LATVIA'S NATIONAL INVENTORY REPORT

Submission under UNFCCC and the Kyoto Protocol

Common Reporting Formats (CRF)

1990 – 2014

2016

PREFACE

Latvia's National Inventory under the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC contains following parts:

1. Latvia's National Inventory Report is prepared using the reporting guidelines of UNFCCC (adopted by decision 24/CP.19) and relevant parts of the Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol;

2. CRF (Common Reporting Format) data tables for years 1990-2014 including KP-LULUCF data tables. The CRF tables are compiled with the UNFCCC CRF Reporter software (version 5.14);

3. SEF (Standard Electronic Tables) for reporting of Kyoto units (AAU, ERU, CER, t-CER, l-CER, RMU) in the registry. SEF tables are provided separately for units relevant to the first commitment period (SEF tables for 2015) and for units relevant to the second commitment period (SEF tables for 2014 and 2015).

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The Latvia's National Inventory Report as well as the CRF tables can be downloaded from address:
http://www.meteo.lv/

DISCLAIMER

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

"Functioning" software means that the data on the greenhouse emissions/removals are reported accurately both in terms of reporting format tables and XML format. The CRF reporter version 5.12.0, released on 27th November 2015, as well as its subsequent hotfixes, still contain issues in the reporting format tables and XML formats, in particular in relation to Kyoto Protocol requirements, and cannot therefore be considered yet as functioning to allow submission of all the information required under Kyoto Protocol.

In 2015 Latvia made an inventory submission under UNFCCC, but not under Kyoto Protocol because the CRF Reporter could not deliver CRF tables for Kyoto Protocol LULUCF activities without errors. The present report is the official inventory submission of Latvia for the year 2016 under the UNFCCC and for the years 2015 and 2016 under the Kyoto Protocol in spite of the remaining deficiencies in the CRF Reporter and underlying CRF tables. Latvia should not be held liable for errors caused by the CRF Reporter in the review of the submitted information. The inventory data reported in the 2015 submission under the UNFCCC have been revised in this submission. Therefore, the 2016 submission should also be considered as a resubmission of the estimates with regard to the 2015 UNFCCC submission.

The CRF Reporter still contains several issues regarding the information required under Kyoto Protocol. For example, it is not possible to make the choice of accounting annually or at the end of the commitment period. Also there are errors and display issues in most sectors. These errors concern data that do not affect the calculation of the total national emissions.

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UNITS AND ABBREVIATIONS

t	1 tonne (metric) = 1 megagram (Mg) = 10^6 g
Mg	1 megagram = 10^6 g = 1 tonne (t)
kt	1 gigagram = 10^9 g = 1 kilotonne (kt)
Tg	1 teragram = 10^{12} g = 1 megatonne (Mt)
TJ	1 terajoule = 1000 Gigajoule = 10^{12} J

AAU – Assigned Amount Units
AR – Afforestation and reforestation
AWMS - Animal waste management systems
CER – Certified Emission Reduction Units
CH_4 – Methane
CIS – Commonwealth of Independent States
CO_2 – Carbon dioxide
CO_2 eq. – Carbon dioxide equivalent
CO – Carbon monoxide
CR – Corinair emission factor
CRF – Common Reporting Format
CS – Country specific
CSB – Central Statistical Bureau
D – Default emission factor
EMEP/CORINAIR 2007 – Atmospheric emission inventory guidebook, Co-operative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe, The Core inventory of air emissions in Europe
EMEP/EEA 2013 - EMEP/EEA air pollutant emission inventory guidebook 2013
EU – European Union
EU ETS – European Union Emission Trading Scheme
EU MMR – European Union Monitoring Mechanism Regulation
EU ESD – European Union Effort Sharing Decision
ERT – Expert review team
ERU – Emission Reduction Units
ETR – Emission trading registry
GHG – Greenhouse Gases
GDP – Gross domestic product
HFC – Hydrofluorocarbon
HWP – Harvested wood products
FM – Forest management
FMRL – Forest Management Reference Level
IE – Included elsewhere
IPCC – Intergovernmental Panel on Climate Change
IPCC 1996 – Revised 1996 IPCC Guidelines for National Greenhouse gas Inventories (1997)
IPCC GPG 2000 - IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000)
IPCC GPG LULUCF 2003 – IPCC Good Practice Guidance for land Use, Land – Use Change and Forestry (2003)

2006 IPCC GUIDELINES – 2006 IPCC Guidelines for National Greenhouse Gas Inventories
IPCC WETLANDS SUPPLEMENT - 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands
IPCC KP SUPPLEMENT - 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol
IPE – Institute of Physical Energetics
IPPC - Integrated Pollution Prevention Control
l-CER – Long term Certified Emission Reduction Unit
LEGMC – Latvian Environment, Geology and Meteorology Centre
LSIAE – Latvian State Institute of Agrarian Economics
LULUCF – Land Use, Land Use Change and Forestry
MoA - Ministry of Agriculture of the Republic of Latvia
MEPRD - Ministry of Environmental Protection and Regional Development of the Republic of Latvia
MoT - Ministry of Transport
MMS – Manure management system
NFI – National forest inventory
NF_3 – Nitrogen trifluoride
N_2O – Nitrous oxide
NOx – Nitrogen oxides
NA – Not applicable
NCV – Net calorific value
NE – Not estimated
NIR – National inventory report
NMVOC - Non-methane volatile organic compounds
NO – Not occuring in Latvia
OECD - Organisation for Economic Co-operation and Development
PFC – Perfluorocarbon
REB – Regional Environment Boards
RMU – Removal Units
RTSD – Road Traffic Safety Department
SAM – State Agency of Medicines of the Republic of Latvia
SEF – Standart Electronic Format
SFRS – State Firefighting & Rescue Service
SFS – State Forest Service
SF_6 – Sulphur hexafluoride
SO_2 – Sulphur dioxide
UN – United Nations
UNFCCC – United Nations Framework Convention on Climate Change
TERT – Technical expert review team
t-CER – Temporary Certified Emission Reduction units

EXECUTIVE SUMMARY

ES.1 Background Information on GHG inventories, climate change and supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

ES.1.1 Background information on climate change

Latvia takes part in the global climate change mitigation process and together with many other countries of the world signed the United Nations (UN) Framework Convention on Climate Change (UNFCCC) in Rio de Janeiro the UN Conference on Environment and Development held in 1992. It entered into force on 21 March 1994. The Parliament of the Republic of Latvia (Saeima) ratified the UNFCCC on 23 February 1995. On May 30, 2002 the Parliament ratified the Kyoto Protocol.

Latvia is a member of European Union since May, 2004 and therefore has reporting obligations also under the Regulation (EU) No 525/2013 of the European Parliament and of the Council on a mechanism for monitoring and reporting GHG emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC (EU MMR). This regulation comprises reporting to fulfil the EU Effort Sharing Decision (406/2009/EC) and the EU LULUCF Decision (529/2013/EU). Commission Implementing Regulation (EU) No 749/2014 and the Commission Delegated Regulation (EU) No 666/2014 determine implementation of the Regulation (EU) No 525/2013.

Under these above mentioned agreements Latvia is required to provide annually information on anthropogenic greenhouse gas emissions by sources and removals by sinks of all greenhouse gases not controlled by Montreal Protocol from following sectors: Energy, Industrial Processes and Product Use, Agriculture, Land Use, Land Use Change and Forestry and Waste.

For the second commitment period of the Kyoto Protocol (agreement under Article 4 of the Kyoto Protocol) until 2020 European Union and its Member States, and Iceland has agreed to achieve jointly their quantified emission limitation and reduction commitment (QELRC) by 20% compared to the emissions in the base year or period during the 2013- 2020. The efforts of the reduction (reduction targets) are shared out as follows:

- 21% reduction compared to 2005 level for the emissions from sectors covered by the European Union Emission Trading Scheme (EU ETS); this goal is EU-wide and defines that all EU ETS operators jointly reduce the total GHG emissions;
- around 10% reduction compared to 2005 for other emitters (sectors and activities not included in the EU ETS which are regulated by Effort Sharing Decision[1] (EU ESD)). Member States have taken on binding annual targets for reducing their GHG emissions from the sectors not covered by the EU ETS, such as housing, agriculture, waste and transport (excluding aviation). The national targets, covering the period 2013-2020, are differentiated according to Member States relative wealth (measured by Gross Domestic Product (GDP) per capita. In accordance with EU ESD

[1] *http://ec.europa.eu/clima/policies/effort/index_en.htm*

(406/2009/EC) Latvia's national target is to limit emission growth to +17% above the 2005 level by 2020.

Allocated emission level of Latvia for the period 2013-2020 set out in the terms of the joint fulfilment for the second commitment period under the Kyoto Protocol is 76633439 tonnes carbon dioxide equivalent (Assigned amount). In addition to non – ETS emissions Latvia is responsible for the emissions/removals related to the Kyoto Protocol LULUCF activities according to decision 2/CMP.7.

