.98%	0.008	0.050	0.556
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N_2O	247.95	40.05	0.009	80.00%	0.007	0.045	0.601
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	CO_2	4 900.29	339.94	0.218	2.48%	0.005	0.036	0.637
6.B.1	Industrial Wastewater	CH_4	106.73	5.15	0.005	107.35%	0.005	0.035	0.672
4.B	Manure Management - Solid Storage and Dry Lot	N_2O	303.38	98.34	0.005	103.56%	0.005	0.034	0.706
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO_2	21 886.83	11 396.09	0.116	4.07%	0.005	0.031	0.737
4.D.1.5	Direct Soil Emissions - Cultivation of Histosols	N_2O	99.13	88.18	0.005	80.00%	0.004	0.024	0.761
1.A.3.B	Road Transport - Liquid Fuels	CO_2	2 236.11	2 148.00	0.120	2.48%	0.003	0.020	0.781
4.A	Enteric Fermentation - Non-Dairy Cattle	CH_4	389.02	133.35	0.006	50.99%	0.003	0.019	0.800
1.A.4.b	Other Sectors/Residential - Biomass	N_2O	6.63	20.10	0.002	150.33%	0.003	0.019	0.818
4.D.2	Pasture, Range and Paddock Manure	N_2O	202.30	75.98	0.002	103.56%	0.002	0.015	0.833
2.B.1	Ammonia Production	CO_2	420.05	24.88	0.019	11.18%	0.002	0.014	0.847
6.D	Biological Treatment	N_2O	0.63	13.77	0.001	100.50%	0.001	0.010	0.857
6.B.2.2	Domestic and Commercial Wastewater - human sewage	N_2O	45.84	33.89	0.001	100.12%	0.001	0.009	0.866
6.D	Biological Treatment	CH_4	0.57	12.44	0.001	100.50%	0.001	0.009	0.875
1.A.1.a	Energy Industries/Electricity and Heat Production - Biomass	N_2O	3.03	21.66	0.002	60.21%	0.001	0.009	0.884
2.F.1.2	Commercial Refrigeration	HFCs	0.00	50.12	0.006	22.36%	0.001	0.008	0.892
2.A.1	Cement Production	CO_2	483.04	407.44	0.020	5.39%	0.001	0.007	0.899

Table A.1.6. Tier 2 trend assessment including LULUCF

	IPCC Source Category	Gas	Emissions 1990	Emissions 2012	Absolute value (2012)	Txt	Uxt	Tier 2 trend assessment	Normalised Tier 2 trend assessment	Cumulative total of column I
5.A.1	Forest Land remaining Forest Land - living biomass	CO_2	-8 510.49	-2 240.46	2 240.46	0.254	46.98%	0.119	0.273	0.273
5.C.1	Grassland remaining Grassland - living biomass	CO_2	-144.61	423.29	423.29	0.054	47.95%	0.026	0.059	0.331
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	478.96	209.85	209.85	0.005	415.98%	0.022	0.051	0.382
5.A.1	Forest Land remaining Forest Land - mineral soils	CO_2	-931.71	-926.95	926.95	0.045	35.05%	0.016	0.036	0.418
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CO_2	65.20	396.91	396.91	0.039	39.04%	0.015	0.035	0.453
5.B.1	Cropland remaining Cropland - organic soils	CO_2	466.36	402.01	402.01	0.016	92.51%	0.015	0.034	0.487
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	CO_2	620.74	0.00	0.00	0.036	39.04%	0.014	0.032	0.519
1.A.4.b	Other Sectors/Residential - Solid Fuels	CO_2	667.08	38.56	38.56	0.035	39.04%	0.013	0.031	0.550
1.A.4.b	Other Sectors/Residential - Biomass	CH_4	33.67	102.14	102.14	0.009	150.33%	0.013	0.031	0.580
6.A	Solid Waste Disposal on Land	CH_4	179.67	240.23	240.23	0.015	83.67%	0.013	0.029	0.610
5.E.2	Land converted to Settlements - living biomass	CO_2	0.53	102.06	102.06	0.011	78.42%	0.009	0.020	0.629
5.A.1	Forest Land remaining Forest Land - organic soils	CO_2	479.39	475.50	475.50	0.023	35.26%	0.008	0.019	0.648
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N_2O	247.95	40.05	40.05	0.010	80.00%	0.008	0.018	0.666
1.A.2	Manufacturing Industries and Constructions - Other Fuels	CO_2	0.00	115.35	115.35	0.012	60.21%	0.007	0.017	0.683
4.B	Manure Management - Solid Storage and Dry Lot	N_2O	303.38	98.34	98.34	0.007	103.56%	0.007	0.017	0.700
5.D.2.1	Forest Land converted to Wetlands - living biomass	CO_2	22.01	65.85	65.85	0.006	112.99%	0.007	0.015	0.715
5.B.1	Cropland remaining Cropland - mineral soils	CO_2	-354.20	-312.10	312.10	0.013	50.08%	0.006	0.015	0.729
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	CO_2	4 900.29	339.94	339.94	0.248	2.48%	0.006	0.014	0.744
5.C.2	Land converted to Grassland - mineral soils	CO_2	-1.68	-151.73	151.73	0.016	37.71%	0.006	0.014	0.757
6.B.1	Industrial Wastewater	CH_4	106.73	5.15	5.15	0.006	107.35%	0.006	0.014	0.771
5.E.2	Land converted to Settlements - soils	CO_2	0.01	120.18	120.18	0.013	42.61%	0.005	0.013	0.784
5.A.2.2	Grassland converted to Forest Land - living biomass	CO_2	-0.64	-91.18	91.18	0.010	51.76%	0.005	0.011	0.795
4.A	Enteric Fermentation - Non-Dairy Cattle	CH_4	389.02	133.35	133.35	0.008	50.99%	0.004	0.010	0.805
4.D.2	Pasture, Range and Paddock Manure	N_2O	202.30	75.98	75.98	0.004	103.56%	0.004	0.009	0.813
5.A.1	Forest Land remaining Forest Land - dead wood	CO_2	-156.43	-342.71	342.71	0.028	13.04%	0.004	0.008	0.822
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid	CO_2	791.47	352.89	352.89	0.008	39.04%	0.003	0.007	0.829

	IPCC Source Category	Gas	Emissions 1990	Emissions 2012	Absolute value (2012)	Txt	Uxt	Tier 2 trend assessment	Normalised Tier 2 trend assessment	Cumulative total of column I
	Fuels									
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N_2O	394.80	180.73	180.73	0.004	85.59%	0.003	0.007	0.836
4.D.1.5	Direct Soil Emissions - Cultivation of Histosols	N_2O	99.13	88.18	88.18	0.004	80.00%	0.003	0.007	0.843
4.A	Enteric Fermentation - Dairy Cattle	CH_4	583.68	266.63	266.63	0.005	50.99%	0.003	0.006	0.849
5.D.1	Wetlands remaining Wetlands\Peatland - organic soils managed for peat extraction	CO_2	99.31	99.53	99.53	0.005	54.93%	0.003	0.006	0.855
1.A.4.b	Other Sectors/Residential - Biomass	N_2O	6.63	20.10	20.10	0.002	150.33%	0.003	0.006	0.861
1.A.3.B	Road Transport - Liquid Fuels	CO_2	2 236.11	2 148.00	2 148.00	0.100	2.48%	0.002	0.006	0.867
2.B.1	Ammonia Production	CO_2	420.05	24.88	24.88	0.022	11.18%	0.002	0.006	0.872
5.B.2.2	Grassland converted to Cropland - mineral soils	CO_2	0.00	47.42	47.42	0.005	44.77%	0.002	0.005	0.877
5.B.2.2	Grassland converted to Cropland - organic soils	CO_2	0.00	12.80	12.80	0.001	165.24%	0.002	0.005	0.883
5.A.2.1	Cropland converted to Forest Land - mineral soil	CO_2	3.75	52.24	52.24	0.005	42.01%	0.002	0.005	0.888
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO_2	21 886.83	11 396.09	11 396.09	0.050	4.07%	0.002	0.005	0.893
4.D.1.2	Direct Soil Emissions - Animal Manure Applied to Soils	N_2O	186.36	81.06	81.06	0.002	93.41%	0.002	0.005	0.897
5.C.1	Grassland remaining Grassland - organic soils	CO_2	128.86	114.27	114.27	0.005	38.85%	0.002	0.004	0.901

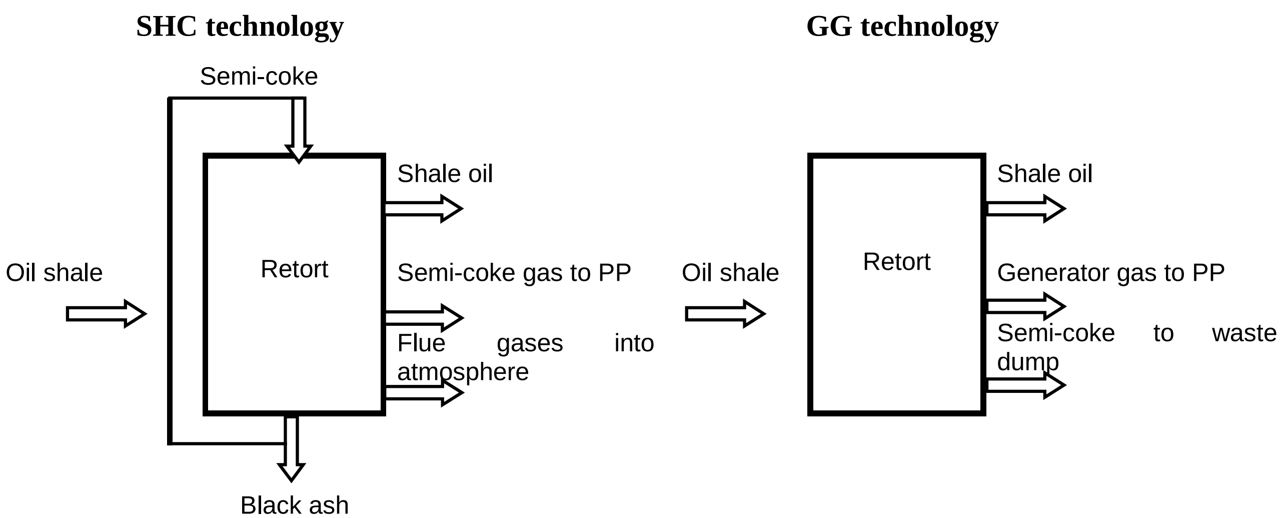
Annex 2. Detailed discussion of methodology and data for estimating CO_2 emissions from fossil fuel combustion

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	10.290	12/44	1.964	0.202	2.806	4.128		0.00
H_2S	2.970		1.520	0.045	0.000	0.000	23.384	0.69
N_2	3.270		1.257	0.041	0.000	0.000		0.00
O_2	0.240		1.428	0.003	0.000	0.000		0.00
CO	9.680	12/28	1.250	0.121	4.149	3.884	12.636	1.22
H_2	15.370		0.090	0.014	0.000	0.000	10.798	1.66
CH_4	14.440	12/16	0.720	0.104	10.830	5.841	35.82	5.17
C_2H_6	9.270	24/30	1.340	0.124	7.416	7.443	63.751	5.91
C_2H_4	9.810	24/28	1.250	0.123	8.409	7.873	59.066	5.79
C_3H_8	3.600	36/44	1.970	0.071	2.945	4.346	91.256	3.29
C_3H_6	7.690	36/42	1.880	0.145	6.591	9.282	86.005	6.61
C_4H_{10}	1.600	48/58	2.590	0.041	1.324	2.569	118.651	1.90
$C_4H_8+C_4H_6$	5.020	48/56	2.500	0.126	4.303	8.057	113.514	5.70
C_5H_{12}	1.540	60/72	3.220	0.050	1.283	3.095	146.084	2.25
C_5H_{10}	0.000	60/70	3.120	0.000	0.000	0.000	140.78	0.00
C_4H_8	5.020	48/56	2.503	0.126	4.303	8.067	113.514	5.70
Total	**99.810**			**1.335**		**64.585**		**45.898**

The carbon emission factor from semi-coke gas combustion can be calculated by the following formula:

$$q_{c\ scg} = 10\ (12/16 \text{ x } CH_4 + 24/30 \text{ x } C_2H_6 + 24/28 \text{ x } C_2H_4 + 36/44 \text{ x } C_3H_8 + 36/42 \text{ x } C_3H_6 + 48/58 \text{ x } C_4H_{10} + 48/56 \text{ x } C_4H_8 + 60/72 \text{ x } C_5H_{12} + 60/70 \text{ x } C_5H_{10} + 72/82 \text{ x } C_6H_{10} + 12/44 \text{ x } CO_2 + 12/28 \text{ x } CO)/Q^{r'}_{scg},\ tC/TJ, \quad (1)$$

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: = **45.898 MJ/Nm^3**,
ρ_{scg} – density of semi-coke gas 1.335 kg/Nm^3 and
$Q^{r'}_{scg} = Q^r_{sg/}\ \rho_{sg}$ = 45.898/1.335 = 34.378 **MJ/kg.**

The carbon emission factor of Narva semi-coke gas:

$$q_{c\ scg} = 10 \text{ x } C_{\Sigma\ /}\ Q^{r'}_{scg} = 10 \text{ x } 64.585/34.378 = \mathbf{18.787\ tC/TJ}$$

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	8.440	12/44	1.964	0.166	2.302	3.546		0.000
H_2S	1.980		1.520	0.030	0.000	0.000	23.384	0.463
N_2	7.450		1.257	0.094	0.000	0.000		0.000
O_2	0.150		1.428	0.002	0.000	0.000		0.000
CO	10.270	12/28	1.250	0.128	4.401	4.316	12.636	1.298
H_2	15.830		0.090	0.014	0.000	0.000	10.798	1.709
CH_4	16.330	12/16	0.720	0.118	12.248	6.918	35.82	5.849
C_2H_6	8.280	24/30	1.340	0.111	6.624	6.963	63.751	5.279
C_2H_4	11.380	24/28	1.250	0.142	9.754	9.565	59.066	6.722
C_3H_8	2.720	36/44	1.970	0.054	2.225	3.439	91.256	2.482
C_3H_6	6.900	36/42	1.880	0.130	5.914	8.722	86.005	5.934
C_4H_{10}	1.060	48/58	2.590	0.027	0.877	1.782	118.651	1.258
C_4H_8+ C_4H_6	4.900	48/56	2.500	0.123	4.200	8.237	113.514	5.562
C_5H_{12}	2.152	60/72	3.220	0.069	1.793	4.530	146.084	3.144
C_5H_{10}	2.152	60/70	3.120	0.067	1.845	4.515	140.78	3.030
C_6H_{10}		72/82	3.210	0.000	0.000	0.000	141.571	0.000
Total	**99.994**			**1.275**		**62.534**		**42.730**