ES.1.2 Background information on greenhouse gas inventories

The annual greenhouse gas inventory contains information on the trends of national greenhouse gas emissions by sources and removals by sinks since 1990.

According to the Regulation No. 217 of Cabinet of Ministers (27.03.2012.) Ministry of Environmental Protection and Regional Development (MEPRD) is a single national entity with overall responsibility for the Latvia's GHG inventory. The main institutions involved in the compilation of the Latvia's GHG inventory are the MEPRD, Latvian Environment, Geology and Meteorology Centre (LEGMC), Latvian State Forest Research Institute "Silava", Latvia University of Agriculture (LUA), Institute of Physical Energetics (IPE). Description of the national greenhouse gas inventory system including the institutional arrangements is provided in Section 1.2.

The GHG inventory is prepared according to the UNFCCC Decision 24/CP.19[2] Annex I reporting guidelines "Guidelines for the preparation of national communications by Parties included in Annex I of the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories on annual inventories" (UNFCCC Annex I GHG inventory reporting guidelines) and tables of the common reporting format to implement the use of the 2006 IPCC Guidelines for National Greenhouse Gas inventories (2006 IPCC Guidelines), 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (IPCC Wetlands Supplement) and 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (IPCC KP Supplement).

For the preparation of the 2016 inventory submission CRF Reporter v5.14 software has been used. Due to severe problems with the CRF software in 2015 and 2016 minor inconsistencies and data display issues may still exist in the reporting tables.

ES.1.2 Background information on supplementary information required under Article 7, paragraph 1 of the Kyoto Protocol

The required information is consistent with relevant decisions and guidelines under Article 7 paragraph 1 and includes information on Latvia's assigned amount for the second commitment period, corresponding emissions and removals (Chapter 12), changes in the national system (Chapter 13) and national registry (Chapter 14), information related to Article 3, paragraphs 3 and 4 (Chapter 11), and Article 3, paragraph 14 (Chapter 15). The summary of information on the accounting of Kyoto units is provided in Chapter 12.

[2] *http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf#page=2*

ES.2 Summary of National Emission and Removal-Related Trends

ES.2.1 GHG inventory

In 2014, Latvia's greenhouse gas emissions constituted 11353.38 kt CO_2 eq (without LULUCF) and 15573.52 kt CO_2 eq (with LULUCF). Latvia's total GHG emissions without LULUCF showed a decrease of 56.76% comparing to the base year, but GHG emissions with LULUCF have decreased by 12.68% compared to base year.

If compared to 2013 total GHG emissions excluding LULUCF have decreased by 0.5%, but including LULUCF GHG emissions have increased by 23.4% (Figure ES.1).

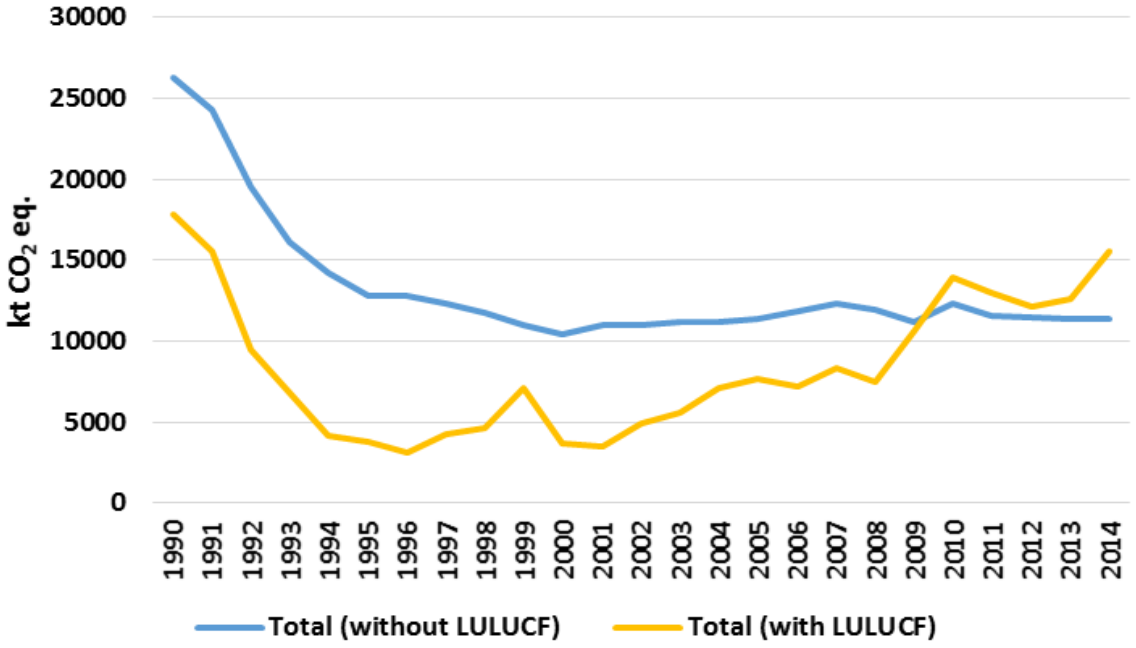

Figure ES.1 Latvia`s total GHG emissions (with and without LULUCF) 1990–2014 (kt CO_2 eq.)

Aggregated GHG emissions 1990 - 2014, kt CO_2 eq by gases are reflected in Table ES.1 a and Table ES.1 b and by sectors reflected in Table ES.2 a and Table ES.2 b.

Table ES.1 a Aggregated GHG emissions by gases (1990 - 2002), kt CO_2 eq.

GREENHOUSE GAS EMISSIONS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
kt CO_2 equivalent													
CO_2 emissions including net CO_2 from LULUCF	19696.76	17917.75	14185.15	11924.39	10364.81	9115.53	9189.79	8660.94	8286.62	7702.50	7069.73	7484.81	7513.66
CO_2 emissions excluding net CO_2 from LULUCF	10391.42	8356.27	3195.54	1792.22	-586.35	-825.79	-1442.51	-309.28	186.74	2891.01	-570.20	-927.66	540.21
CH_4 emissions including CH_4 from LULUCF	3671.26	3618.13	3127.74	2399.59	2221.66	2195.31	2149.66	2114.38	2020.45	1886.83	1922.68	2011.13	1988.24
CH_4 emissions excluding CH_4 from LULUCF	3978.78	3920.49	3513.28	2707.83	2528.59	2512.92	2470.30	2439.73	2347.79	2246.75	2268.63	2318.27	2323.97
N_2O emissions including N_2O from LULUCF	2888.42	2733.79	2211.11	1784.12	1623.45	1476.64	1497.21	1507.69	1465.25	1396.00	1420.33	1517.21	1478.85
N_2O emissions excluding N_2O from LULUCF	3464.60	3311.17	2800.02	2365.67	2206.13	2062.45	2085.22	2098.48	2058.25	1993.90	2018.53	2112.76	2079.87
HFCs	NO,NA,NE	NO,NA,NE	NO,NA,NE	NO,NA,NE	NO,NA,NE	11.50	12.59	12.73	15.33	17.07	20.46	23.92	27.20
PFCs	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA
Unspecified mix of HFCs and PFCs	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA
SF_6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.17	0.18	0.37	0.52	0.71	0.88	1.39	2.62
NF_3	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA
Total (without LULUCF)	26256.43	24269.68	19524.00	16108.10	14209.92	12799.16	12849.42	12296.11	11788.17	11003.11	10434.07	11038.46	11010.57
Total (with LULUCF)	17834.80	15587.93	9508.84	6865.72	4148.37	3761.25	3125.77	4242.03	4608.63	7149.43	3738.30	3528.68	4973.87
Total (without LULUCF, with indirect)	26299.86	24310.73	19562.26	16144.28	14245.38	12833.33	12881.87	12326.59	11817.09	11031.09	10460.47	11064.39	11036.92
Total (with LULUCF, with indirect)	17878.23	15628.98	9547.09	6901.91	4183.83	3795.42	3158.22	4272.51	4637.55	7177.41	3764.70	3554.61	5000.22

Table ES.1 b Aggregated GHG emissions by gases (2003 - 2014), kt CO_2 eq.

GREENHOUSE GAS EMISSIONS	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Change from 1990 to latest reported year (%)
kt CO_2 equivalent													
CO_2 emissions including net CO_2 from LULUCF	7710.50	7721.00	7796.46	8293.58	8616.09	8188.85	7443.50	8528.14	7785.47	7500.68	7331.99	7139.01	-63.76
CO_2 emissions excluding net CO_2 from LULUCF	1233.72	2733.73	3185.62	2643.19	3679.80	2874.11	5876.01	9149.89	8165.60	7139.68	7483.51	10272.49	-1.14
CH_4 emissions including CH_4 from LULUCF	1894.33	1871.49	1929.45	1906.51	1967.58	1962.60	1944.00	1949.62	1897.77	1971.19	2010.24	2082.21	-43.28
CH_4 emissions excluding CH_4 from LULUCF	2208.82	2179.76	2211.32	2231.04	2248.81	2242.75	2247.45	2263.16	2226.59	2318.06	2376.88	2471.09	-37.89
N_2O emissions including N_2O from LULUCF	1532.56	1523.55	1587.19	1597.04	1653.07	1641.94	1670.71	1711.99	1726.28	1823.61	1859.45	1911.52	-33.82
N_2O emissions excluding N_2O from LULUCF	2133.09	2125.38	2187.28	2206.16	2256.70	2247.21	2294.35	2351.49	2382.43	2496.89	2550.06	2609.30	-24.69
HFCs	31.18	47.54	63.48	98.09	123.59	142.02	152.14	164.42	184.97	190.21	204.35	212.06	
PFCs	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NA,NO	
Unspecified mix of HFCs and PFCs	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NA,NO	
SF_6	2.76	3.25	3.78	4.07	4.55	5.23	7.33	7.35	7.47	7.78	8.50	8.58	
NF_3	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NA,NO	
Total (without LULUCF)	11171.32	11166.82	11380.36	11899.29	12364.87	11940.64	11217.68	12361.52	11601.95	11493.46	11414.54	11353.38	-56.76
Total (with LULUCF)	5609.57	7089.66	7651.48	7182.55	8313.44	7511.32	10577.28	13936.31	12967.06	12152.61	12623.30	15573.52	-12.68
Total (without LULUCF, with indirect)	11192.38	11187.13	11401.99	11915.74	12382.82	11957.86	11234.02	12377.17	11612.38	11505.76	11429.70	11373.59	-56.75
Total (with LULUCF, with indirect)	5630.63	7109.98	7673.11	7199.00	8331.39	7528.54	10593.62	13951.96	12977.48	12164.92	12638.46	15593.73	-12.78

Table ES.2 a Aggregated GHG emissions by sectors (1990 - 2001), kt CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	kt CO_2 equivalent											
1. Energy	19283.59	17767.42	14434.58	12339.12	10710.49	9447.74	9513.29	8943.56	8528.63	7893.77	7278.72	7703.47
2. Industrial processes and Product Use	707.49	610.71	322.83	169.86	217.84	237.25	249.20	266.26	273.35	307.50	260.31	283.27
4. Agriculture	5454.03	5046.68	3960.74	2870.04	2569.14	2402.49	2373.38	2360.20	2255.46	2063.64	2098.00	2221.44
5. Land use, land use change and forestry	-8421.63	-8681.75	-10015.17	-9242.38	-10061.55	-9037.92	-9723.65	-8054.08	-7179.54	-3853.68	-6695.77	-7509.78
6. Waste	811.33	844.87	805.86	729.08	712.44	711.68	713.55	726.09	730.73	738.19	797.04	830.28
7. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total emissions (including LULUCF)	17834.80	15587.93	9508.84	6865.72	4148.37	3761.25	3125.77	4242.03	4608.63	7149.43	3738.30	3528.68

Table ES.2 b Aggregated GHG emissions by sectors (2002 - 2014), kt CO_2 eq.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Change from 1990 to latest reported year (%)
	kt CO_2 equivalent													
1. Energy	7707.29	7863.85	7892.21	8003.77	8433.73	8758.30	8305.10	7584.11	8379.65	7511.33	7195.26	7117.63	6952.97	-63.94
2. Industrial processes and Product Use	298.08	315.17	350.66	347.38	404.92	432.84	447.99	441.11	711.12	823.16	892.51	828.38	837.00	18.31
4. Agriculture	2202.85	2255.76	2187.26	2270.81	2278.80	2374.42	2352.33	2385.02	2430.52	2456.41	2573.92	2639.74	2726.42	-50.01
5. Land use, land use change and forestry	-6036.70	-5561.76	-4077.16	-3728.88	-4716.73	-4051.43	-4429.32	-640.40	1574.79	1365.10	659.16	1208.75	4220.14	-150.11
6. Waste	802.34	736.55	736.68	758.40	781.84	799.31	835.22	807.43	840.22	811.05	831.77	828.80	836.99	3.16
7. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Total emissions (including LULUCF)	4973.87	5609.57	7089.66	7651.48	7182.55	8313.44	7511.32	10577.28	13936.31	12967.06	12152.61	12623.30	15573.52	-12.68

ES.2.2 KP-LULUCF activities

For the LULUCF activities under Article 3 paragraphs 3 and 4, of Kyoto Protocol Latvia has chosen accounting at the end of period[3]. Therefore the accounting quantity will be reported in the annual report commitment submitted for the last year of the commitment period (in 2022) and calculated over the entire commitment period.

Article 3.3 covers human induced afforestation (A), reforestation (R) and deforestation activities, which should be accounted mandatory. Under Article 3.4 Latvia has elected the activity Forest Management (FM) for the second commitment period. Latvia's FM reference level for the second commitment period is -16302 kt CO_2 equivalent a year, including harvested wood products, and -14255 kt CO_2 equivalent a year assuming instantaneous oxidation of harvested wood products according to the appendix to the annex to decision 2/CMP.7[4]. Latvia will make technical corrections for the forest management reference level according to the requirements of decision 2/CMP.7 and 2/CMP.8.

ES.3 Overview of Source and Sink Category Emission Estimates and Trends

ES.3.1 GHG inventory

The main sources of greenhouse gas emissions are divided into the following sectors (according to Decision 24/CP.19): Energy (CRF 1), Industrial processes and Product Use (CRF 2), Agriculture (CRF 3), Land use, Land use change and Forestry (LULUCF) (CRF 4) and Waste (CRF 5). GHG emissions by sectors are shown in the Figure ES.2.

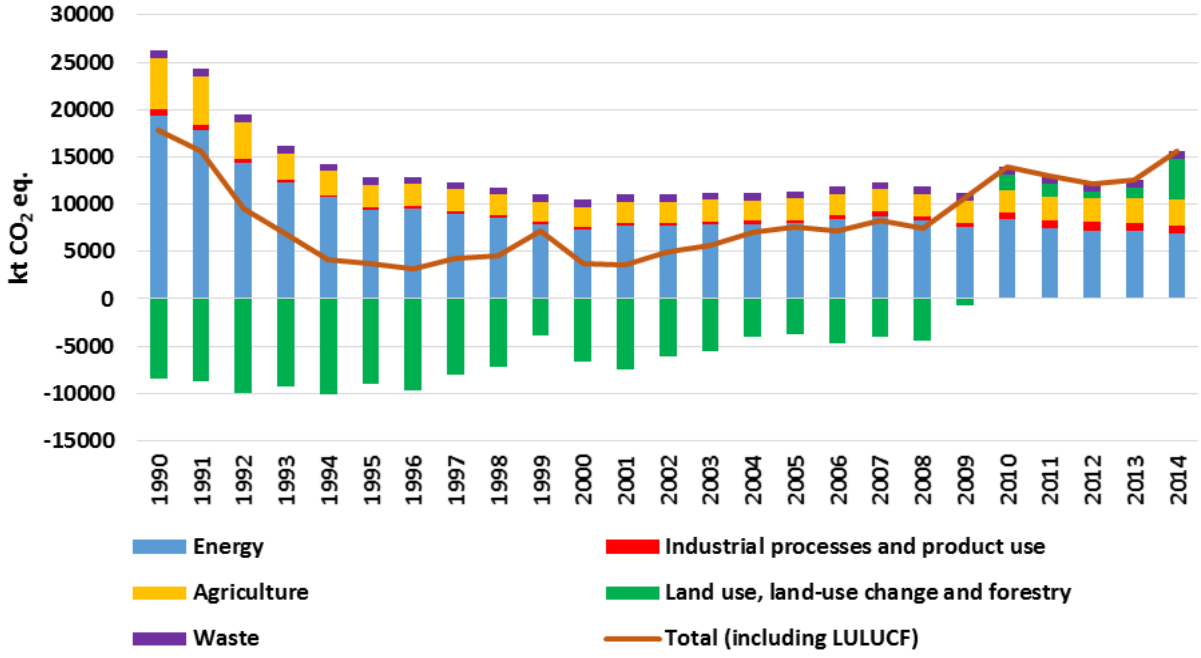

Figure ES.2 Latvia`s GHG emissions and removals by sectors 1990-2014 (kt CO_2 eq.)