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: = **42.730 MJ/Nm^3**,
ρ_{scg} – density of semi-coke gas 1.275kg/Nm^3 and
$Q^{r'}_{scg}$ = $Q^r_{sg/}$ ρ_{sg} = 42.730/1.275 = **33.520 MJ/kg.**

The carbon emission factor of VKG semi-coke gas:

$q_{c\ scg}$ = 10 x $C_{\Sigma\ /}$ $Q^{r'}_{scg}$ = 10 x 62.534/33.520 = **18.656 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	2.260	12/44	1.964	0.044	0.616	0.987		0.000
H_2S	3.450		1.520	0.052	0.000	0.000	23.384	0.807
N_2	18.380		1.257	0.231	0.000	0.000		0.000
O_2	0.270		1.428	0.004	0.000	0.000		0.000
CO	11.710	12/28	1.250	0.146	5.019	5.116	12.636	1.480
H_2	15.060		0.090	0.014	0.000	0.000	10.798	1.626
CH_4	13.860	12/16	0.720	0.100	10.395	6.103	35.82	4.965
C_2H_6	7.630	24/30	1.340	0.102	6.104	6.670	63.751	4.864
C_2H_4	10.000	24/28	1.250	0.125	8.571	8.737	59.066	5.907
C_3H_8	2.440	36/44	1.970	0.048	1.996	3.207	91.256	2.227
C_3H_6	6.110	36/42	1.880	0.115	5.237	8.029	86.005	5.255
C_4H_{10}	1.020	48/58	2.590	0.026	1.749	3.693	118.651	1.210
C_4H_8+ C_4H_6	4.620	48/56	2.500	0.116	3.960	8.073	113.514	5.244
C_5H_{12}	3.190	60/72	3.220	0.103	2.658	6.980	146.084	4.660
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	**100.000**			**1.226**		**57.597**		**38.244**

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: = **38.244 MJ/Nm^3**,
ρ_{scg} – density of semi-coke gas 1.226 kg/Nm^3 and
$Q^{r'}_{scg} = Q^r_{sg}/\rho_{sg}$ = 38.244/1.226 = 31.188 **MJ/kg.**

The carbon emission factor of Kiviõli semi-coke gas:

$$q_{c\ scg} = 10 \times C_\Sigma / Q^{r'}_{scg} = 10 \times 57.597/31.188 = \mathbf{18.468\ tC/TJ}$$

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	16.550	12/44	1.964	0.325	4.514	6.840		0.000
H_2S	0.500		1.520	0.008	0.000	0.000	23.38	0.117
N_2	65.440		1.257	0.823	0.000	0.000		0.000
O_2	1.340		1.428	0.019	0.000	0.000		0.000
CO	6.230	12/28	1.250	0.078	2.670	2.575	12.64	0.787
H_2	6.670		0.090	0.006	0.000	0.000	10.80	0.720
C_mH_n (C_2H_4)	3.020	24/28	1.250	0.038	2.589	2.497	59.07	1.784
Total	**99.750**			**1.296**		**11.912**		**3.409**

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: = **3.409 MJ/Nm^3**,
ρ_{gg} – density of generator gas 1.296 kg/Nm^3 and
$Q^{r'}_{gg} = Q^r_{sg/}\ \rho_{sg}$ = 3.409/1.296 = **2.630 MJ/kg.**

The carbon emission factor of VKG generator gas:

$$q_{c\ gg} = 10 \text{ x } C_{\Sigma\ /}\ Q^{r'}_{scg} = 10 \text{ x } 11.912/2.630 = \mathbf{45.291\ tC/TJ}$$

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	17.350	12/44	1.964	0.341	4.732	7.049		0.000
H_2S	0.510		1.520	0.008	0.000	0.000	23.384	0.119
N_2	68.340		1.257	0.859	0.000	0.000		0.000
O_2	1.860		1.428	0.027	0.000	0.000		0.000
CO	3.670	12/28	1.250	0.046	1.573	1.491	12.636	0.464
H_2	9.680		0.090	0.009	0.000	0.000	10.798	1.045
CH_4	1.480	12/16	0.720	0.011	1.110	0.606	35.82	0.530
C_2H_6	0.280	24/30	1.340	0.004	0.224	0.228	63.751	0.179
C_2H_4	0.530	24/28	1.250	0.007	0.454	0.431	59.066	0.313
C_3H_8	0.090	36/44	1.970	0.002	0.074	0.110	91.256	0.082
C_3H_6	0.190	36/42	1.880	0.004	0.163	0.232	86.005	0.163
C_4H_{10}	0.040	48/58	2.590	0.001	0.069	0.135	118.651	0.047
$C_4H_8+C_4H_6$	0.090	48/56	2.500	0.002	0.077	0.146	113.514	0.102
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	**104.110**			**1.318**		**10.428**		**3.045**

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: = **3.045 MJ/Nm³**,
ρ_{gg} – density of generator gas 1.318 kg/Nm^3 and
$Q^{r'}_{gg} = Q^r_{sg/}\ \rho_{sg}$ = 3.045/1.318 = **2.310 MJ/kg.**

The carbon emission factor of Kiviõli generator gas:

$$q_{c\ gg} = 10 \times C_{\Sigma\ /}\ Q^{r'}_{gg} = 10 \times 10.428/2.310 = \mathbf{45.149\ tC/TJ}$$

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 SHC	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
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	429
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	13.07
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**	**2012**
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	3 055	3 348	3 485
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	93.14	102.09	106.25
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	167.92
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	5.12
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**	**2012**
Semi-coke to landfill	TJ	1 618	1 468	1 361	1 463	1 223	1 306	1 375	1 480	1 089	105	1 253	1 227	1 337	1 305	968	636	458	406	196	287	327	199	291
Carbon stored with semi-coke	Gg	49.34	44.75	41.49	44.59	37.29	39.83	41.93	45.11	33.22	3.21	38.20	37.40	40.76	39.79	29.52	19.39	13.96	12.37	5.99	8.75	9.97	6.06	8.86
Kiviõli 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	5.01	11.10	7.52
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	0.15	0.34	0.23

Total carbon stored with semi-coke

	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
Oil Shale Total	TJ	5 462	4 861	4 376	5 346	3 419	5 084	4 761	5 130	4 159	2 028	3 693	
Carbon stored with semi-coke and black ash	Gg	166.54	148.21	133.40	162.98	104.24	155.00	145.16	156.39	126.78	61.83	112.58	
		2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Oil Shale Total	TJ	4 928	4 070	4 142	4 017	4 138	3 629	3 368	3 140	3 151	3 842	4 091	4 380
Carbon stored with semi-coke and black ash	Gg	150.25	124.08	126.29	122.48	126.17	110.65	102.68	95.74	96.06	117.13	124.72	133.53

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	2012
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**	**151.93**	**139.66**
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	139.45	126.55
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	1.49
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	0.33
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	0.21
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	1.74
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	4.13
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	3.32
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	1.89
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	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**	**42.18**	**42.33**	**42.67**	**42.73**	**44.76**	**41.89**	**38.91**	**41.19**	**41.58**	**42.18**
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	0.04
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	0.32
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	10.91
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	25.32
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	0.40
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	0.05
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	2.61
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	2.53
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**	**21.64**
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	21.64
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**	**1.45**
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	0.16
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	0.00

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
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	1.30
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**	**34.29**
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	34.01
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	0.15
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	0.12

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	2012
Solid Fuels	24.074	21.865	17.510	13.209	13.752	12.766	13.106	12.775	11.254	10.530	10.553	10.335	10.013	11.793	11.702	10.989	10.355	13.054	11.813	9.788	13.099	13.665	12.187
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	12.320	10.851
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	0.156
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	0.033
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	0.020
Coal	0.889	0.861	0.544	0.280	0.209	0.240	0.268	0.230	0.175	0.186	0.219	0.283	0.154	0.114	0.149	0.144	0.181	0.337	0.341	0.224	0.155	0.180	0.166
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	0.259	0.283
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	0.549
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	0.130
Coke	0.043	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	0.000
Liquid Fuels	9.168	8.351	4.642	4.514	4.376	3.499	3.726	3.609	3.599	3.251	2.647	3.088	3.186	3.103	3.111	3.109	3.094	3.239	3.036	2.828	3.013	3.039	3.079
Heavy fuel oil	5.263	4.788	2.088	2.228	1.819	1.120	1.223	1.016	1.051	0.854	0.290	0.259	0.185	0.094	0.052	0.039	0.017	0.020	0.015	0.015	0.017	0.005	0.003
Light fuel oil	0.374	0.274	0.118	0.064	0.054	0.071	0.125	0.145	0.165	0.199	0.237	0.362	0.350	0.348	0.321	0.297	0.189	0.213	0.208	0.159	0.153	0.030	0.023
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	0.785
Diesel oil	1.789	1.740	1.054	0.971	1.048	0.952	1.041	1.035	1.109	0.928	0.912	1.038	1.296	1.335	1.427	1.508	1.622	1.758	1.570	1.507	1.709	1.758	1.853
LPG	0.103	0.095	0.035	0.022	0.031	0.021	0.022	0.023	0.025	0.021	0.021	0.024	0.017	0.019	0.019	0.020	0.018	0.022	0.023	0.018	0.023	0.021	0.026
Aviation Gasoline	0.006	0.006	0.002	0.004	0.003	0.004	0.003	0.004	0.003	0.003	0.002	0.002	0.003	0.002	0.003	0.002	0.001	0.001	0.002	0.002	0.002	0.003	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	0.200
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	0.186
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	1.190
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	0.115
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	0.011
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	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	0.104

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	2012
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**	**4.532**	**25.214**
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	0.905	21.912
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	0.937
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	0.205
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	0.205
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	1.797
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	0.157
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	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**	**5.200**
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	0.002
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	0.048
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	3.286
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	1.430
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	0.040
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	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	0.168
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	0.222
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**	**0.884**
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**	**113.811**
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	113.799
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	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	0.003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
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**	**0.916**
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	0.098
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	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	0.818

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	2012
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**	**11.954**	**10.443**
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	8.111	6.711
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	1.845
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	0.404
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	0.262
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	0.990
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	0.231
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	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**	**44.271**	**45.120**	**43.227**	**37.886**	**38.616**	**37.120**	**40.734**	**42.681**	**44.060**	**52.925**
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	0.007
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	0.873	0.808	0.745	0.476	0.536	0.522	0.399	0.383	0.076	0.059
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	13.611
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	38.245
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	0.012
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	0.034
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	0.486
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	0.471
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**	**0.671**
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**	**42.209**
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	42.209
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	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	0.000
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**	**1.802**
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	0.193
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	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	1.610

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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**	**2012**
Fuel Consumption, TJ	1085.1	1044.9	683.2	522.5	683.2	442.1	482.3	361.7	401.9	281.3	361.7	321.5	241.1	281.3	241.1	160.8	160.8	281.3	201.0	160.8	160.8	129.3	120.6
Fraction of C 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	0.5
CEF, tC/TJ	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
C stored, Gg	10.9	10.4	6.8	5.2	6.8	4.4	4.8	3.6	4.0	2.8	3.6	3.2	2.4	2.8	2.4	1.6	1.6	2.8	2.0	1.6	1.6	1.3	1.2
CO_2 not emitted, Gg	39.8	38.3	25.1	19.2	25.1	16.2	17.7	13.3	14.7	10.3	13.3	11.8	8.8	10.3	8.8	5.9	5.9	10.3	7.4	5.9	5.9	4.7	4.4
Bitumen	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Fuel Consumption, TJ	2170.3	1848.7	964.6	1245.9	1366.5	844.0	1125.3	1044.9	1286.1	1286.1	1366.5	1125.3	2732.9	2049.7	2652.5	3657.3	4220.0	4099.4	3697.5	3416.2	3054.4	2692.7	2411.4
Fraction of C 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	1.0
CEF, tC/TJ	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
C stored, Gg	47.7	40.7	21.2	27.4	30.1	18.6	24.8	23.0	28.3	28.3	30.1	24.8	60.1	45.1	58.4	80.5	92.8	90.2	81.3	75.2	67.2	59.2	53.1
CO_2 not emitted, Gg	175.1	149.1	77.8	100.5	110.2	68.1	90.8	84.3	103.7	103.7	110.2	90.8	220.5	165.3	214.0	295.0	340.4	330.7	298.3	275.6	246.4	217.2	194.5
Natural Gas	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Fuel Consumption, TJ	7657.0	7361.0	3665.0	1440.0	4736.0	4978.0	4930.0	4859.0	4899.0	4674.0	4166.0	4459.0	1152.0	2413.0	4533.0	4915.0	4919.0	4715.0	4872.0	538.0	0.0	0.0	448.0
Fraction of C 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	1.0
CEF, tC/TJ	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1	15.1
C stored, Gg	115.4	110.9	55.2	21.7	71.4	75.0	74.3	73.2	73.8	70.4	62.8	67.2	17.4	36.4	68.3	74.1	74.1	71.1	73.4	8.1	0.0	0.0	6.8
CO_2 not emitted, Gg	423.1	406.7	202.5	79.6	261.7	275.1	272.4	268.5	270.7	258.3	230.2	246.4	63.7	133.3	250.5	271.6	271.8	260.5	269.2	29.7	0.0	0.0	24.8
Oil Shale	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Fuel Consumption, TJ	5462.4	4861.4	4375.5	5345.6	3419.0	5084.1	4761.3	5129.7	4158.5	2028.1	3692.7	4928.3	4070.0	4142.4	4017.3	4138.4	3629.4	3367.8	3140.3	3150.6	3841.7	4090.7	4379.9
Fraction of C 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	1.0
CEF, tC/TJ	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
C stored, Gg	166.5	148.2	133.4	163.0	104.2	155.0	145.2	156.4	126.8	61.8	112.6	150.3	124.1	126.3	122.5	126.2	110.7	102.7	95.7	96.1	117.1	124.7	133.5
CO_2 not emitted, Gg	610.6	543.4	489.1	597.6	382.2	568.3	532.3	573.4	464.9	226.7	412.8	550.9	455.0	463.1	449.1	462.6	405.7	376.5	351.0	352.2	429.5	457.3	489.6