[3] *Current version of CRF Reporter (v5.14) does not provide option to make the choice of accounting annually or at the end of the commitment period. "End of the period" option will be selected when this will be technically possible in CRF Reporter.*
[4] *http://unfccc.int/resource/docs/2011/cmp7/eng/10a01.pdf*

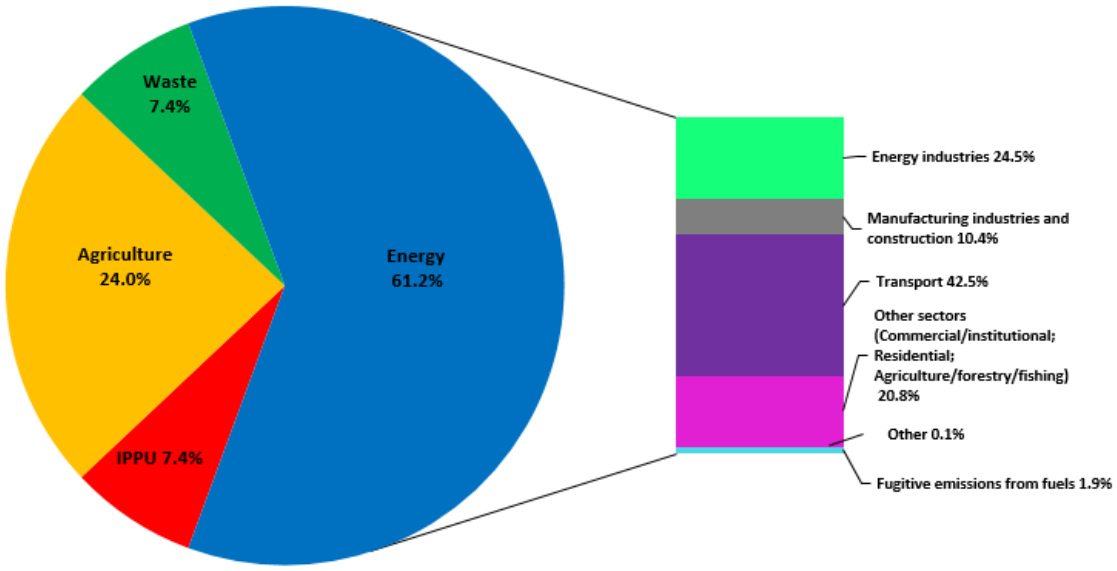

Figure ES.3 The composition of Latvian greenhouse gas emissions in 2014 (excluding LULUCF)

The **Energy sector** is the most significant source of GHG emissions with 61.2% share of the total emissions in the 2014. GHG emissions fluctuate in the latest years mainly due to the economic trend, the energy supply structure and climate conditions. Total emissions in Energy sector in 2014 decreased by 63.94% if compared to the base year. A large part of energy sector emissions comes from transport sector (42.5%). Emissions from transport increased by 4.3% compared to 2013 mainly due to GHG emission increase in road transport.

Agriculture is the second most significant source of GHG emissions, with approximately 24.0% of Latvia's total GHG emissions excluding LULUCF in 2014. Emissions from agriculture include CH_4, N_2O emissions from enteric fermentation, manure management and agricultural soils and CO_2 emissions from liming and urea application. In 2014 GHG emissions have increased by 3.3% compared to 2013 due to increase of cattle, sheep and fur animal number, synthetic N fertilizer consumption, crop production and lime application to soils. The annual emissions have reduced approximately by 50% since 1990 due to decrease in agricultural production. In 2014, given in CO_2 eq, the N_2O contributed 63.4%, CH_4 contributed 35.7% of total GHG emission from the agricultural sector, remaining 0.9% refer to CO_2 emissions from liming and urea application.

Emissions from the **Waste sector** contribute 7.4% of total GHG emissions excluding LULUCF in 2014. Emissions from Waste include CH_4 and N_2O emissions from solid waste disposal, biological treatment of solid waste, incineration and open burning of waste as well as waste water treatment and discharge. Waste emissions have been fluctuating since 1990. In 2014, emissions were approximately 3.2% higher than in 1990, but compared to 2013 emissions increased by 1.0%. Trend could be explained with changes in economic situation in Latvia.

The emissions from **Industrial Processes and Product Use (IPPU)** (referred to as non-energy related ones), include CO_2, CH_4, N_2O and F-gases. The category constitutes 7.4% of the total GHG emissions excluding LULUCF in 2014. Compared to 1990 emissions from IPPU have increased by 18.3%, but compared to 2013 emissions increased by 1.0%.

The largest decrease in IPPU emissions occurred between years 1991 and 1993, when industry was affected by a crisis. Emission fluctuations in product uses sectors are also linked

with the economic situation of the country. In the latest years emissions increased significantly due to overall increase of activity in industrial production processes.

F-gases emissions from 2.F Product uses as substitutes for ozone depleting substances (ODS) constitute 1.9% from total GHG emissions excluding LULUCF in 2014. Emissions from HFC and SF_6 have grown significantly since 1995. Compared to 2013 F-gases emissions increased by 3.8% due to increase of activity data reported by F-gases importers and users.

In 2014 indirect CO_2 emissions from Solvent Use sector have decreased by 3.2%, compared to 2013. Solvent Use sector was the largest NMVOC emission source in Latvia and it covered 32.8% (14.65 kt) from the total Latvia's NMVOC emissions in 2014.

Net GHG emissions from **Land use, Land use change and forestry (LULUCF)** in 2014 were 4220.14 kt CO_2 eq compared to -8421.63 kt CO_2 eq in the base year. Change from base to latest reported year of emissions/removals from LULUCF constitutes -150%. This decrease of removals from LULUCF sector is related to increase of harvesting stock (more than double), increase of natural mortality due to ageing of forest stands and reduction of increment in ageing forests. The difference between previous and latest submission is due to recalculation of deforested area in 2009-2013 resulting in increase of deforested area and considerably higher GHG emissions due to land use change to cropland and settlements category. Besides, harvested wood products (HWP) has significant role in recalculations of the carbon stock changes in living biomass in LULUCF sector in 2012 and 2013. Due to changes in export and import data in FAO and Eurostat databases, recalculations of HWP lead to increase of emissions by 0.3 mill. tonnes CO_2.

ES.3.2 KP-LULUCF activities

Information table on accounting for activities under Articles 3.3 and 3.4 of the Kyoto Protocol is shown in the Table ES.3.

Table ES.3 Accounting for activities under Articles 3.3 and 3.4 of the Kyoto Protocol

Greenhouse gas source and sink activities	Net emissions/removals									Accounting parameters	Accounting quantity
	2013	2014	2015	2016	2017	2018	2019	2020	Total		
A. Article 3.3 activities											
A.1. Afforestation and Reforestation	-85.68	-89.64							-175.32		-175.32
Excluded emissions from natural disturbances	NA	NA							NA		NA
Excluded subsequent removals from land subject to natural disturbances	NA	NA							NA		NA
A.2. Deforestation	1383.41	1404.83							2788.23		2788.23
B. Article 3.4 activities											
B.1. Forest management									-3920.99		7351.80
Net emissions/removals	-3492.58	-428.40							-3920.99		
Excluded emissions from natural	NA	NA							NA		NA

Greenhouse gas source and sink activities	Net emissions/removals									Accounting parameters	Accounting quantity
	2013	2014	2015	2016	2017	2018	2019	2020	Total		
disturbances											
Excluded subsequent removals from land subject to natural disturbances	NA	NA							NA		NA
Any debits from newly established forest (CEF-ne)	NA	NA							NA		NA
Forest management reference level (FMRL)										-16302.00	
Technical corrections to FMRL										9922.00	
Forest management cap[5]										7351.80	7351.80
B.2. Cropland management	NA	NA							NA		NA
B.3. Grazing land management	NA	NA							NA		NA
B.4. Revegetation	NA	NA							NA		NA
B.5. Wetland drainage and rewetting	NA,NO	NA,NO							NA,NO		NA,NO

ES.4 Overview of Emission Estimates and Trends of Indirect GHG and SO_2

Emissions from indirect GHGs are presented in Table ES.4.

Table ES.4. Indirect GHG emissions 1990-2014 (kt)

	NO_x	CO	NMVOC	SO_2
	kt			
1990	92.95	389.29	91.04	99.98
1991	86.25	356.46	86.02	81.68
1992	70.76	374.24	79.56	69.79
1993	62.39	338.74	73.55	65.74
1994	56.20	322.05	70.05	66.71
1995	51.16	297.43	67.81	49.39
1996	50.94	302.89	66.96	55.67
1997	49.14	275.16	63.52	43.91
1998	45.47	257.79	60.55	39.84
1999	44.35	258.74	58.55	31.95
2000	43.52	243.58	57.32	17.56
2001	46.31	241.72	59.75	14.10
2002	45.18	243.32	58.15	12.77
2003	46.85	232.98	56.72	11.93
2004	46.04	224.44	56.04	10.11
2005	44.33	203.59	54.53	8.83
2006	45.27	219.56	53.14	8.52
2007	44.79	186.67	53.86	8.11

[5] FM cap is calculated in accordance with paragraph 13 of the annex to decision 2/CMP.7, 3.5 per cent of the national total emissions excluding LULUCF in the base year times eight.