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
2012	13 328 084	0.5090	44/12	24 876 114	24.876

A.3.3. Agriculture

APPENDIX A.3.3_I. LIVESTOCK POPULATION IN ESTONIA IN 1990–2012

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															

	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												
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**
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	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													
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				
					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
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				
					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
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					
				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
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					
		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
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)

	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
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			heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other	bulls	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					
				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
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			heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other	bulls	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)

		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
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: piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	fattening pigs: total	of which, live weight: 50–80 kg	80–110 kg	more than 110 kg	breeding pigs, live weight more than 50 kg: boars	sows: total	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

Table A.3.3_I.30. Number of cattle in 2012 by counties of Estonia, 1000 heads (SE, 2013)

	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
2012	246	96.8	15.4	2.6	16.2	1.2	15	6.7	42.8	1.4	41.4	65.5	3.1	44.3	18.1
No distribution by county	1.3	0.5	0.1	0.1	0.1	0	0.1	0	0.2	0	0.2	0.3	0	0.2	0.1
Harju	13,5	5,1	0.9	0,2	1,3	0,1	1,2	0,5	2,2	0,1	2.1	3.3	0,1	2.1	1.1
Hiiu	4,5	0,6	1,2	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	5,8	2,2	0,5	0,1	0,3	0	0,3	0,2	1	0,2	0,8	1,5	0	1	0,5
Jõgeva	23,3	10	0,6	0,1	1,2	0,1	1,1	0,2	4,5	0,2	4,3	6,7	0,3	4.1	1,7
Järva	29	13,6	0,5	0	1,5	0	1,5	0,4	5,6	0,1	5,5	7,4	0,3	5.7	1,5
Lääne	12,1	3,1	2	0,3	1,1	0,4	0,7	0,5	1,9	0,1	1,8	3,2	0,2	1.8	1,1
Lääne-Viru	27,9	11,5	1,3	0,2	1,9	0,1	1,8	0,7	4,9	0,1	4,8	7,4	0,2	5.1	1,9
Põlva	14,8	6,4	0,4	0,1	0,8	0,1	0,7	0,4	2,8	0	2,8	3,9	0,2	2.5	0,9
Pärnu	24,9	9,5	1,6	0,2	1,9	0	1,9	0,6	4,5	0,1	4,4	6,6	0,4	4	1,6
Rapla	17,7	6,4	1,5	0,3	1,3	0,3	1	0,7	2,9	0,2	2,7	4,6	0,3	3	1,4
Saare	17,8	5,9	2	0,2	1,6	0	1,6	0,7	2,9	0,1	2,8	4,5	0,2	2.8	1,3
Tartu	16,2	7,4	0,2	0,2	0,7	0	0,7	0,2	3	0	3	4,5	0,4	3.1	1,1
Valga	10,9	3,7	0,8	0,1	0,6	0	0,6	0,5	1,8	0	1,8	3,4	0,3	1.6	1,2
Viljandi	17,6	7,7	0,9	0,3	1,1	0	1,1	0,5	2,7	0	2,7	4,4	0,2	2.9	1,2
Võru	8,7	3,2	0,9	0,1	0,5	0	0,5	0,3	1,3	0,1	1,2	2,4	0	1.5	0,9

Table A.3.3_I.31. Swine population size in 2012 by counties of Estonia, 1000 heads (SE, 2013)

		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
2012	375.1	125.6	94.4	120.2	68.5	48.4	3.3	0.6	34.3	26.3	4.8	8	4.3
No distribution by county	11.4	2.1	3.9	3.7	3.3	0.4	0	0	1.7	1.1	0.2	0.6	0
Harju	23.4	3.8	5.6	12.5	8.9	3.1	0,5	0	1.5	1.1	0.1	0.4	0.2
Hiiu	0	0	0	0	0	0,9	0	0	0	0	0	0	0
Ida-Viru	3,5	0,4	0,9	1,9	0,8	3,7	0,2	0	0,3	0,3	0	0	0
Jõgeva	53,8	10,3	20,1	17,4	13,4	0,1	0,3	0,1	5,9	3,8	1,1	2,1	1,2
Järva	3,6	1,7	0,2	1,3	1,2	.	0	0	0,4	0,4	0	0	0
Lääne	.	.	.	.	.	10,4	.	.	.	.	.	.	.
Lääne-Viru	65,1	17,2	20,6	21,7	11	1,4	0,3	0,1	5,5	4,1	0,9	1,4	0,4
Põlva	8,1	2,4	2	3,1	1,1	1,6	0,6	0	0,6	0,4	0	0,2	0
Pärnu	7,2	2,1	1,1	3,4	1,7	.	0,1	0,1	0,5	0,4	0,1	0,1	0
Rapla	.	.	.	.	.	4,9	.	.	.	.	.	.	.
Saare	28,9	9,2	10,3	7,1	1,4	4,4	0,8	0,1	2,2	1,8	0,3	0,4	0,1
Tartu	38,4	14,6	9,8	11,4	6,9	0,1	0,1	0,1	2,5	1,9	0,3	0,6	0,3
Valga	1,1	0,2	0,3	0,6	0,4	16,7	0,1	0	0	0	0	0	0
Viljandi	125,3	60	18,5	34	17	0,6	0,3	0,1	12,7	10,6	1,7	2,1	2,1
Võru	4,7	1,4	0,9	1,9	1,3	0	0	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 1990–2010

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 1994–2012, kg/cow/year (Agriculture 1994–2005; SE, 2012)

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 1994–2012, kg/cow/year (continued)

Country	2007	2008	2009	2010	2011	2012
Average yield per cow, kg	6,484	6,781	6,838	7,021	7,168	7,526
Harju county	6,019	6,396	6,359	6,402	6,600	6,769
Hiiu county	4,687	4,646	5,052	4,520	4,667	5,266
Ida-Viru county	5,438	6,053	6,039	6,334	6,298	6,554
Jõgeva county	6,812	7,119	7,058	7,230	7,465	7,657
Järva county	7,045	7,164	7,048	7,254	7,473	7,816
Lääne county	5,512	6,295	6,281	6,368	6,388	6,802
Lääne-Viru county	6,823	7,096	7,139	7,390	7,524	7,783
Põlva county	7,339	7,562	7,581	7,671	7,737	7,980
Pärnu county	6,407	6,651	6,733	6,948	7,294	7,690
Rapla county	6,325	6,796	7,078	7,355	7,267	7,784
Saare county	5,619	5,844	6,008	6,243	6,179	6,633
Tartu county	7,103	7,880	8,019	7,997	8,237	8,544
Valga county	5,870	5,851	5,926	6,127	6,470	7,125
Viljandi county	5,932	6,205	6,530	6,784	6,711	7,220
Võru county	6,281	6,319	6,493	6,461	6,345	6,948

Table A.3.3_II.3. Average fat content of milk in Estonia in 1990–1997, % (EARC, 2012)[239]

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

[239] 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 1998–2012 by county of Estonia, % (EARC, 2012)[240]

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
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	4,03
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	4,22
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	4,09
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	4,06
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	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	4,03
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	4,02
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	4,13
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	3,99
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	4,09
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	3,98
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	3,91
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	4,16
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	4,08
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	4,16

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

240 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 1998–2012 by county of Estonia, %

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
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	90,2
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	85,1
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	65,3
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	82,1
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	97,2
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	92,4
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	85,7
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	92,6
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	91,7
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	95,4
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	83,8
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	84,8
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	81,9
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	93,5
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	88,6
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	94,7

APPENDIX A.3.3_III. WEIGHT OF DAIRY CATTLE BY CATTLE BREED IN ESTONIA IN 1990–2012

Table A.3.3_III.1. Average weight of dairy cattle by breed in Estonia in 1990–2012

Year	Population by dairy-cattle breed				Average weight of cows, kg
	Estonian Red	Estonian Holstein	Estonian Native	Total number in Registry	
Typical weight, kg[241]	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
2012	18 294	70 511	479	89 284	547.5

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[242]:		
…Mature females	500	
…Mature males	600	
Bovine animals (aged between 1 and 2 years)[243]	300	0.70
Calves (6-12 months)[244]	200	0.55

[241] References sources: Estonian Red and Estonian Holstein – (Ling et al., 2012); Estonian Native – (Kalamees, K., 2008).

[242] 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.

[243] Bovine animals – (Juhend, 2008).

Cattle category	Weight, kg	Weight gain, kg/day
Calves (0-6 months) [245]	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

[244] 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.

[245] 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.

1990: 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[246]).

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[247] 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

[246] IPCC 1997. Agriculture. Reference Manual. Table 4-8, pp. 4.25.
[247] 1 dairy cow = 1 livestock unit (Põllumajandusministri määrus nr 130, 12.12.2009).

		total	1–9	10–49	50–99	100–299	>=300
	2005	9 210	8 082	771	112	159	86
	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[248]	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).

[248] 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.

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 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:

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Table A.3.3_IV.7. Share of Liquid/Slurry MMS in 1990–2012 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
2012	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 1990–2012 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
2012	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 1990–2012 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
2012	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 1990–2012 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
2012	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 1990–2012 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
2012	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 1990–2012 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
2012	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 1990–2012 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
2012	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 1990–2012 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
2012	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 1990–2012 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
2012	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 1990–2012 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
2012	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

The sharp increase of N excretion for dairy cattle between 2007 and 2008, is explained by the combined effect of the sharp increase of milk yield between 2007 and 2008 and the use of milk yield dependent values for the N content in cattle feed. The N content in food values are based on an Estonian publication (Kaasik et al., 2002). According to this publication the N content in cattle feed is about 2.3 per cent for cows producing less than 6,900–7,000 kg of milk per year; and 2.4 per cent for cows producing more than 6,900–7,000 kg of milk per year.

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, 2012)[249]

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

[249] Results of animal recording in Estonia in 1997–2012. Annual Reports. Available at: www.jkkeskus.ee/page.php?page=0147.

Table A.3.3_V.4. Protein content of milk in 1998–2012 in Estonia, % in mass (EARC, 2012)

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
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	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	3,37
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	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	3,38
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	3,44
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	3,39
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	3,34
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	3,38
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	3,4
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	3,36
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	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	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	3,41
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	3,44
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	3,41
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	3,42

APPENDIX A.3.3_VI. SYNTHETIC FERTILIZERS APPLIED ON AGRICULTURAL SOILS IN ESTONIAN IN 1990–2012

Table A.3.3_VI.1. Amounts of synthetic fertilizers applied on agricultural soils, tonnes (SE, 2012)

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
2012	19,362	8,314	321	4,721	184	76	32,978

APPENDIX A.3.3_VII. PRODUCTION OF CROPS IN ESTONIA IN 1990–2012

Table A.3.3_VII.1. Production of field crops in 1990–2012, 1000 tonnes (SE, 2012)

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
2012	991.2	12.9	0	0	0	157.8	66.1	0.2	138.9	0.2

Table A.3.3_VII.2. Sown area of field crops in 1990–2012, 1000 ha (SE, 2012)

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	297.0	8.5	90.0	3.0	0.1	9.2	0.1
2012	290.5	11.0	87.9	2.9	0.3	7.6	0

Table A.3.3_VII.3. Average yields of field crops by field crop in 1990–2012, 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	2,598	1,811	0	878	1,620	17,836	13,939
2012	3,412	1,179	0	513	1,811	18,217	17,000

Table A.3.3_VII.3. Production, sown area and yields of clover and alfalfa in 1990–2012 in Estonia (SE, 2012)

Year	Production, 1000 tonnes		Sown area, 1000 ha		Average yields, t/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*[250]	*253.5*	*224.1*[251]	*19.6*	*13.54*[252]	*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

[250] The production quantities for 1990–2003 were calculated based on the sown areas and the average yields.
[251] The data of 1991.
[252] 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, t/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%)
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
2011	527.4	85.5	40.5	6.1	13.01	14.02
2012	402.6	111.3	26.1	6.3	15.44	17.74

APPENDIX A.3.3_VIII. AVERAGE MONTHLY TEMPERATURE AND PRECIPITATION IN ESTONIA IN 1992–2012

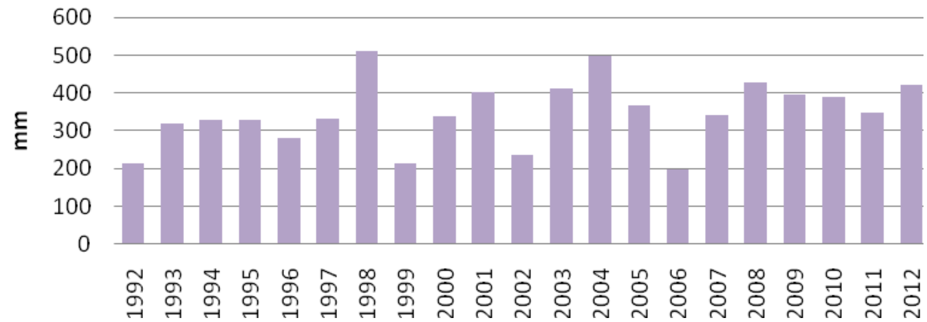

Figure A.3.3_VIII.1. Total precipitation from May to September in Estonia in 1992–2012, mm (SE, 2012)

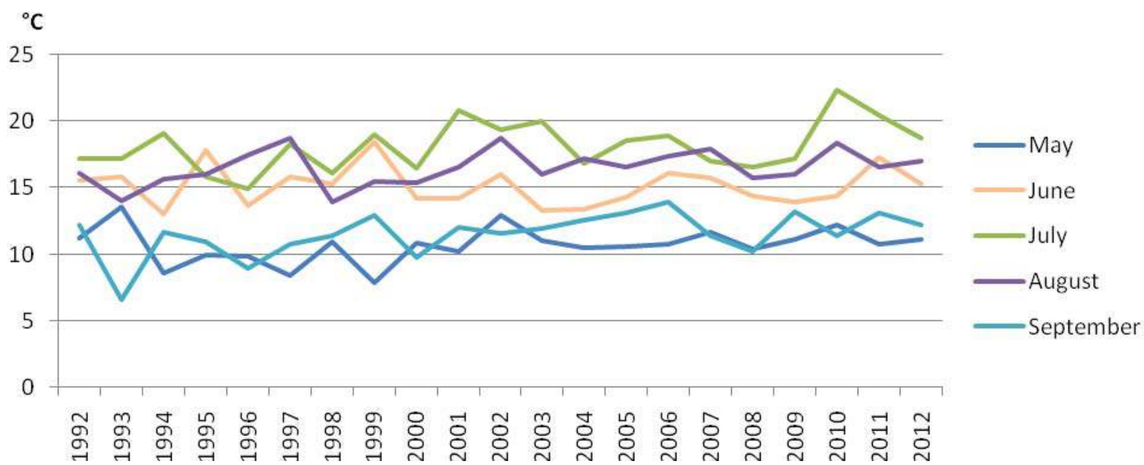

Figure A.3.3_VIII.2. Average monthly temperature in May-September in Estonia in 1992–2012, ^{0}C (SE, 2012)

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 2014 inventory, the difference of CO_2 emissions between RA and Sectoral Approach (SA) was 6.43%.