	NO_x	CO	NMVOC	SO_2
	kt			
2008	41.04	174.05	52.17	6.65
2009	38.58	185.85	50.39	6.42
2010	41.20	148.49	44.24	4.48
2011	35.29	152.01	43.65	4.27
2012	35.48	156.41	46.98	4.33
2013	35.21	142.41	44.12	3.83
2014	35.20	138.44	44.69	3.76

In the period from 1990 to 2014 indirect GHG emissions have decreased: NO_x by 62%, CO by 64% and NMVOC by 51%. Starting from 2001, slight fluctuations in NO_x, NMVOC and CO emissions can be observed as a reason of increasing firewood consumption in Residential sector as well as fuel consumption in Transport sector in particular years. SO_2 emissions have decreased significantly from 1990 to 2014 by 96% because of fuel switch and approved legislation.

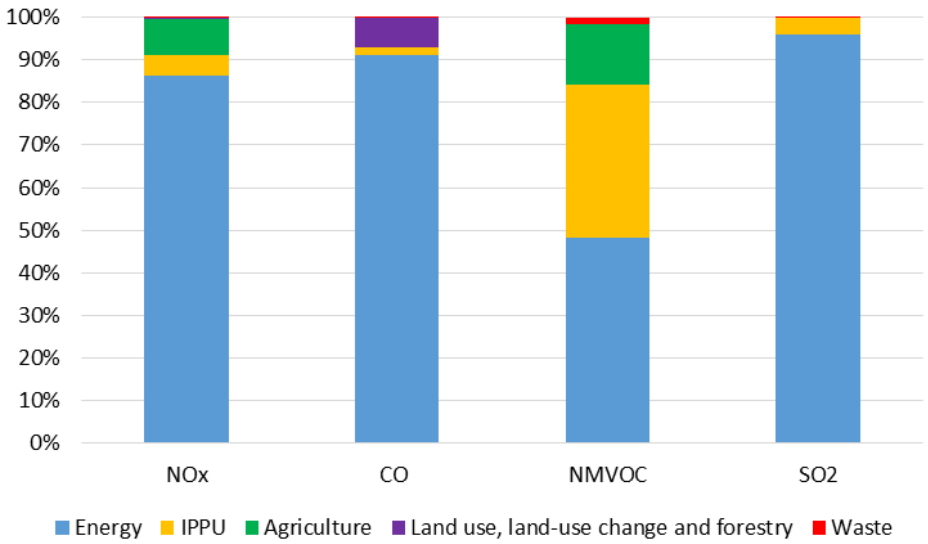

Figure ES.4 Indirect GHG emission by sector in 2014 (% of total indirect GHG emissions in sector)

In 2014, the most important sector producing indirect GHGs (including LULUCF) was Energy sector (including fugitive emissions). Fuel combustion in Energy sector causes the largest part of NO_x emissions (86.2% from total NO_x emissions in 2014), but IPPU and Agriculture sectors make 5.1% and 8.3%, accordingly. Very small part of NO_x emissions is produced in LULUCF sector (0.5% from total NOx emissions). Almost all CO emissions (91.3%) appear in Energy sector, mainly from fuel combustion in Residential and Commercial/Institutional subsectors (70.8% from all emissions). A small part of CO emissions come from LULUCF sector (7.1%) and IPPU sector (1.6%). The major part of SO_2 emissions (95.9%) comes from Energy sector (fuel combustion), but the other sulphur dioxide emissions come from Industrial processes (Cement production and Iron and Steel production), and a negligible part of SO_2 comes also from Waste sector (Waste incineration). The largest amounts of NMVOC emissions are produced in Energy sector (48.3%; fuel combustion mainly in Residential sector)and 39.8% from total NMVOC emissions in 2014 are produced in IPPU sector (35.8%), mainly from solvent use. 14.1% of NMVOC emissions are produced in Agriculture sector, but the remaining 1.8% in Waste sector. In Agriculture sector, CO and SO_2 emissions, and in LULUCF sector, NMVOC and SO_2 emissions do not appear.

PART I: 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

Latvia is a country by the Baltic Sea with total area of 64 573 km^2 and there are 2 001 468 (2014) inhabitants[6]. Baltic coastline is approximately 498 km. Since the beginning of the previous century the forest area in Latvia has almost doubled reaching 3 299.38 kha (51% from the total area of the country in 2014). Latvia lies in a temperate climate zone where active cyclone determines rapid changes in weather conditions (190-200 days per year). Annual mean precipitation is 600-700 mm. Main rocks in Latvia are clay, dolomite, sand, gravel, limestone and gypsum.

The analysis of long-term climatological data series in Latvia has shown that the climate has changed during last centuries. Air temperature has increased for the whole period of observations (from the 1795); however it has been more expressed during winter and spring and for the last decades. Increasing trends are evident in precipitation series for the cold period, while the decreasing trends were found for summer and autumn seasons. Ice and snow cover period in Latvia became shorter during last decades. River discharge regime has been subjected to major changes in relation to climate changes. Well expressed regular changes of high-water and low-water periods are evident. Seasonality indices have changed: increased values of growing degree days especially from the beginning of the 20th century, decreased number of frost days, reduced heating degree-days.

The climate change and climate variability have and will have a notable impact on inland and sea hydro ecosystems as well as changes in vegetation. The increasing growth of aquatic vegetation in recent years has been related to climatic factors – higher mean temperature and earlier spring. The absence and lowering of the ice cover during winter's causes the prolonged growing season. There is a significant temporal gradient in vegetation dynamic from light nutrient-poor and species-poor forests to more nutrient-rich, more diverse species and closed forests. This is evident that the future climate changes will have significant effect on natural and socio-economic systems in Latvia[7].

1.1.2 Background information on greenhouse gas inventories

The Parliament of the Republic of Latvia ratified the United Nations Framework Convention on February 23, 1995 and since March 23, 1995 Latvia is a Party to the Convention thus undertaking to implement series of international commitments. On May 30, 2002 the Parliament also ratified the Kyoto Protocol. Latvia is a member of EU since May 2004 and Latvia's climate change policy is based on Europe Union climate policy.

As a party of the UNFCCC, Kyoto Protocol and European Union Latvia is required to submit annual national GHG inventory covering emissions and removals of direct GHGs (CO_2, CH_4,

[6] *http://data.csb.gov.lv/pxweb/lv/Sociala/Sociala__ikgad__iedz__iedzskaits/IS0020.px/table/tableViewLayout1/?rxid=cdcb978c-22b0-416a-aacc-aa650d3e2ce0*

[7] *Kļaviņš, M. Climate change in Latvia. University of Latvia.*

N_2O, HFC, PFC, SF_6 and NF_3) from the base year to the most recent inventory year. This report is the annual submission of the Latvia to the UNFCCC, Kyoto protocol and European Commission. It presents the GHG inventory, the process and the methods used for the compilation of the inventory for 1990 to 2014. The structure of NIR follows the UNFCCC Annex I GHG inventory reporting guidelines.
The legislation act – Regulation No. 217 of Cabinet of Ministers (27.03.2012.) determinates the institutions that are responsible for GHG inventory preparation. Ministry of Environmental Protection and Regional Development (MEPRD) Climate Change Department is responsible for the implementation and development of climate change mitigation and adaptation (and related) policies and measures. MEPRD is responsible for the actions (coordination, implementation and development) to meet the international and EU emission reduction targets. MEPRD also coordinates the monitoring and reporting of GHG emission data as well as is designated as the single national entity with overall responsibility for the Latvian GHG inventory.

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

Latvia, 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 consistent with relevant decisions and guidelines under Article 7 paragraph 1.

1.2 Description of the institutional national inventory arrangements

1.2.1 Overview of institutional, legal and procedural arrangements for compiling GHG inventory and supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

The national inventory arrangements are described below. The description is prepared according to requirements for reporting on national inventory systems under the Kyoto Protocol, EU MMR and UNFCCC reporting guidelines.

Latvian national GHG inventory system is designed and operated according to the Kyoto Protocol to ensure the transparency, consistency, comparability, completeness and accuracy of inventory.

Inventory activities include planning, preparation and management.
The inventory phases are:

- collecting activity data;
- selecting methods and emission factors appropriately;
- estimating anthropogenic GHG emissions by sources and removals by sinks;
- implementing uncertainty assessment;
- implementing QA/QC activities.

A schematic model for the national system (NIS) according to the CoM Regulation No.217 (27.03.2012) is shown in Figure 1.1.