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.

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 2012 (TJ) updated 05.12.2013

	Coal	Coke*	Oil shale	Milled peat	Sod peat	Peat briquette	Wood*	Firewood	Wood chips and waste	Wood chips	Wood waste	Briquette and pellets	Briquette	Pellets
In stocks at the beginning of the year	689	47	21665	1868	313	192	1036	221	815	570	245	303	132	171
Production of primary energy	0	0	167287	1252	490	0	33376	12776	20600	11497	9103	7842	356	7486
Imports	2230	10	0	0	0	0	363	82	281	0	281	248	0	248
Resources of primary energy	2919	57	188952	3120	803	192	34775	13079	21696	12067	9629	8393	488	7905
Exports	20	668	0	0	206	656	1387	1052	335	0	335	6116	0	6116
Marine bunkering	0	0	0	0	0	0	0	0	0	0	0	0	0	0
In stocks at the end of the year	1146	120	32966	806	269	157	1045	232	813	606	207	1721	123	1598
Supply of primary energy	1753	-731	155986	2315	328	-621	32343	11795	20548	11461	9087	556	365	191
Consumption for conversion to other forms of energy	91	0	152915	2313	326	40	16229	338	15891	11442	4449	131	23	107
..consumption for electricity generation	0	0	98866	644	0	0	4860	0	4860	4334	526	0	0	0
..consumption for heat generation	91	0	4046	844	326	40	11331	303	11028	7108	3920	131	23	107
..consumption for conversion to other forms of fuels	0	0	50003	824	0	0	38	35	3	0	3	0	0	0
Production of converted energy	0	731	0	0	0	833	0	0	0	0	0	0	0	0
Own use by energy sector	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Losses	1	0	0	0	2	0	2	1	1	1	0	0	0	0
Consumption for non-energy purposes	0	0	870	0	0	0	0	0	0	0	0	0	0	0
Final consumption calculated	1661	0	2201	0	0	172	16111	11455	4656	18	4638	425	342	84
Final consumption observed	1648	0	2201	0	0	171	16111	11455	4656	19	4637	339	339	0
..final consumption in industry	1410	0	2201	0	0	0	33	17	16	8	8	126	126	0
....final consumption in iron and steel industry	1	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	0
....final consumption in production of non-ferrous metals	20	0	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in production of other non-metallic mineral products	1387	0	2201	0	0	0	7	2	5	0	5	0	0	0
....final consumption in production of transport equipment	0	0	0	0	0	0	2	2	0	0	0	0	0	0
....final consumption in machinery	0	0	0	0	0	0	6	6	0	0	0	0	0	0
....final consumption in mining and	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Coal	Coke*	Oil shale	Milled peat	Sod peat	Peat briquette	Wood*	Firewood	Wood chips and waste	Wood chips	Wood waste	Briquette and pellets	Briquette	Pellets
quarrying														
....final consumption in food processing, beverages and tobacco	2	0	0	0	0	0	10	3	7	6	1	0	0	0
....final consumption in pulp, paper and printing industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in production of wood and wood products	0	0	0	0	0	0	1	0	1	0	1	126	126	0
....final consumption in construction	0	0	0	0	0	0	3	1	2	2	0	0	0	0
....final consumption in textile, leather and clothing industry	0	0	0	0	0	0	1	1	0	0	0	0	0	0
....final consumption in other industries	0	0	0	0	0	0	3	2	1	0	1	0	0	0
..final consumption in agriculture and fishing	0	0	0	0	0	0	21	10	11	11	0	0	0	0
..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 ommercial and public services	0	0	0	0	0	3	51	47	4	0	4	7	7	0
..final consumption in households	238	0	0	0	0	168	16006	11381	4625	0	4625	206	206	0
Statistical difference	13	0	0	0	0	1	0	0	0	-1	1	86	3	84

Natural gas	Liquefied gas	Heavy fuel oil	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
1	126	298	1667	92	2792	79	2713	2068	88	0	0	15	..	33260	0	0	33260
0	0	0	0	0	0	0	0	0	0	0	122	1173	..	211542	1712	0	213254
22095	354	57136	0	0	29995	2724	27271	22505	2501	0	0	0	..	137437	9756	0	147193
22096	480	57434	1667	92	32787	2803	29984	24573	2589	0	122	1188	..	382239	11468	0	393707
0	16	51449	18410	0	538	168	370	11529	884	0	0	0	..	91879	17820	0	109699
0	0	5710	0	0	1418	0	1418	0	0	0	0	0	..	7128	0	0	7128
0	59	237	1759	147	2927	146	2781	1969	88	0	0	29	..	45445	0	0	45445
22096	405	38	-18502	-55	27904	2489	25415	11075	1617	0	122	1159	..	237787	-6352	0	231435
16339	24	31	2395	1050	222	86	136	0	0	7087	122	1146	..	200461	50	0	200511
593	0	0	592	0	16	0	16	0	0	3807	71	144	..	109594	0	0	109594
15746	24	31	1803	1050	206	86	120	0	0	3280	51	1002	..	40002	50	0	40052
0	0	0	0	0	0	0	0	0	0	0	0	0	..	50865	0	0	50865
0	0	1	21108	2587	0	0	0	0	0	7422	0	0	..	32681	41367	34489	108537
191	1	0	108	0	693	2	691	2	0	335	0	0	..	1331	6674	1603	9608
2	1	0	1	0	8	1	7	5	0	0	0	0	..	22	3164	3535	6721
448	0	0	0	0	0	0	0	0	0	0	0	0	..	1318	0	0	1318
5116	379	8	102	1482	26981	2400	24581	11068	1617	0	0	13	..	67336	25127	29351	121814
5113	378	7	110	1480	24800	219	24581	11067	1617	0	0	10	..	65052	25202.2	29354	119608.2
2186	180	7	74	924	1145	0	1145	22	0	0	0	9	..	8317	7866	7854	24037
0	0	0	0	0	0	0	0	0	0	0	0	0	..	1	4	3	8
462	95	0	0	0	21	0	21	0	0	0	0	0	..	578	713	696	1987
6	2	0	0	0	2	0	2	0	0	0	0	0	..	30	31	1	62
742	1	0	22	0	37	0	37	0	0	0	0	9	..	4406	742	157	5305
15	1	0	0	0	4	0	4	0	0	0	0	0	..	22	218	151	391
194	13	0	0	0	17	0	17	2	0	0	0	0	..	232	1026	525	1783
322	0	0	0	0	261	0	261	1	0	0	0	0	..	584	67	5	656
61	6	0	0	0	8	0	8	0	0	0	0	0	..	87	1154	1315	2556
72	2	0	0	0	11	0	11	0	0	0	0	0	..	85	1310	1503	2898

Natural gas	Liquefied gas	Heavy fuel oil	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
141	8	0	0	169	72	0	72	1	0	0	0	0	..	518	1130	2523	4171
106	30	7	52	755	604	0	604	18	0	0	0	0	..	1575	293	135	2003
13	0	0	0	0	0	0	0	0	0	0	0	0	..	14	426	226	666
52	22	0	0	0	108	0	108	0	0	0	0	0	..	185	752	614	1551
35	33	0	36	556	2770	0	2770	6	0	0	0	0	..	3457	790	410	4657
1	5	0	0	0	17478	23	17455	2591	1604	0	0	0	..	21680	279.2	107	22066.2
0	0	0	0	0	1255	7	1248	0	0	0	0	0	..	1255	22	4	1281
1	5	0	0	0	16034	0	16051	2591	0	0	0	0	..	18648	162	102	18912
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	79.2	..	..
0	0	0	0	0	173	17	156	0	10	0	0	0	..	183	14	0	197
0	0	0	0	0	0	0	0	0	1594	0	0	0	..	1594	2	1	1597
597	24	0	0	0	363	0	363	28	13	0	0	1	..	1087	9225	6752	17064
2294	136	0	0	0	3043	195	2848	8420	0	0	0	0	..	30511	7042	14231	51784
3	1	1	-8	2	2181	2181	0	1	0	0	0	3	..	2284	-75.2	-3	2205.8

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.
The data on wood are added on 23.09.2013.
The data on light fuel oil and diesel, diesel, total fuels, total energy for 2002-2011, oil shale for 2011 have been revised on 23.09.2013.
Since 2012 data for imports and exports include re-exports.
Coke*:
** Oil-shale coke is exported as coke.
Wood*:
* Firewood, wood chips and waste.
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 2012 (natural units)

	Coal, thousand tons	Coke*, thousand tons	Oil shale, thousand tons	Milled peat, thousand tons	Sod peat, thousand tons	Peat briquette, thousand tons	Wood*,thousand m³ solid volume	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
In stocks at the beginning of the year	25	2	2434	187	26	12	147	29	118	82	36	19
Production of primary energy	0	0	18796	125	41	0	4632	1690	2942	1642	1300	463
Production of converted energy	0	26	0	0	0	52	0	0	0	0	0	0
Imports	82	0	0	8	0	0	51	11	40	0	40	15
Resources of energy	108	28	21231	320	67	64	4830	1730	3100	1724	1376	497
Exports	1	23	0	0	17	41	187	139	48	0	48	362
Marine bunkering	0	0	0	0	0	0	0	0	0	0	0	0
In stocks at the end of the year	42	4	3704	83	22	10	148	31	117	87	30	102
Supply of energy	65	0	17527	237	27	13	4497	1560	2937	1638	1299	32
Gross inland consumption	64	0	17527	237	27	13	4496	1560	2936	1637	1299	32
Consumption for conversion to other forms of energy	3	0	17258	237	27	3	2316	45	2271	1635	636	7
..consumption for electricity generation	0	0	12057	66	0	0	694	0	694	619	75	0
..consumption for heat generation	3	0	493	87	27	3	1616	40	1576	1016	560	7
..consumption for conversion to other forms of fuels	0	0	4708	85	0	0	5	5	0	0	0	0
Own use by energy sector	0	0	0	0	0	0	0	0	0	0	0	0
Losses	0	0	0	0	0	0	0	0	0	0	0	0
Consumption for non-energy purposes	0	0	77	0	0	0	0	0	0	0	0	0
Final consumption calculated	61	0	191	0	0	11	2181	1515	666	3	663	25
Final consumption observed	61	0	191	0	0	11	2180	1515	665	2	663	25
..final consumption in industry	52	0	191	0	0	0	4	2	2	1	1	8
....final consumption in iron and steel industry	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
....final consumption in production of non-ferrous metals	1	0	0	0	0	0	0	0	0	0	0	0
....final consumption in production of other non-metallic mineral products	51	0	191	0	0	0	1	0	1	0	1	0

	Coal, thousand tons	Coke*, thousand tons	Oil shale, thousand tons	Milled peat, thousand tons	Sod peat, thousand tons	Peat briquette, thousand tons	Wood*,thousand m³ solid volume	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
....final consumption in production of transport equipment	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in machinery	0	0	0	0	0	0	1	1	0	0	0	0
....final consumption in mining and quarrying	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in food processing, beverages and tobacco	0	0	0	0	0	0	1	0	1	1	0	0
....final consumption in pulp, paper and printing industry	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in production of wood and wood products	0	0	0	0	0	0	0	0	0	0	0	7
....final consumption in construction	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in textile, leather and clothing industry	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	0	0
..final consumption in agriculture and fishing	0	0	0	0	0	0	2	1	1	1	0	0
..final consumption in transport	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
....final consumption in land transport	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
....final consumption in air transport	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	7	6	1	0	1	0
..final consumption in households	9	0	0	0	0	11	2166	..	..	..	..	17
Statistical difference	0	0	0	0	0	0	-1	0	-1	-1	0	0

Briquette, thousand tons	Pellets, thousand tons	Natural gas, million m³	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
8	11	0	2.8	7	42	2	66	2	64	47	2	0	0	2	..	0	0
21	442	0	0	0	0	0	0	0	0	0	0	0	7	145	..	476	0
0	0	0	0	0	538	61	0	0	0	0	0	1142	0	0	..	11491	9580
0	15	658	7.8	1423	0	0	709	64	645	511	58	0	0	0	..	2710	0
29	468	658	10.5	1431	581	63	775	66	709	558	60	1142	7	147	..	14676	9580
0	362	0	0.4	1281	469	0	13	4	9	262	21	0	0	0	..	4950	0
0	0	0	0	142	0	0	86	52	34	0	0	0	0	0	..	0	0
7	95	0	1.3	6	45	3	69	3	66	45	2	0	0	2	..	0	0
21	11	658	8.9	1	66	60	608	7	601	252	38	1142	7	145	..	9726	9580
21	11	657	8.9	1	67	60	608	7	601	252	38	1142	7	145	..	8847	8599
1	6	486	0.5	1	61	25	5	2	3	0	0	1090	7	144	..	14	0
0	0	18	0	0	15	0	0	0	0	0	0	586	4	18	..	0	0
1	6	469	0.5	1	46	25	5	2	3	0	0	505	3	126	..	14	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	..	0	0
0	0	6	0	0	3	0	16	0	16	0	0	52	0	0	..	1854	445
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	..	879	982
0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	..	0	0
20	5	152	8.3	0	3	35	586	5	581	252	38	0	0	1	..	6980	8153
20	5	152	8.3	0	3	35	586	5	581	252	38	0	0	1	..	6979	8154
8	0	65	4	0	2	22	27	0	27	1	0	0	0	1	..	2186	2181
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	..	1	1
0	0	14	2.1	0	0	0	0	0	0	0	0	0	0	0	..	198	193
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	..	9	0
0	0	22	0	0	1	0	1	0	1	0	0	0	0	1	..	206	44