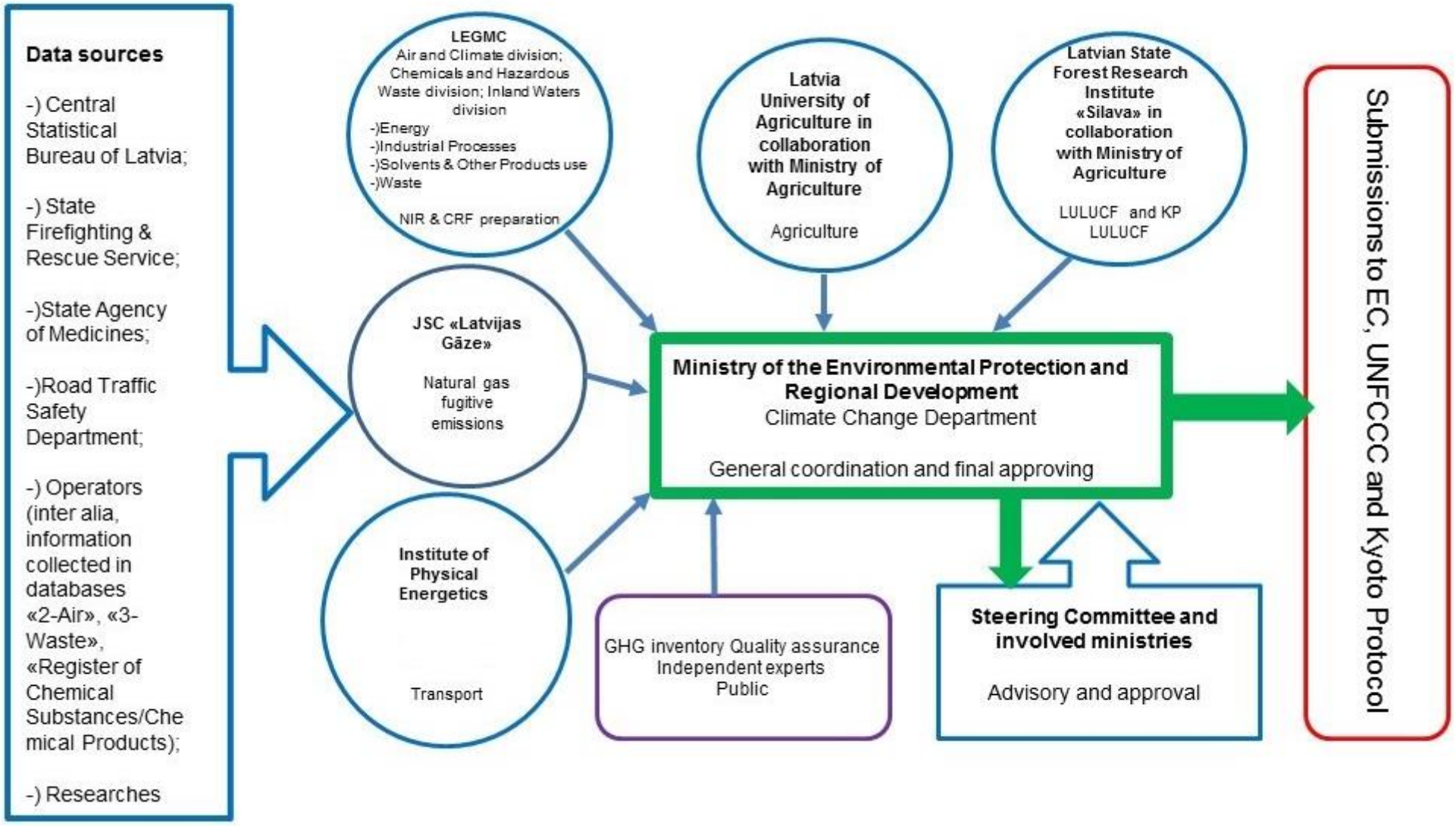

Figure 1.1 The structure of Latvia`s National Inventory System

The MEPRD Climate Change Department is responsible for:

- Preparation of legal basis for maintaining the National System;
- Informing the inventory compilers about requirements of the national system;
- Overall coordination of GHG inventory process;
- Final checking and approving of the GHG inventory before official submission to the EC and UNFCCC;
- Formal agreements with inventory experts and for third part experts that evaluate quality assurance process;
- Coordinating the work between the involved institutions, experts, European Commission and UNFCCC (including coordination of the UNFCCC inventory reviews);
- Timely submission of GHG inventory to the UNFCCC and European Commission;
- Keeping of archive of official submissions to UNFCCC and European Commission.

Latvian Environment, Geology and Meteorology Centre (LEGMC) is a governmental limited liability company and is responsible for:

- Collecting of activity data for Energy, Industrial Processes and Product Use and Waste sectors (activity data are mainly collected from other institutions and LEGMC (Air and Climate division, Chemicals and Hazardous Waste division, Inland Waters division) use them to calculate emissions);
- Preparation of the emission estimates for the Energy, Industrial Processes and Product Use and Waste sectors;
- Preparation of QC procedures for relevant categories and documentation and archiving of used materials for emission calculation;
- LEGMC Air and Climate Division compile the final NIR using information from all involved institutions as well as summarized emission data in CRF Reporter;
- Quality manager from LEGMC Air and Climate division perform the overall QC/QA procedures for all sectors according to the QA/QC plan;
- LEGMC is the National Emissions Trading Authority in Latvia and prepare relevant information for GHG inventory from registry – on emission reduction units, certified emission reductions, temporary certified emission reductions, long term certified emission reductions and assigned amount units for annual inventory submissions in accordance with guidelines for preparation of information under Article 7 of the Kyoto Protocol (SEF tables).

Calculations of removals and emissions for the LULUCF, KP-LULUCF sector were done by Latvian State Forest Research Institute "Silava" in collaboration with MoA. LSFRI "Silava" is responsible for collecting of activity data, preparation of the removals/emission estimates, preparation of QC procedures as well as documentation and archiving of used materials for calculation.

Institute of Physical Energetic (IPE) calculates emissions for Transport sector. IPE is responsible for collecting of activity data, preparation of the emission estimates, preparation of QC procedures as well as documentation and archiving of used materials for calculation.

Emission calculations from Agriculture sector were done by Latvia University of Agriculture in collaboration with MoA. Latvia University of Agriculture is responsible for collecting of necessary activity data cooperating with Central Statistical Bureau (CSB), preparation of the emission estimates, preparation of QC procedures as well as documentation and archiving of used materials for calculation.

The main data supplier for the Latvian GHG inventory is the CSB.

For ensuring the continuity of the functions of the national system, the delegation contracts are signed between the MEPRD and LEGMC, LSFRI "Silava", IPE and Latvia University of Agriculture.

Before final GHG inventory are submitted to European Commission and UNFCCC secretariat draft inventory submission to the EU 15 January is sent to the involved Latvia's ministries for comments and approving. Based on received comments inventory is corrected appropriate.

Several sectoral meetings were held before and during preparation of inventory to discuss and agree on the methodological issues, problems that have arisen and improvements that need to be implemented. There were discussions on the different problems that came up during the last inventory preparation to find solutions how to improve the overall system.

The following issues for solving different problems and to improve cooperation between inventory experts and inventory compilers are:

- Discussion on methodologies and possible changes in the future;
- Discussion on QA/QC plan, available resources and possible improvements;
- Discussion on data collection;
- Agreement on recalculations;
- Archiving system, updating and possible improvements;
- Exchange of relevant information;
- Reporting the conclusions from the meetings.

The detailed responsibilities of the institutions of activity data and main experts responsible for the sectoral inventories and the corresponding charters and annexes are summarized in the Table 1.1.

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

Inventory planning is one of the main stages in national GHG inventory management system and all responsible institutions are involved in this process, which consists of:

- establishing of national entity with overall responsibility for the national inventory;
- assigning responsibilities for inventory preparation and management;
- developing time schedule;
- making arrangements to collect data from statistical agencies, companies, industry associations, etc.;
- creating QA/QC plan;

- defining formal approval process within government;
- developing review processes;
- implementing continuous improvements.

The inventory preparation plan is a part of the Latvia's QA/QC plan and has to be followed by all institutions defined in CoM Regulation No. 217 (27.03.2012)[8]. The responsible institutions are reflected in the Table 1.1 and inventory preparation plan is presented in Table 1.2.

After the end of the annual reporting cycle in April, the institutions involved in inventory preparation start to plan the next annual inventory following received improvements and recommendations by ERT. Within the EU level the recommendations by a Technical Expert Review Team (TERT) are also taken into account. Planning includes the identification of improvements to be undertaken due to revised methodologies, updated activity data or emission factors and other relevant technical elements of inventory as well as addressing the issues and recommendations in the review of the previous inventory submission.

Table 1.1 Institutions responsible for activity data and calculating emissions

CRF sectors	Data	Responsible institutions/ Responsible experts
Table 1.A(a) - Fuel Combustion Activities (Sectoral Approach)	Activity data	CSB Environment and Energy Statistics Section, Road Traffic Safety Department (RTSD)
	Calculations	LEGMC Air and Climate division (Ieva Sile, Asnate Skrebele), Institute of Physical Energetics (Gaidis Klāvs, Larisa Gračkova)
Table 1.A(b) – CO_2 from Fuel Combustion Activities – Reference Approach	Activity data	CSB Environment and Energy Statistics Section
	Calculations	LEGMC Air and Climate division (Ieva Sīle, Asnate Skrebele)
Table 1.A(d) – Feedstock's and Non-Energy Use of Fuels	Activity data	CSB Environment and Energy Statistics Section
	Calculations	LEGMC Air and Climate division (Ieva Sīle, Asnate Skrebele)
Table 1.B.2. – Fugitive Emissions from Oil and Natural Gas	Activity data	CSB Environment and Energy Statistics Section
	Calculations	LEGMC Air and Climate Division (Ieva Sīle, Asnate Skrebele), JSC "Latvijas Gāze"
Table 1.D – International Bunkers and Multilateral Operations	Activity data	CSB Environment and Energy Statistics Section
	Calculations	Institute of Physical Energetics (Gaidis Klāvs, Larisa Gračkova)
Table 2(I).A-E,G-H – Industrial Processes and Product Use	Activity data	CSB Population Statistics Section State Agency of Medicines; Research of experts; LEGMC "2-AIR" and "Chemical" databases CSB Industrial Statistics Section EU Emission Trading Scheme operators
	Calculations	LEGMC Chemicals and Hazardous Waste Division (Liga Rubene), LEGMC Air and

[8] *http://likumi.lv/doc.php?id=246033.*

CRF sectors	Data	Responsible institutions/ Responsible experts
		Climate division/EU Emission Trading Scheme operators (Aiva Puļķe)
Table 2(II) F – Industrial Processes - HFCs, PFCs and SF_6	Activity data	CSB Population Statistics Section, Environment and Energy Statistics Section "Latvenergo" AS; State Agency of Medicines; Annual reports by operators using F-gases (reported to LEGMC) Data from Chemicals Register (maintained by LEGMC)
	Calculations	LEGMC Air and Climate division (Vita Ratniece)
Table 3.A – Agriculture, Enteric Fermentation	Activity data	CSB Agricultural Statistics Section
	Calculations	Latvia University of Agriculture (Laima Bērziņa, Renāte Ondzule)
Table 3.B.1 - Agriculture, CH_4 Emissions from Manure Management	Activity data	CSB Agricultural Statistics Section
	Calculations	Latvia University of Agriculture (Laima Bērziņa, Renāte Ondzule)
Table 3.B.2 - Agriculture, N_2O un NMVOC Emissions from Manure Management	Activity data	CSB Agricultural Statistics Section
	Calculations	Latvia University of Agriculture(Laima Bērziņa, Renāte Ondzule)
Table 3.D - Agriculture, Agricultural Soils	Activity data	LEGMC database "2-Water", Latvian State Forest Research Institute "Silava"
	Calculations	Latvia University of Agriculture (Laima Bērziņa, Renāte Ondzule)
Table 3 G Liming	Activity data	CSB
	Calculations	Latvia University of Agriculture (Laima Bērziņa, Renāte Ondzule)
Table 3 H Urea application	Activity data	CSB
	Calculations	Latvia University of Agriculture(Laima Bērziņa, Renāte Ondzule)
Table 4. A. Forest Land Table 4. B. Cropland Table 4. C. Grassland Table 4. D. Wetlands Table 4. E. Settlements Table 4. F. Other Land	Activity data	National Forest monitoring program (NFI)
	Calculations	Latvian State Forest Research Institute "Silava" collaborated with Ministry of Agriculture (Andis Lazdiņš, Arta Bārdule, Aldis Butlers, Ainārs Lupiķis)
Table 4. B. Cropland – 4.B.1 Cropland remaining Cropland	Activity data – Area of organic soil	NFI, National studies and expert judgement
	Calculations – Net carbon stock change in organic soils	Latvian State Forest Research Institute "Silava"
Table 4. C. Grassland – 4.C.1 Grassland remaining Grassland	Activity data - Area of organic soil	National studies and expert judgment
	Calculations – Net carbon stock change in organic soils	National studies and expert judgment, Latvian State Forest Research Institute "Silava"
Table 4. (V) Biomass Burning	Activity data	State Fire and Rescue Service of Latvia, State forest service of Latvia
	Calculations	Latvian State Forest Research Institute "Silava"

CRF sectors	Data	Responsible institutions/ Responsible experts
KP LULUCF NIR-1 NIR-2 NIR-2.1 NIR-3 4(KP)	Activity data	State Fire and Rescue Service of Latvia, State forest service of Latvia National Forest monitoring program (NFI) National studies and expert judgement
	Calculations	Latvian State Forest Research Institute "Silava" (Andis Lazdiņš, Arta Bārdule, Aldis Butlers, Ainārs Lupiķis)
Table 5 A - Waste, Solid Waste Disposal on Land	Activity data	LEGMC "3-Waste" database, Methane recovery installations
	Calculations	LEGMC Chemicals and Hazardous Waste Division (Intars Cakars)
Table 5 B – Biological Treatment and Solid Waste	Activity data	CSB, LEGMC Chemicals and Hazardous Waste Division
	Calculations	CSB, LEGMC Chemicals and Hazardous Waste Division (Intars Cakars)
Table 5.B.1 – Composting	Activity data	LEGMC Chemicals and Hazardous Waste Division
	Calculations	LEGMC Chemicals and Hazardous Waste Division (Intars Cakars)
Table 5 C – Incineration and open Burning of Waste	Activity data	LEGMC database "3-Waste"
	Calculations	LEGMC Chemicals and Hazardous Waste Division (Intars Cakars)
5.D Wastewater Treatment and Discharge	Activity Data	LEGMC "2-Water" database, CSB statistics on national population and production rates of certain industries
	Calculations	LEGMC Inland Waters Division (Lauris Siņics)

Inventory management system includes 3 main stages – inventory planning, preparation and management.

The inventory preparation stage consists of:

- Identification of key categories, which have a significant influence on a country's total inventory in terms of level or trend in emissions;
- Selection of methods, emission factors and all necessary relevant information for estimating anthropogenic GHG emissions by sources and removals by sinks;
- Collection of activity data;
- Managing recalculations from previous submissions taking into account updates of activity data by CSB, recommendations by ERT, TERT and suggestions from the third-part experts etc.
- NIR compilation;
- QA/QC plan implementation (include basic checks on entire inventory (Tier 1) and more in-depth investigations into key sources (Tier 2);
- Documentation.

The inventory management stage consists of:

- Implementation of inventory review processes (e.g., expert review, public review);
- Obtaining formal approval of final results and reporting within government;
- Submission reporting to UNFCCC;
- Making inventory information available to stakeholders and respond to information requests;
- Archiving all documentation and results (The special centralised folder is created where experts can upload/download and store all files and information related to inventory preparation);
- Continuous improvement feedback.

Latvia prepares a NIR and Common Reporting Format (CRF) tables annually according to requirements of the UNFCCC, the Kyoto Protocol and the EU MMR.

Table 1.2 Inventory preparation plan

Element	Activity	Responsible performers	Procedures	Due date	
To reconsider the changes needed for the inventory, taking into account comments and recommendations made by the review team (ERT)	All institutions established by Regulation of Cabinet of Ministers No.217 (Part II „National Inventory System", Paragraph 3)		All institutions involved in inventory preparation process to reconsider the changes needed for the inventory, taking into account comments and recommendations made by the review team (ERT) and send to national inventory compiler for summarizing.	Middle of May	
Annual meeting	All institutions established by Regulation of Cabinet of Ministers No.217 (Part II „National Inventory System", Paragraph 3)		Participation of all institutions involved in inventory preparation and approval process. Discussions on previous submissions' review results and planned submission including necessary improvements, changes, recalculations, problems etc.	Till 30th June	
Activity data and description	Submission to LEGMC	EU Emission Trading Scheme (EU ETS) operators	EU ETS operators send to LEGMC activity data, CO_2 emission factors, CO_2 emissions and descriptions as verified GHG report for enterprises involved in EU ETS annually for previous year.	till 30th March	
			LEGMC uses EU ETS data in GHG inventory for emission estimates in Energy and Industrial Processes sectors.		Starting from September
		Operators	LEGMC (Air and Climate division, Chemicals and Hazardous Waste division, Inland Waters Division) collects information for emission calculation in following databases: • "2-AIR" database;	till 15th June	