Briquette, thousand tons	Pellets, thousand tons	Natural gas, million m³	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
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	..	61	42
0	0	6	0.3	0	0	0	0	0	0	0	0	0	0	0	..	285	146
0	0	10	0	0	0	0	6	0	6	0	0	0	0	0	..	19	1
0	0	2	0.1	0	0	0	0	0	0	0	0	0	0	0	..	321	365
0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	..	364	418
7	0	4	0.2	0	0	4	2	0	2	0	0	0	0	0	..	314	701
0	0	3	0.7	0	1	18	14	0	14	0	0	0	0	0	..	82	38
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	..	118	63
0	0	2	0.5	0	0	0	3	0	3	0	0	0	0	0	..	209	170
0	0	1	0.7	0	1	13	65	0	65	0	0	0	0	0	..	220	114
0	0	0	0.1	0	0	0	413	0	413	59	37	0	0	0	..	56	30
0	0	0	0	0	0	0	30	0	30	0	0	0	0	0	..	6	1
0	0	0	0.1	0	0	0	380	0	380	59	0	0	0	0	..	45	28
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	22	..
0	0	0	0	0	0	0	4	0	4	0	0	0	0	0	..	4	0
0	0	0	0	0	0	0	0	0	0	0	37	0	0	0	..	1	0
0	0	18	0.5	0	0	0	9	0	9	1	0	0	0	0	..	2563	1876
12	5	68	3	0	0	0	72	5	67	191	0	0	0	0	..	1956	3953
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	..	-1	1

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.
The data on wood are added on 23.09.2013.
The data on firewood, wood chips and waste for 1999, light fuel oil and diesel, diesel for 2002-2011, oil shale for 2011 have been revised on 23.09.2013.
Since 2012 data for imports and exports include re-exports.
Coke*, thousand tons:
* Oil-shale coke is exported as coke.
Wood*,thousand m^3 solid volume:
* Firewood, wood chips and waste.
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 m^3:
** Generator gas, coke oven gases.
Biogas*, million m^3:
* 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	NO	NO	NO	NO	NO	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	

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NOx	CO	NMVOC	SO_2	Notes*
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	There is no method available in IPCC Guidelines for SO_2 emissions estimates.
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 from 2009-2012.
2. B. Chemical Industry								
2.B.1. Ammonia Production	X	NO	NO	NO	X	X	X	There was no production of ammonia in 2010 and 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.

Greenhouse gas source and sink categories	HFC_s	PFC_s	SF6	Explanation notes
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	
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	NA	NA	NA	NA	
5(I) Direct N_2O emissions from N fertilization	NA	NA	NO	NA	NA	NA	
5(II) Non-CO_2 emissions from drainage of soils and wetlands	NO	NE	NE	NA	NA	NA	According to IPCC GPG 2003 it is not mandatory to report CH_4 and N_2O emissions here.
5(V) Biomass burning	IE, NO	X	X	NA	NA	NA	CO_2 emission estimates are included in FL remaining FL living biomass emission estimates due to *Stock Change method* used.
5.A.1. Forest Land remaining Forest Land							
Carbon stock change	X	NO	NA	NA	NA	NA	
5(I) Direct N_2O emissions from N fertilization	NA	NA	NO	NA	NA	NA	
5(II) Non-CO_2 emissions from drainage of soils and wetlands	NO	NE	NE	NA	NA	NA	According to IPCC GPG 2003 it is not mandatory to report CH_4 and N_2O

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	Notes*
							emissions here.
5(V) Biomass burning	IE, NO	X	X	NA	NA	NA	CO_2 emission estimates are included in FL remaining FL living biomass emission estimates due to *Stock Change method* used.
5.A.2. Land converted to Forest Land							
5.A.2.1. Cropland converted to Forest Land	X	NO	NA	NA	NA	NA	
5.A.2.2. Grassland converted to Forest Land	X	NO	NA	NA	NA	NA	
5.A.2.3. Wetlands converted to Forest Land	X	NO	NA	NA	NA	NA	
5.A.2.4. Settlements converted to Forest Land	X	NO	NA	NA	NA	NA	
5.A.2.5. Other Land converted to Forest Land	X	NO	NA	NA	NA	NA	
5.B. Cropland							
Carbon stock change	X	NO	NA	NA	NA	NA	
5(III) N_2O emissions from disturbances associated with land-use conversion to cropland	NA	NA	X	NA	NA	NA	
5(IV) CO_2 emissions from agricultural lime application	X	NO	NA	NA	NA	NA	
5(V) Biomass burning	NO	NO	NO	NA	NA	NA	
5.B.1. Cropland remaining Cropland							
Carbon Stock Change	X	NO	NA	NA	NA	NA	
5(V) Biomass Burning	NO	NO	NO	NA	NA	NA	
5(IV) CO_2 emissions from agricultural lime application	X	NO	NO	NA	NA	NA	
5.B.2. Land converted to Cropland							
5.B.2.1. Forest Land Converted to Cropland	NO	NO	NA	NA	NA	NA	
5.B.2.2. Grassland converted to Cropland	X	NO	NA	NA	NA	NA	
5.B.2.3. Wetlands converted to Cropland	NO	NO	NA	NA	NA	NA	
5.B.2.4. Settlements converted to Cropland	NO	NO	NA	NA	NA	NA	
5.B.2.5. Other land converted to Cropland	NO	NO	NA	NA	NA	NA	
5(III) N_2O emissions from disturbances associated with land-use conversion to cropland	NA	NA	X	NA	NA	NA	
5(V) Biomass Burning	NO	NO	NO	NA	NA	NA	
5.C. Grassland							
Carbon Stock Change	X	NO	NA	NA	NA	NA	
5(IV) Carbon emissions from agricultural lime application	NO	NO	NO	NA	NA	NA	
5(V) Biomass Burning	IE, NO	X	X	NA	NA	NA	CO_2 emission estimates are included in GL remaining GL living biomass emission estimates due to *Stock Change method* used.
5.C.1. Grassland remaining Grassland							
Carbon stock change	X	NO	NA	NA	NA	NA	

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	Notes*
5(IV) CO_2 emissions from agricultural lime application	NO	NO	NO	NA	NA	NA	
5 (V) Biomass Burning	IE, NO	X	X	NA	NA	NA	
5.C.2. Land converted to Grassland							
5.C.2.1. Forest Land Converted to Grassland	X	NO	NA	NA	NA	NA	
5.C.2.2. Cropland converted to Grassland	X	NO	NA	NA	NA	NA	
5.C.2.3. Wetlands converted to Grassland	X	NO	NA	NA	NA	NA	
5.C.2.4. Settlements converted to Grassland	X	NO	NA	NA	NA	NA	
5.C.2.5. Other land converted to Grassland	X	NO	NA	NA	NA	NA	
5(V) Biomass Burning	IE, NO	IE, NO	IE, NO	NA	NA	NA	
5.D. Wetlands							
Carbon Stock Change	X	NO	NA	NA	NA	NA	
5(II) N_2O emissions from drainage of soils and wetlands	NA	NA	X	NA	NA	NA	
5(V) Biomass Burning	IE, NO	IE, NO	IE, NO	NA	NA	NA	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	NA	NA	NA	
5(V) Biomass Burning	IE, NO	IE, NO	IE, NO	NA	NA	NA	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	NA	NA	NA	NA	
5.D.2.2. Cropland converted to Wetlands	NO	NO	NA	NA	NA	NA	
5.D.2.3. Grassland converted to Wetlands	NA	NA	NA	NA	NA	NA	This is a non human-induced land-use change, thus no emissions are reported, area is reported.
5.D.2.4. Settlements converted to Wetlands	NO	NO	NA	NA	NA	NA	
5.D.2.5. Other land converted to Wetlands	X	NO	NA	NA	NA	NA	Under this category, Wetlands to Peatland is reported.
5(II) Non-CO_2 emissions from drainage of soils and wetlands	NO	X	X	NA	NA	NA	
5.E. Settlements							
5.E.1. Settlements remaining Settlements	NE	NE	NE	NA	NA	NA	According to the IPCC good practice guidance for LULUCF, it is not mandatory for Parties to prepare estimates for the category contained in appendix 3a.4 Settlements Remaining Settlements.

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	Notes*
5.E.2. Land converted to Settlements	X	NO	NA	NA	NA	NA	
Greenhouse gas source and sink categories	**CO_2**	**CH_4**	**N_2O**	**NO_x**	**CO**	**NMVOC**	
5.E.2.1. Forest Land Converted to Settlements	X	NO	NA	NA	NA	NA	
5.E.2.2. Cropland converted to Settlements	X	NO	NA	NA	NA	NA	
5.E.2.3. Grassland converted to Settlements	X	NO	NA	NA	NA	NA	
5.E.2.4. Wetlands converted to Settlements	NO	NO	NA	NA	NA	NA	
5.E.2.5. Other land converted to Settlements	X	NO	NA	NA	NA	NA	
5.F. Other Land							
5.F.2.1. Forest Land converted to Other Land	X	NO	NA	NA	NA	NA	
5.F.2.2. Cropland converted to Other Land	X	NO	NA	NA	NA	NA	
5.F.2.3. Grassland converted to Other Land	X	NO	NA	NA	NA	NA	
5.F.2.4. Wetlands converted to Other Land	X	NO	NA	NA	NA	NA	
5.F.2.5. Settlements converted to Other Land	NO	NO	NA	NA	NA	NA	
5.G. Other Land (please specify)							
Harvested Wood Products	IE	IE	NE	NA	NA	NA	Instant oxidation of biomass harvested is assumed. 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	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

2013

Tallinn 2014

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 2013 (hereinafter as SIAR) and other information included in this report.

In this document, 2013 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_2014_1_11-27-54 13-1-2014.xls". The Standard Electronic Format (hereinafter as SEF) report for 2013 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 2013. Also the SEF includes information on transfers of the units during the year 2013.

The total number of units in the NR at the beginning of the year 2013 was: 131 081 678 AAU, 3 758 479 ERU and 29 551 CER. In the end of the year the total balance of units was: 132 642 010 AAU (68 157 883 in retirement and 216 300 in cancellation accounts), 2 463 976 ERU (282068 in retirement account) and 457 584 CER (33 110 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 is also included in Estonian Standard Independent Assessment Report (hereinafter as SIAR) 2013 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 2013 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 1990–2012. National Inventory Report under the UNFCCC and the Kyoto Protocol. Common Reporting Formats (CRF) 1990–2012. Tallinn 2014" (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.

Annual Submission Item	Reporting Guidance
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 2013.
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 2013.
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 2013.
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 2013.
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.

Annual Submission Item	Reporting Guidance
15/CMP.1 annex I.E Publicly accessible information	Following information is publicly accessible via user interface of the MoE http://www.envir.ee/1170489. Information regarding the NR is publicly available to users via MoE web page http://www.envir.ee/register. 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: 1. account information (information on paragraph 45 of annex to the decision 13/CMP.1); 2. JI projects in Estonia (information on paragraph 46 of annex to the decision 13/CMP.1); 3. information about unit holdings and transactions (information on paragraph 47 of annex to the decision 13/CMP.1); 4. information about Entities Authorized to Hold Units (information on paragraph 48 of annex to the decision 13/CMP.1). 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/1170489 (selecting the headline “*Ühisrakendusprojektide ülevaade / JI projects overview*”); 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

Annual Submission Item	Reporting Guidance
	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 (NAP) - information on national allocation plan for Estonia (NAP) 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.
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 2012. This would mean that five times the emissions from the total inventory of 2012 will be lower, than 90% of the assigned amount. This would give an estimated commitment period reserve of **95 942 143 tonnes CO_2 equivalents.** 19 188 428.598 x 5 = 95 942 143 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 occurred in 2013:

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	No change of name or contact occurred during the reported period. National administrator is: Mr Mihkel Visnapuu khgregister@envir.ee tel. +372 6262 829
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	An updated diagram of the database structure is attached as Annex A. Iteration 5 of the national registry released in January 2013 and Iteration 6 of the national registry released in June 2013 introduces changes in the structure of the database. Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. However, each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex B). Annex H testing was carried out in February 2014 and the successful test report has been attached. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No change of security measures occurred during the reporting period
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex B. Annex H testing was carried out in February 2014 and the successful test report has been attached.

Previous Annual Review recommendation and response

ARR 2013 para 87	The ERT concluded that, taking into account the confirmed changes in the national registry, including the additional information provided to the ERT during the review, Estonia's national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1 and continues to adhere to the technical standards for data exchange between registry systems in accordance with relevant decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP). With respect to the provision of information related to the database structure specifically, the ERT encourages the Party to provide additional information in the NIR. The ERT recommends that Estonia include all other additional information in response to the SIAR findings in its NIR in accordance with decision 15/CMP.1, annex, chapter I.G.	An updated diagram of the database structure is submitted together with the NIR. This separate document (Annex A – CSEUR_DB_model.pdf) shall not be published.

3. PART III. APPENDIXES

Appendix 1 – Report R-1: SEF_2013

UNFCCC SEF application

Version 1.2.1

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:	2014
Reported year:	2013
Commitment period:	1
Completeness check:	YES
Consistency check:	YES
File locked:	YES
Lock timestamp:	13.01.2014 11:27
Submission version number:	1
Submission type:	Official

Party	Estonia
Submission year	2014
Reported year	2013
Commitment period	1

Table 1. Total quantities of Kyoto Protocol units by account type at beginning of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	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	1,31E+08	3758479	NO	29551	NO	NO

Party	Estonia
Submission year	2014
Reported year	2013
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		3092					3092		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							6300	NO	NO	NO	NO	NO
Sub-total		3092	NO				9392	NO	NO	NO	NO	NO

Transaction type	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Retirement	15072383	141034	NO	16555	NO	NO

Add registry | Delete registry

Party	Estonia
Submission year	2014
Reported year	2013
Commitment period	1

Table 2 (b). Annual external transactions

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Transfers and acquisitions												
EU	NO	2131376	NO	424474	NO	NO	8633959	7269552	NO	12996	NO	NO
LU	NO	NO	NO	NO	NO	NO	4875000	NO	NO	NO	NO	NO
SE	NO	NO	NO	NO	NO	NO	NO	16787	NO	NO	NO	NO
CH	NO	52564	NO	NO	NO	NO	NO	2347395	NO	NO	NO	NO
FI	NO	NO	NO	NO	NO	NO	NO	22057	NO	NO	NO	NO
AT	NO	NO	NO	NO	NO	NO	NO	7696	NO	NO	NO	NO
NZ	NO	NO	NO	NO	NO	NO	NO	1000000	NO	NO	NO	NO
UA	NO	7040918	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sub-total	NO	9224858	NO	424474	NO	NO	13508959	10663487	NO	12996	NO	NO

Additional information

Independently verified ERUs								NO				

Table 2 (c). Total annual transactions

Total (Sum of tables 2a and 2b)	NO	9227950	NO	424474	NO	NO	13518351	10663487	NO	12996	NO	NO

Party	Estonia
Submission year	2014
Reported year	2013
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	2014
Reported year	2013
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	64267827	2181908	NO	424474	NO	NO
Entity holding accounts	NO	NO	NO	NO	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	216300	NO	NO	NO	NO	NO
Retirement account	68157883	282068	NO	33110	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	1,33E+08	2463976	NO	457584	NO	NO

Party	Estonia
Submission year	2014
Reported year	2013
Commitment period	1

Table 5 (a). Summary information on additions and subtractions

	Additions						Subtractions					
	Unit type						Unit type					
Starting values	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Issuance pursuant to Article 3.7 and 3	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	9227950	NO	424474	NO	NO	1,4E+07	1,1E+07	NO	12996	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	1,4E+07	NO	454025	NO	NO	1,1E+08	1,2E+07	NO	12996	NO	NO
Total	2,3E+08	1,4E+07	NO	454025	NO	NO	1,1E+08	1,2E+07	NO	12996	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)	1,5E+07	141034	NO	16555	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO
Total	6,8E+07	282068	NO	33110	NO	NO

Party	Estonia
Submission year	2014
Reported year	2013
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.

REFERENCES

1. Greenhouse Gas emissions in Estonia 1990–2012. National Inventory Report under the UNFCCC and the Kyoto Protocol. Common Reporting Formats (CRF) 1990–2012. Tallinn 2014;

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 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	2012	AD	EF					due to EF	due to AD		
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	CO2	4 900,29	339,94	1,70%	1,80%	2,48%	**0,04%**	-0,0486	0,0084	-0,09%	0,02%	**0,09%**	E1
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO2	21 886,83	11 396,09	3,30%	2,39%	4,07%	**2,42%**	0,0259	0,2806	0,06%	1,31%	**1,31%**	E1, E7
1.A.1.a	Energy Industries/Electricity and Heat Production - Gaseous Fuels	CO2	1 968,74	908,83	1,40%	3,60%	3,86%	**0,18%**	-0,0005	0,0224	0,00%	0,04%	**0,04%**	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	1,33	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	11,01	5,00%	60,00%	60,21%	**0,03%**	0,0003	0,0003	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%**	-0,0001	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	7,66	5,00%	60,00%	60,21%	**0,02%**	0,0001	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	0,51	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	21,66	5,00%	60,00%	60,21%	**0,07%**	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	396,91	3,30%	38,90%	39,04%	**0,81%**	0,0090	0,0098	0,35%	0,05%	**0,35%**	E1
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CH4	0,07	0,45	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	0,10	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	3,04	0,10	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 - 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 - 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.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - Solid Fuels	CO2	0,00	1,91	3,30%	38,90%	39,04%	**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	CO2	0,00	0,28	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 - Gaseous Fuels	CO2	0,00	0,33	1,40%	3,60%	3,86%	**0,00%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	E1
1.A.2.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - Solid 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	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 - 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.b	Manufacturing Industries and Constructions/Non-Ferrous Metals -	N2O	0,00	0,01	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	2012	AD	EF					due to EF	due to AD		
	Solid Fuels													
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.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - 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.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	CO2	620,74	0,00	3,30%	38,90%	39,04%	**0,00%**	-0,0072	0,0000	-0,28%	0,00%	**0,28%**	E1
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Liquid Fuels	CO2	12,68	7,68	1,70%	1,80%	2,48%	**0,00%**	0,0000	0,0002	0,00%	0,00%	**0,00%**	E1
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Gaseous Fuels	CO2	165,88	25,40	1,40%	3,60%	3,86%	**0,01%**	-0,0013	0,0006	0,00%	0,00%	**0,00%**	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/Chemicals - 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	0,05	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 - 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	0,01	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	0,94	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	3,96	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	0,01	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	4,59	0,19	3,30%	38,90%	39,04%	**0,00%**	0,0000	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	437,77	0,97	1,70%	1,80%	2,48%	**0,00%**	-0,0051	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	3,35	1,40%	3,60%	3,86%	**0,00%**	-0,0001	0,0001	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

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	2012	AD	EF					due to EF	due to AD		
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	0,01	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	0,01	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
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	791,47	352,89	3,30%	38,90%	39,04%	**0,72%**	-0,0005	0,0087	-0,02%	0,04%	**0,05%**	E1
1.A.2.f	Manufacturing Industries and Constructions/Other - Liquid Fuels	CO2	327,98	161,14	1,70%	1,80%	2,48%	**0,02%**	0,0002	0,0040	0,00%	0,01%	**0,01%**	E1
1.A.2.f	Manufacturing Industries and Constructions/Other - Gaseous Fuels	CO2	99,68	87,14	1,40%	3,60%	3,86%	**0,02%**	0,0010	0,0021	0,00%	0,00%	**0,01%**	E1
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CH4	1,71	0,75	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	0,10	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	0,17	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	0,15	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	1,60	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	0,40	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	0,30	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	115,35	5,00%	60,00%	60,21%	**0,36%**	0,0028	0,0028	0,17%	0,02%	**0,17%**	E2, E4
1.A.2	Manufacturing Industries and Constructions - Other Fuels	CH4	0,00	0,92	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	N2O	0,00	1,80	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	5,67	3,44	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	2 148,00	1,70%	1,80%	2,48%	**0,28%**	0,0269	0,0529	0,05%	0,13%	**0,14%**	E1
1.A.3.C	Railway - Liquid Fuels	CO2	142,65	91,88	1,70%	1,80%	2,48%	**0,01%**	0,0006	0,0023	0,00%	0,01%	**0,01%**	E1
1.A.3.C	Railways - Solid Fuels	CO2	11,39	0,00	3,30%	38,90%	39,04%	**0,00%**	-0,0001	0,0000	-0,01%	0,00%	**0,01%**	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	2012	AD	EF					due to EF	due to AD		
1.A.3.D	Navigation - Liquid Fuels	CO2	21,80	12,67	1,70%	1,80%	2,48%	**0,00%**	0,0001	0,0003	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	3,76	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	0,13	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
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	18,74	5,00%	50,00%	50,25%	**0,05%**	0,0002	0,0005	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	0,23	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	0,03	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	8,04	0,28	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	18,98	1,55	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	32,82	1,40%	3,60%	3,86%	**0,01%**	0,0006	0,0008	0,00%	0,00%	**0,00%**	E1
1.A.4.a	Other Sectors/Commercial - Solid 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 - 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	0,06	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	0,37	10,00%	150,00%	150,33%	**0,00%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	E2, E4
1.A.4.a	Other Sectors/Commercial - Solid Fuels	N2O	0,06	0,00	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 - Liquid Fuels	N2O	0,05	0,00	5,00%	75,00%	75,17%	**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	0,07	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	667,08	38,56	3,30%	38,90%	39,04%	**0,08%**	-0,0068	0,0009	-0,26%	0,00%	**0,26%**	E1
1.A.4.b	Other Sectors/Residential - Liquid Fuels	CO2	544,67	39,50	1,70%	1,80%	2,48%	**0,01%**	-0,0054	0,0010	-0,01%	0,00%	**0,01%**	E1
1.A.4.b	Other Sectors/Residential - Gaseous Fuels	CO2	116,28	126,12	1,40%	3,60%	3,86%	**0,03%**	0,0018	0,0031	0,01%	0,01%	**0,01%**	E1
1.A.4.b	Other Sectors/Residential - Solid Fuels	CH4	25,92	1,68	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	0,48	5,00%	50,00%	50,25%	**0,00%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	E2, E3

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	2012	AD	EF					due to EF	due to AD		
1.A.4.b	Other Sectors/Residential - Gaseous Fuels	CH4	0,22	0,24	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	102,14	10,00%	150,00%	150,33%	**0,80%**	0,0021	0,0025	0,32%	0,04%	**0,32%**	E2, E4
1.A.4.b	Other Sectors/Residential - Solid Fuels	N2O	8,72	0,50	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	0,67	5,00%	75,00%	75,17%	**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	20,10	10,00%	150,00%	150,33%	**0,16%**	0,0004	0,0005	0,06%	0,01%	**0,06%**	E2, E4
1.A.4.c	Other Sectors/Agriculture - Solid Fuels	CO2	15,98	0,00	3,30%	38,90%	39,04%	**0,00%**	-0,0002	0,0000	-0,01%	0,00%	**0,01%**	E1
1.A.4.c	Other Sectors/Agriculture - Liquid Fuels	CO2	475,95	248,89	1,70%	1,80%	2,48%	**0,03%**	0,0006	0,0061	0,00%	0,01%	**0,01%**	E1
1.A.4.c	Other Sectors/Agriculture - Gaseous Fuels	CO2	3,68	1,92	1,40%	3,60%	3,86%	**0,00%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	E1
1.A.4.c	Other Sectors/Agriculture - Solid Fuels	CH4	1,05	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.c	Other Sectors/Agriculture - Liquid Fuels	CH4	2,31	0,38	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	0,00	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	0,13	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	24,67	5,00%	75,00%	75,17%	**0,10%**	0,0001	0,0006	0,01%	0,00%	**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	43,44	22,62	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	0,03	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	0,39	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	177,54	76,57	10,00%	25,00%	26,93%	**0,11%**	-0,0002	0,0019	0,00%	0,03%	**0,03%**	E6
2.A.1	Cement Production	CO2	483,04	407,44	2,00%	5,00%	5,39%	**0,11%**	0,0044	0,0100	0,02%	0,03%	**0,04%**	I1
2.A.2	Lime Production	CO2	131,30	48,72	5,00%	5,00%	7,07%	**0,02%**	-0,0003	0,0012	0,00%	0,01%	**0,01%**	I2
2.A.4.2	Soda Ash Use	CO2	0,31	0,25	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	9,53	10,00%	10,00%	14,14%	**0,01%**	0,0002	0,0002	0,00%	0,00%	**0,00%**	I2
2.A.7.2a	Ceramics Production - Bricks and Tiles	CO2	12,30	2,43	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	24,88	5,00%	10,00%	11,18%	**0,01%**	-0,0043	0,0006	-0,04%	0,00%	**0,04%**	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	50,12	20,0%	10,0%	22,36%	**0,06%**	0,0012	0,0012	0,01%	0,03%	**0,04%**	I4

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			1990	2012	AD	EF					due to EF	due to AD		
2.F.1.3	Transport Refrigeration - Refrigerated Vehicles	HFCs	0,00	16,91	8,5%	5,0%	9,86%	**0,01%**	0,0004	0,0004	0,00%	0,01%	**0,01%**	I4
2.F.1.3	Transport Refrigeration - Reefer Containers	HFCs	0,00	1,07	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	30,85	26,00%	15,00%	30,02%	**0,05%**	0,0008	0,0008	0,01%	0,03%	**0,03%**	I4
2.F.1.5	Stationary Air-Conditioning - Heat Pumps	HFCs	0,00	3,55	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	16,28	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	24,57	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	4,68	8,5%	5,0%	9,86%	**0,00%**	0,0001	0,0001	0,00%	0,00%	**0,00%**	I4
2.F.1.6	Mobile Air-Conditioning - Buses	HFCs	0,00	2,11	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	3,26	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	3,43	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	4,80	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	2,18	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	2,97	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	1,90	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	4,36	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	20,82	14,36	25,00%	10,00%	26,93%	**0,02%**	0,0001	0,0004	0,00%	0,01%	**0,01%**	S2
4.A	Enteric Fermentation - Dairy Cattle	CH4	583,68	266,63	10,00%	50,00%	50,99%	**0,71%**	-0,0002	0,0066	-0,01%	0,09%	**0,09%**	A1
4.A	Enteric Fermentation - Non-Dairy Cattle	CH4	389,02	133,35	10,00%	50,00%	50,99%	**0,35%**	-0,0012	0,0033	-0,06%	0,05%	**0,08%**	A2
4.A	Enteric Fermentation - Sheep	CH4	23,18	12,90	10,00%	25,00%	26,93%	**0,02%**	0,0000	0,0003	0,00%	0,00%	**0,00%**	A3
4.A	Enteric Fermentation - Goats	CH4	0,19	0,48	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	3,25	2,34	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	17,49	7,72	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	0,20	0,11	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	14,32	21,38	10,00%	25,00%	26,93%	**0,03%**	0,0004	0,0005	0,01%	0,01%	**0,01%**	A8

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	2012	AD	EF					due to EF	due to AD		
4.B	Manure Management -Non-Dairy Cattle	CH4	8,00	5,65	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	0,55	0,31	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	0,00	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	0,25	0,18	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	41,56	15,67	10,00%	25,00%	26,93%	**0,02%**	-0,0001	0,0004	0,00%	0,01%	**0,01%**	A13
4.B	Manure Management - Poultry	CH4	10,71	3,56	10,00%	20,00%	22,36%	**0,00%**	0,0000	0,0001	0,00%	0,00%	**0,00%**	A14
4.B	Manure Management - Fur animals	CH4	0,27	0,15	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	0,00	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	3,47	2,89	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	303,38	98,34	26,93%	100,00%	103,56%	**0,53%**	-0,0011	0,0024	-0,11%	0,09%	**0,14%**	A18
4.B	Manure Management - Other AWMS	N2O	0,00	5,99	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	394,80	180,73	5,00%	85,44%	85,59%	**0,81%**	-0,0001	0,0044	-0,01%	0,03%	**0,03%**	A20
4.D.1.2	Direct Soil Emissions - Animal Manure Applied to Soils	N2O	186,36	81,06	26,93%	89,44%	93,41%	**0,39%**	-0,0002	0,0020	-0,02%	0,08%	**0,08%**	A21
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N2O	247,95	40,05	0,00%	80,00%	80,00%	**0,17%**	-0,0019	0,0010	-0,15%	0,00%	**0,15%**	A22
4.D.1.4	Direct Soil Emissions - Crop Residue	N2O	68,37	32,66	0,00%	80,00%	80,00%	**0,14%**	0,0000	0,0008	0,00%	0,00%	**0,00%**	A23
4.D.1.5	Direct Soil Emissions - Cultivation of Histosols	N2O	99,13	88,18	0,00%	80,00%	80,00%	**0,37%**	0,0010	0,0022	0,08%	0,00%	**0,08%**	A24
4.D.1.6	Direct Soil Emissions - Sludge	N2O	0,18	0,10	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	202,30	75,98	26,93%	100,00%	103,56%	**0,41%**	-0,0005	0,0019	-0,05%	0,07%	**0,09%**	A26
4.D.3.1	Indirect Emissions - Atmospheric Deposition	N2O	92,63	39,90	57,01%	100,00%	115,11%	**0,24%**	-0,0001	0,0010	-0,01%	0,08%	**0,08%**	A27
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N2O	478,96	209,85	169,23%	380,00%	415,98%	**4,55%**	-0,0004	0,0052	-0,15%	1,24%	**1,25%**	A28
4.F.1	Field Burning of Agricultural Residues - Cereals	CH4	4,98	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	1,02	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	0,00	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	0,00	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	0,51	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	0,31	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	240,23	10,00%	83,07%	83,67%	**1,05%**	0,0038	0,0059	0,32%	0,08%	**0,33%**	W1
6.B.1	Industrial Wastewater	CH4	106,73	5,15	25,00%	104,40%	107,35%	**0,03%**	-0,0011	0,0001	-0,12%	0,00%	**0,12%**	W2
6.B.2	Domestic and Commercial Wastewater (anaerobic)	CH4	8,13	0,74	5,00%	42,43%	42,72%	**0,00%**	-0,0001	0,0000	0,00%	0,00%	**0,00%**	W3

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	2012	AD	EF					due to EF	due to AD		
6.B.2.2	Domestic and Commercial Wastewater - human sewage	N2O	45,84	33,89	5,00%	100,00%	100,12%	**0,18%**	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	0,88	5,00%	100,00%	100,12%	**0,00%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	W5
6.D	Biological Treatment	CH4	0,57	12,44	10,00%	100,00%	100,50%	**0,07%**	0,0003	0,0003	0,03%	0,00%	**0,03%**	W6
6.D	Biological Treatment	N2O	0,63	13,77	10,00%	100,00%	100,50%	**0,07%**	0,0003	0,0003	0,03%	0,00%	**0,03%**	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
	TOTAL		**40 614,54**	**19 188,43**				**5,65%**					**1,98%**	

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	2012	AD	EF					due to EF	due to AD		
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	CO2	4 900,29	339,94	1,70%	1,80%	2,48%	**0,05%**	-0,0728	0,0107	-0,13%	0,03%	**0,13%**	E1
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO2	21 886,83	11 396,09	3,30%	2,39%	4,07%	**2,69%**	-0,0147	0,3584	-0,04%	1,67%	**1,67%**	E1, E7
1.A.1.a	Energy Industries/Electricity and Heat Production - Gaseous Fuels	CO2	1 968,74	908,83	1,40%	3,60%	3,86%	**0,20%**	-0,0050	0,0286	-0,02%	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	1,33	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	11,01	5,00%	60,00%	60,21%	**0,04%**	0,0003	0,0003	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	7,66	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	0,51	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	21,66	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	396,91	3,30%	38,90%	39,04%	**0,90%**	0,0114	0,0125	0,44%	0,06%	**0,45%**	E1
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CH4	0,07	0,45	5,00%	50,00%	50,25%	**0,00%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	E2, E3

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	2012	AD	EF					due to EF	due to AD		
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	N2O	0,10	0,10	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	3,04	0,10	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 - 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 - 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.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - Solid Fuels	CO2	0,00	1,91	3,30%	38,90%	39,04%	**0,00%**	0,0001	0,0001	0,00%	0,00%	**0,00%**	E1
1.A.2.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - Liquid Fuels	CO2	0,00	0,28	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 - Gaseous Fuels	CO2	0,00	0,33	1,40%	3,60%	3,86%	**0,00%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	E1
1.A.2.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - Solid 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	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 - 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.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - Solid Fuels	N2O	0,00	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.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.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - 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.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	CO2	620,74	0,00	3,30%	38,90%	39,04%	**0,00%**	-0,0106	0,0000	-0,41%	0,00%	**0,41%**	E1
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Liquid Fuels	CO2	12,68	7,68	1,70%	1,80%	2,48%	**0,00%**	0,0000	0,0002	0,00%	0,00%	**0,00%**	E1
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Gaseous Fuels	CO2	165,88	25,40	1,40%	3,60%	3,86%	**0,01%**	-0,0020	0,0008	-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/Chemicals - 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	0,05	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 - 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	0,01	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	0,94	1,70%	1,80%	2,48%	**0,00%**	0,0000	0,0000	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	2012	AD	EF					due to EF	due to AD		
1.A.2.d	Manufacturing Industries and Constructions/Pulp, Paper and Print-Gaseous Fuels	CO2	0,00	3,96	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	0,01	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	4,59	0,19	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	437,77	0,97	1,70%	1,80%	2,48%	**0,00%**	-0,0074	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	3,35	1,40%	3,60%	3,86%	**0,00%**	-0,0001	0,0001	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	0,01	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	0,01	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
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	791,47	352,89	3,30%	38,90%	39,04%	**0,80%**	-0,0024	0,0111	-0,09%	0,05%	**0,11%**	E1
1.A.2.f	Manufacturing Industries and Constructions/Other - Liquid Fuels	CO2	327,98	161,14	1,70%	1,80%	2,48%	**0,02%**	-0,0005	0,0051	0,00%	0,01%	**0,01%**	E1
1.A.2.f	Manufacturing Industries and Constructions/Other - Gaseous Fuels	CO2	99,68	87,14	1,40%	3,60%	3,86%	**0,02%**	0,0010	0,0027	0,00%	0,01%	**0,01%**	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	2012	AD	EF					due to EF	due to AD		
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CH4	1,71	0,75	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	0,10	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	0,17	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	0,15	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	1,60	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	0,40	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	0,30	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	115,35	5,00%	60,00%	60,21%	**0,40%**	0,0036	0,0036	0,22%	0,03%	**0,22%**	E2, E4
1.A.2	Manufacturing Industries and Constructions - Other Fuels	CH4	0,00	0,92	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	N2O	0,00	1,80	5,00%	60,00%	60,21%	**0,01%**	0,0001	0,0001	0,00%	0,00%	**0,00%**	E2, E4
1.A.3.A	Civil Aviation - Liquid Fuels	CO2	5,67	3,44	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	2 148,00	1,70%	1,80%	2,48%	**0,31%**	0,0294	0,0676	0,05%	0,16%	**0,17%**	E1
1.A.3.C	Railway - Liquid Fuels	CO2	142,65	91,88	1,70%	1,80%	2,48%	**0,01%**	0,0005	0,0029	0,00%	0,01%	**0,01%**	E1
1.A.3.C	Railways - Solid Fuels	CO2	11,39	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	21,80	12,67	1,70%	1,80%	2,48%	**0,00%**	0,0000	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	3,76	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	0,13	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
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	18,74	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	0,23	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	0,03	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	8,04	0,28	3,30%	38,90%	39,04%	**0,00%**	-0,0001	0,0000	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	2012	AD	EF					due to EF	due to AD		
1.A.4.a	Other Sectors/Commercial - Liquid Fuels	CO2	18,98	1,55	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	32,82	1,40%	3,60%	3,86%	**0,01%**	0,0007	0,0010	0,00%	0,00%	**0,00%**	E1
1.A.4.a	Other Sectors/Commercial - Solid 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 - 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	0,06	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	0,37	10,00%	150,00%	150,33%	**0,00%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	E2, E4
1.A.4.a	Other Sectors/Commercial - Solid Fuels	N2O	0,06	0,00	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 - Liquid Fuels	N2O	0,05	0,00	5,00%	75,00%	75,17%	**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	0,07	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	667,08	38,56	3,30%	38,90%	39,04%	**0,09%**	-0,0102	0,0012	-0,40%	0,01%	**0,40%**	E1
1.A.4.b	Other Sectors/Residential - Liquid Fuels	CO2	544,67	39,50	1,70%	1,80%	2,48%	**0,01%**	-0,0080	0,0012	-0,01%	0,00%	**0,01%**	E1
1.A.4.b	Other Sectors/Residential - Gaseous Fuels	CO2	116,28	126,12	1,40%	3,60%	3,86%	**0,03%**	0,0020	0,0040	0,01%	0,01%	**0,01%**	E1
1.A.4.b	Other Sectors/Residential - Solid Fuels	CH4	25,92	1,68	5,00%	50,00%	50,25%	**0,00%**	-0,0004	0,0001	-0,02%	0,00%	**0,02%**	E2, E3
1.A.4.b	Other Sectors/Residential - Liquid Fuels	CH4	1,53	0,48	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	0,24	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	102,14	10,00%	150,00%	150,33%	**0,89%**	0,0026	0,0032	0,40%	0,05%	**0,40%**	E2, E4
1.A.4.b	Other Sectors/Residential - Solid Fuels	N2O	8,72	0,50	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	0,67	5,00%	75,00%	75,17%	**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	20,10	10,00%	150,00%	150,33%	**0,18%**	0,0005	0,0006	0,08%	0,01%	**0,08%**	E2, E4
1.A.4.c	Other Sectors/Agriculture - Solid Fuels	CO2	15,98	0,00	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	475,95	248,89	1,70%	1,80%	2,48%	**0,04%**	-0,0003	0,0078	0,00%	0,02%	**0,02%**	E1
1.A.4.c	Other Sectors/Agriculture - Gaseous Fuels	CO2	3,68	1,92	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	0,00	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	0,38	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	0,00	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	0,13	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

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	2012	AD	EF					due to EF	due to AD		
1.A.4.c	Other Sectors/Agriculture - Liquid Fuels	N2O	43,64	24,67	5,00%	75,00%	75,17%	**0,11%**	0,0000	0,0008	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	43,44	22,62	1,70%	1,80%	2,48%	**0,00%**	0,0000	0,0007	0,00%	0,00%	**0,00%**	E1
1.A.5	Other - Liquid Fuels	CH4	0,05	0,03	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	0,39	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	177,54	76,57	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	407,44	2,00%	5,00%	5,39%	**0,13%**	0,0046	0,0128	0,02%	0,04%	**0,04%**	I1
2.A.2	Lime Production	CO2	131,30	48,72	5,00%	5,00%	7,07%	**0,02%**	-0,0007	0,0015	0,00%	0,01%	**0,01%**	I2
2.A.4.2	Soda Ash Use	CO2	0,31	0,25	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	9,53	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	2,43	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	24,88	5,00%	10,00%	11,18%	**0,02%**	-0,0064	0,0008	-0,06%	0,01%	**0,06%**	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	50,12	20,0%	10,0%	22,36%	**0,07%**	0,0016	0,0016	0,02%	0,04%	**0,05%**	I4
2.F.1.3	Transport Refrigeration - Refrigerated Vehicles	HFCs	0,00	16,91	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	1,07	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	30,85	26,00%	15,00%	30,02%	**0,05%**	0,0010	0,0010	0,01%	0,04%	**0,04%**	I4
2.F.1.5	Stationary Air-Conditioning - Heat Pumps	HFCs	0,00	3,55	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	16,28	15,00%	18,00%	23,43%	**0,02%**	0,0005	0,0005	0,01%	0,01%	**0,01%**	I4
2.F.1.6	Mobile Air-Conditioning - Passenger Cars	HFCs	0,00	24,57	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	4,68	8,5%	5,0%	9,86%	**0,00%**	0,0001	0,0001	0,00%	0,00%	**0,00%**	I4
2.F.1.6	Mobile Air-Conditioning - Buses	HFCs	0,00	2,11	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	3,26	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	3,43	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

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			1990	2012	AD	EF					due to EF	due to AD		
2.F.2	...One Component PU Foam	HFCs	0,00	4,80	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	2,18	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	2,97	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	1,90	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	4,36	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	20,82	14,36	25,00%	10,00%	26,93%	**0,02%**	0,0001	0,0005	0,00%	0,02%	**0,02%**	S2
4.A	Enteric Fermentation - Dairy Cattle	CH4	583,68	266,63	10,00%	50,00%	50,99%	**0,79%**	-0,0016	0,0084	-0,08%	0,12%	**0,14%**	A1
4.A	Enteric Fermentation - Non-Dairy Cattle	CH4	389,02	133,35	10,00%	50,00%	50,99%	**0,39%**	-0,0024	0,0042	-0,12%	0,06%	**0,14%**	A2
4.A	Enteric Fermentation - Sheep	CH4	23,18	12,90	10,00%	25,00%	26,93%	**0,02%**	0,0000	0,0004	0,00%	0,01%	**0,01%**	A3
4.A	Enteric Fermentation - Goats	CH4	0,19	0,48	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	3,25	2,34	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	17,49	7,72	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	0,20	0,11	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	14,32	21,38	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	8,00	5,65	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	0,55	0,31	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	0,00	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	0,25	0,18	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	41,56	15,67	10,00%	25,00%	26,93%	**0,02%**	-0,0002	0,0005	-0,01%	0,01%	**0,01%**	A13
4.B	Manure Management - Poultry	CH4	10,71	3,56	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	0,27	0,15	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	0,00	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	3,47	2,89	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	303,38	98,34	26,93%	100,00%	103,56%	**0,59%**	-0,0021	0,0031	-0,21%	0,12%	**0,24%**	A18
4.B	Manure Management - Other AWMS	N2O	0,00	5,99	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	394,80	180,73	5,00%	85,44%	85,59%	**0,90%**	-0,0010	0,0057	-0,09%	0,04%	**0,10%**	A20
4.D.1.2	Direct Soil Emissions - Animal Manure Applied to Soils	N2O	186,36	81,06	26,93%	89,44%	93,41%	**0,44%**	-0,0006	0,0025	-0,06%	0,10%	**0,11%**	A21
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N2O	247,95	40,05	0,00%	80,00%	80,00%	**0,19%**	-0,0030	0,0013	-0,24%	0,00%	**0,24%**	A22

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			1990	2012	AD	EF					due to EF	due to AD		
4.D.1.4	Direct Soil Emissions - Crop Residue	N2O	68,37	32,66	0,00%	80,00%	80,00%	**0,15%**	-0,0001	0,0010	-0,01%	0,00%	**0,01%**	A23
4.D.1.5	Direct Soil Emissions - Cultivation of Histosols	N2O	99,13	88,18	0,00%	80,00%	80,00%	**0,41%**	0,0011	0,0028	0,09%	0,00%	**0,09%**	A24
4.D.1.6	Direct Soil Emissions - Sludge	N2O	0,18	0,10	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	202,30	75,98	26,93%	100,00%	103,56%	**0,46%**	-0,0011	0,0024	-0,11%	0,09%	**0,14%**	A26
4.D.3.1	Indirect Emissions - Atmospheric Deposition	N2O	92,63	39,90	57,01%	100,00%	115,11%	**0,27%**	-0,0003	0,0013	-0,03%	0,10%	**0,11%**	A27
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N2O	478,96	209,85	169,23%	380,00%	415,98%	**5,06%**	-0,0016	0,0066	-0,60%	1,58%	**1,69%**	A28
4.F.1	Field Burning of Agricultural Residues - Cereals	CH4	4,98	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	1,02	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	0,00	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	0,00	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	0,51	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	0,31	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	-8 510,49	-2 240,46	1,67%	46,95%	46,98%	**-6,11%**	0,0749	-0,0705	3,51%	-0,17%	**3,52%**	L1
5.A.1	Forest Land remaining Forest Land - mineral soils	CO2	-931,71	-926,95	1,89%	35,00%	35,05%	**-1,88%**	-0,0133	-0,0292	-0,46%	-0,08%	**0,47%**	L2
5.A.1	Forest Land remaining Forest Land - organic soils	CO2	479,39	475,50	4,31%	35,00%	35,26%	**0,97%**	0,0068	0,0150	0,24%	0,09%	**0,25%**	L2
5.A.1	Forest Land remaining Forest Land - dead wood	CO2	-156,43	-342,71	1,97%	12,89%	13,04%	**-0,26%**	-0,0081	-0,0108	-0,10%	-0,03%	**0,11%**	L3
5.A.2.1	Cropland converted to Forest Land - living biomass	CO2	0,00	16,96	24,38%	46,95%	52,90%	**0,05%**	0,0005	0,0005	0,03%	0,02%	**0,03%**	L1
5.A.2.1	Cropland converted to Forest Land - mineral soil	CO2	3,75	52,24	23,24%	35,00%	42,01%	**0,13%**	0,0016	0,0016	0,06%	0,05%	**0,08%**	L2
5.A.2.1	Cropland converted to Forest Land - dead wood	CO2	-1,32	-17,77	92,05%	12,89%	92,95%	**-0,10%**	-0,0005	-0,0006	-0,01%	-0,07%	**0,07%**	L3
5.A.2.2	Grassland converted to Forest Land - living biomass	CO2	-0,64	-91,18	21,80%	46,95%	51,76%	**-0,27%**	-0,0029	-0,0029	-0,13%	-0,09%	**0,16%**	L1
5.A.2.2	Grassland converted to Forest Land - mineral soils	CO2	1,07	16,92	21,11%	35,00%	40,87%	**0,04%**	0,0005	0,0005	0,02%	0,02%	**0,02%**	L2
5.A.2.2	Grassland converted to Forest Land - organic soils	CO2	0,24	3,07	73,77%	35,00%	81,66%	**0,01%**	0,0001	0,0001	0,00%	0,01%	**0,01%**	L2
5.A.2.2	Grassland converted to Forest Land - dead wood	CO2	-1,55	-26,87	27,97%	12,89%	30,80%	**-0,05%**	-0,0008	-0,0008	-0,01%	-0,03%	**0,04%**	L3
5.A.2.3	Wetlands converted to Forest Land - living biomass	CO2	0,00	2,28	40,17%	46,95%	61,79%	**0,01%**	0,0001	0,0001	0,00%	0,00%	**0,01%**	L1
5.A.2.3	Wetlands converted to Forest Land - organic soils	CO2	0,28	12,29	39,49%	35,00%	52,77%	**0,04%**	0,0004	0,0004	0,01%	0,02%	**0,03%**	L2
5.A.2.3	Wetlands converted to Forest Land - dead wood	CO2	-0,15	-6,37	97,43%	12,89%	98,28%	**-0,04%**	-0,0002	-0,0002	0,00%	-0,03%	**0,03%**	L3
5.A.2.4	Settlements converted to Forest Land - living biomass	CO2	0,00	4,86	52,11%	46,95%	70,14%	**0,02%**	0,0002	0,0002	0,01%	0,01%	**0,01%**	L1
5.A.2.4	Settlements converted to Forest Land - mineral soils	CO2	-0,21	-1,60	55,58%	35,00%	65,68%	**-0,01%**	0,0000	-0,0001	0,00%	0,00%	**0,00%**	L2
5.A.2.4	Settlements converted to Forest Land - organic soils	CO2	0,15	1,05	138,58%	35,00%	142,94%	**0,01%**	0,0000	0,0000	0,00%	0,01%	**0,01%**	L2

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			1990	2012	AD	EF					due to EF	due to AD		
5.A.2.4	Settlements converted to Forest Land - dead wood	CO2	-0,46	-3,05	102,92%	12,89%	103,73%	**-0,02%**	-0,0001	-0,0001	0,00%	-0,01%	**0,01%**	L3
5.A.2.5	Other Land converted to Forest Land - living biomass	CO2	0,00	10,52	34,65%	46,95%	58,35%	**0,04%**	0,0003	0,0003	0,02%	0,02%	**0,02%**	L1
5.A.2.5	Other Land converted to Forest Land - mineral soil	CO2	-0,46	-4,49	33,85%	35,00%	48,69%	**-0,01%**	-0,0001	-0,0001	0,00%	-0,01%	**0,01%**	L2
5.A.2.5	Other Land converted to Forest Land - dead wood	CO2	-0,81	-7,37	95,28%	12,89%	96,15%	**-0,04%**	-0,0002	-0,0002	0,00%	-0,03%	**0,03%**	L3
5.B.1	Cropland remaining Cropland - living biomass	CO2	3,73	10,34	39,29%	46,95%	61,22%	**0,04%**	0,0003	0,0003	0,01%	0,02%	**0,02%**	L1
5.B.1	Cropland remaining Cropland - mineral soils	CO2	-354,20	-312,10	2,76%	50,00%	50,08%	**-0,91%**	-0,0038	-0,0098	-0,19%	-0,04%	**0,19%**	L4
5.B.1	Cropland remaining Cropland - organic soils	CO2	466,36	402,01	21,41%	90,00%	92,51%	**2,16%**	0,0047	0,0126	0,42%	0,38%	**0,57%**	L5
5.B.2.2	Grassland converted to Cropland - living biomass	CO2	0,00	13,84	33,28%	46,95%	57,55%	**0,05%**	0,0004	0,0004	0,02%	0,02%	**0,03%**	L1
5.B.2.2	Grassland converted to Cropland - mineral soils	CO2	0,00	47,42	33,24%	30,00%	44,77%	**0,12%**	0,0015	0,0015	0,04%	0,07%	**0,08%**	L4
5.B.2.2	Grassland converted to Cropland - organic soils	CO2	0,00	12,80	138,58%	90,00%	165,24%	**0,12%**	0,0004	0,0004	0,04%	0,08%	**0,09%**	L5
5.B.2.2	Grassland converted to Cropland - dead wood	CO2	0,00	0,24	33,28%	12,89%	35,69%	**0,00%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	L3
5.B.2.2	Grassland converted to Cropland - (5III) mineral soils	N2O	0,00	5,25	33,24%	50,00%	60,04%	**0,02%**	0,0002	0,0002	0,01%	0,01%	**0,01%**	L4
5.C.1	Grassland remaining Grassland - living biomass	CO2	-144,61	423,29	9,74%	46,95%	47,95%	**1,18%**	0,0158	0,0133	0,74%	0,18%	**0,76%**	L1
5.C.1	Grassland remaining Grassland - organic soils	CO2	128,86	114,27	16,85%	35,00%	38,85%	**0,26%**	0,0014	0,0036	0,05%	0,09%	**0,10%**	L2
5.C.1	Grassland remaining Grassland - dead wood	CO2	-1,20	3,35	19,19%	12,89%	23,12%	**0,00%**	0,0001	0,0001	0,00%	0,00%	**0,00%**	L3
5.C.2.1	Forest Land converted to Grassland - net carbon stock change in living biomass	CO2	15,75	15,76	40,58%	46,95%	62,05%	**0,06%**	0,0002	0,0005	0,01%	0,03%	**0,03%**	L1
5.C.2	Land converted to Grassland - living biomass (excl. FL)	CO2	0,00	-13,32	16,30%	46,95%	49,69%	**-0,04%**	-0,0004	-0,0004	-0,02%	-0,01%	**0,02%**	L1
5.C.2	Land converted to Grassland - mineral soils	CO2	-1,68	-151,73	14,03%	35,00%	37,71%	**-0,33%**	-0,0047	-0,0048	-0,17%	-0,09%	**0,19%**	L2
5.C.2	Land converted to Grassland - organic soils	CO2	1,72	24,48	45,67%	35,00%	57,54%	**0,08%**	0,0007	0,0008	0,03%	0,05%	**0,06%**	L2
5.C.2.1	Forest Land converted to Grassland - dead wood	CO2	-0,08	16,08	40,59%	30,07%	50,51%	**0,05%**	0,0005	0,0005	0,02%	0,03%	**0,03%**	L3
5.C.2	Land converted to Grassland - dead wood (excl. FL)	CO2	0,00	-0,41	23,21%	30,07%	37,98%	**0,00%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	L3
5.D.1	Wetlands remaining Wetlands\Peatland - organic soils managed for peat extraction	CO2	99,31	99,53	22,76%	50,00%	54,93%	**0,32%**	0,0014	0,0031	0,07%	0,10%	**0,12%**	L6
5.D.2	Land converted to Wetlands - (5II) Non-CO2 emissions from drainage of soils and wetlands\Peatland	CH4	0,05	0,06	26,34%	50,00%	56,51%	**0,00%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	L6
5.D.2	Land converted to Wetlands - (5II) Non-CO2 emissions from drainage of soils and wetlands\Peatland	N2O	1,44	1,72	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	22,01	65,85	102,78%	46,95%	112,99%	**0,43%**	0,0017	0,0021	0,08%	0,30%	**0,31%**	L1
5.D.2.1	Forest Land converted to Wetlands - organic soils managed for peat extraction	CO2	0,00	16,41	74,07%	50,00%	89,36%	**0,09%**	0,0005	0,0005	0,03%	0,05%	**0,06%**	L6

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			1990	2012	AD	EF					due to EF	due to AD		
5.D.2.1	Forest Land converted to Wetlands - dead wood	CO2	0,78	1,88	51,23%	12,89%	52,82%	**0,01%**	0,0000	0,0001	0,00%	0,00%	**0,00%**	L3
5.D.2.5	Wetlands converted to Peatland - organic soils	CO2	0,15	2,75	74,07%	50,00%	89,36%	**0,01%**	0,0001	0,0001	0,00%	0,01%	**0,01%**	L6
5.E.2	Land converted to Settlements - living biomass	CO2	0,53	102,06	62,81%	46,95%	78,42%	**0,46%**	0,0032	0,0032	0,15%	0,29%	**0,32%**	L1
5.E.2	Land converted to Settlements - soils	CO2	0,01	120,18	24,31%	35,00%	42,61%	**0,30%**	0,0038	0,0038	0,13%	0,13%	**0,19%**	L2
5.E.2	Land converted to Settlements - dead wood	CO2	0,02	41,57	28,74%	12,89%	31,50%	**0,08%**	0,0013	0,0013	0,02%	0,05%	**0,06%**	L3
5.F.2	Land converted to Other Land - living biomass (excl FL)	CO2	0,00	0,06	72,75%	46,95%	86,58%	**0,00%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	L1
5.F.2.1	Forest Land converted to Other Land - living biomass	CO2	0,00	13,42	62,81%	46,95%	78,42%	**0,06%**	0,0004	0,0004	0,02%	0,04%	**0,04%**	L1
5.F.2	Land converted to Other Land - soils	CO2	0,00	18,50	55,34%	35,00%	65,48%	**0,07%**	0,0006	0,0006	0,02%	0,05%	**0,05%**	L2
5.F.2	Land converted to Other Land - dead wood	CO2	0,00	0,00	78,78%	12,89%	79,83%	**0,00%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	L3
5.F.2.1	Forest Land converted to Other Land - dead wood	CO2	0,00	11,04	62,82%	12,89%	64,13%	**0,04%**	0,0003	0,0003	0,00%	0,03%	**0,03%**	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	0,01	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	0,00	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	15,32	29,15%	50,00%	57,88%	**0,05%**	-0,0005	0,0005	-0,03%	0,02%	**0,03%**	L8
6.A	Solid Waste Disposal on Land	CH4	179,67	240,23	10,00%	83,07%	83,67%	**1,17%**	0,0045	0,0076	0,37%	0,11%	**0,39%**	W1
6.B.1	Industrial Wastewater	CH4	106,73	5,15	25,00%	104,40%	107,35%	**0,03%**	-0,0017	0,0002	-0,17%	0,01%	**0,17%**	W2
6.B.2	Domestic and Commercial Wastewater (anaerobic)	CH4	8,13	0,74	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	33,89	5,00%	100,00%	100,12%	**0,20%**	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	0,88	5,00%	100,00%	100,12%	**0,01%**	0,0000	0,0000	0,00%	0,00%	**0,00%**	W5
6.D	Biological Treatment	CH4	0,57	12,44	10,00%	100,00%	100,50%	**0,07%**	0,0004	0,0004	0,04%	0,01%	**0,04%**	W6
6.D	Biological Treatment	N2O	0,63	13,77	10,00%	100,00%	100,50%	**0,08%**	0,0004	0,0004	0,04%	0,01%	**0,04%**	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
	TOTAL		**31 794,37**	**17 237,25**				**9,45%**					**4,57%**	

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