Element	Activity	Responsible performers	Procedures	Due date	
			• "3-Waste"; • "2-Water" databases; • Chemical Register. • Cement producer and Iron & Steel plant send additional information for detailed CO_2 emission estimation according to national legislation.	till 1st October	
			LEGMC uses data from databases for emission estimates in Energy (CRF1), IPPU (CRF2), Waste (CRF5) sectors.		Starting from September
		JSC "Latvijas Gāze"	The only natural-gas transmission, storage, distribution, and sales operator in Latvia sends the total fugitive emissions for previous year and short information of emission fluctuation according to national legislation.	till 1st October	
			LEGMC uses data from JSC "Latvijas Gāze for emission estimates in Energy (CRF1) sector.		Starting from October
		Ministry of Health collaborating with State Agency of Medicines (SAM)	SAM sends to LEGMC activity data – data of imported metered dose inhalers containing GHG (F gases subsector) and amount of used N_2O for Anaesthesia (Solvent and other product use sector).	till 1st October	
			LEGMC uses data from SAM for emission estimates in IPPU sector.		Starting from October
Activity data and description	Submission to LEGMC, Latvia University of	Statistical Bureau of	CSB send activity data regarding Energy, Agriculture, Industrial Processes and Product	till 1st October	

Element	Activity	Responsible performers	Procedures	Due date	
	Agriculture	Latvia (CSB)	Use and Waste sectors according to CoM Regulation No. 217. Many of received and used activity data is available in CSB statistical databases: http://www.csb.gov.lv/dati/statistikas-datubazes-28270.html		
			LEGMC, Latvia University of Agriculture use received data for Energy, Agriculture, Industrial Processes and Product Use and Waste sectors emission calculation		Starting from October
	Submission to MEPRD/ LSFRI "Silava"	State Firefighting & Rescue Service (SFRS)	SFRS send to MEPRD activity data - area of last year`s grass burning (ha).	till 1st October	
			LSFRI "Silava" uses received data for emission calculation from biomass burning (CRF 4 (V)).		Starting from October
Emissions/CO_2 removals	Data entry in the CRF Reporter according to CRF Reporter User Manual	LEGMC, Latvia University of Agriculture, IPE, LSFRI "Silava"	Data entry in the CRF Reporter by responsible sectoral experts.	till 15 December	
Emissions/ CO_2 removals descriptions	Preparation of NIR chapters	LEGMC, Latvia University of Agriculture, IPE, LSFRI "Silava"	LSFRI "Silava"/ Latvia University of Agriculture (in coloboration with MoA), LEGMC, IPE and MEPRD prepare relevant chapters of NIR	till 15 December	
CRF Reporter	Data check by sectoral experts	LEGMC, Latvia University of Agriculture,	Sectoral experts check the data in the CRF Reporter for consistency and quality assurance (e.g. to check whether the sum of	till 15 December	

Element	Activity	Responsible performers	Procedures	Due date	
		IPE, LSFRI "Silava"	the following adds up to 100%, to check the year to year changes between values reported etc.). LEGMC (Quality manager) checks completeness, consistency and quality assurance.	till 30 December	
Data in CRF, Draft NIR according to Regulation (EU) No 525/2013 and Commission Implementing Regulation 749/2014	CRF, NIR, Annexes	MEPRD - Climate Change Department	After corrections in CRF tables, NIR \(if necessary) MEPRD uploaded CRF tables, XML, draft NIR, relevant Annexes to the EIONET CDR.	15th January	
Quality control checks: Draft NIR	QA	MEPRD - Climate Change Department	According to the CoM Regulation No. 217, MEPRD send to involved institutions Draft NIR for comments and approving. NIR was uploaded in the LEGMC home page for review by public.	till 16th January	
		Expert Public			
		All institutions involved in GHG emissions and removals preparation	Expert meetings to improve inventory, quality control activities etc.	January-February	
		Involved institutions	Involved institutions send to MEPRD comments about NIR 1st draft and approval.		8th February

Element	Activity	Responsible performers	Procedures	Due date
	QC	All institutions involved in the GHG inventory preparation process	Answers to the compiled questions by EU review team, which based on 15/1 submissions (https://emrt.eea.europa.eu/). MEPRD approves provided answers from experts. Verification of national data in EC inventory and updates if necessary and response to EC. This process includes collaboration with involved institutions for preparing of response to EC.	28st February to 15th March
CRF data, NIR according to Regulation (EU) No 525/2013 and Commission Implementing Regulation 749/2014	CRF, NIR, Annexes	MEPRD - Climate Change Department	MEPRD uploaded CRF tables, XML and NIR to the EIONET CDR.	15th March
NIR and emission data in CRF to UNFCCC	Inventory submission (CRF, NIR)	MEPRD - Climate Change Department	MEPRD uploaded approved GHG inventory to the UNFCCC portal.	15th April

1.2.3 Quality assurance, quality control and verification plan

QA/QC procedures are an important component in the development of greenhouse gas emission inventory preparation. The basic aim of the QA/QC process is to ensure the quality of the inventory and to contribute to the improvement of the inventory. Improving the submission during QA/QC process, the main findings and conclusions concerning the inventory quality and improvements needs to be considered and communicated into Latvia`s GHG inventory system for making decisions concerning the annual inventory process and next inventory preparation.

The outcomes of the QA/QC process results in a reassessment of inventory or source category uncertainty estimates. For example, if data quality is found to be lower than previously thought and this situation cannot be rectified in the timeframe of the current inventory, the uncertainty estimates are re-evaluated. Increased effort on QC results in improved emissions estimates and reduced uncertainties.

According to CoM Regulation No. 217 (27.03.2012.) all institutions involved in inventory process are responsible for implementing QC procedures.

Mainly Tier 1 general inventory QC procedures outlined in Table 6.1 of 2006 IPCC Guidelines are used.

The legislation act determines:

- the quality objectives for GHG inventory;
- tasks and responsibilities of involved institutions;
- QA/QC time schedule;
- QA/QC plan that has been prepared to improve transparency, comparability, and completeness of GHG inventory. In the QA/QC plan quality control procedures to be used before and during the compilation of GHG inventory are described;
- check-lists and procedure descriptions for experts and independent experts for quality assurance of GHG inventory;
- background for inventory improvement plan preparation activities.

Figure 1.2 shows the annual inventory process how the inventory is produced within the national system.

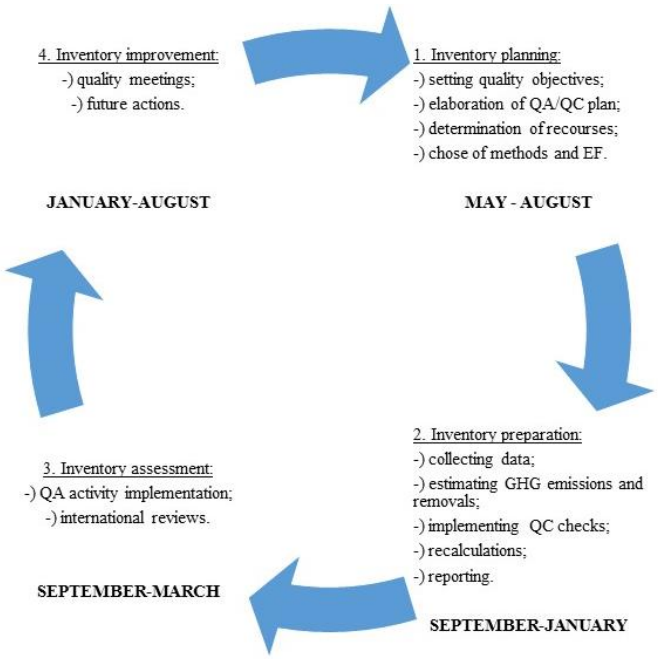

Figure 1.2 Inventory Process

The result of quality depends on four main stages – planning, preparation, evaluation and improvements and is ensured by inventory experts during compilation and reporting of inventory.

The inventory planning stage includes the setting of quality objectives and elaboration of the QA/QC plan for the coming inventory preparation, compilation and reporting work. The main objective of Latvia's GHG inventory system is to produce high quality GHG inventories.

The quality requirements set for the annual inventories – transparency, consistency, comparability, completeness, accuracy, improvements and timelines. To ensure these inventory principles the following QA/QC activities of the inventory is done (Figure 1.3).

Figure 1.3 QA/QC activities of the inventory

The setting of quality objectives is based on the inventory principles taking into account the available resources.

The quality objectives for the 2016 inventory were the following:

- Allocate sufficient resources for the implementation of the QA/QC plan especially with regard to the QC activities performed by the inventory compilers preparing the NIR and CRF tables;
- Allocate sufficient time and human resources to the final stages of the inventory compilation process in which cross-sectoral work such as the key category analysis occurs, and enhance the QC procedures so that errors are avoided in future annual submissions;

In order to ensure improvements:

- All improvements included in the previous NIR are carried out or ongoing;
- Feedback on reviews is systematic;
- Inventory QC procedures meet requirements.

In order to ensure transparency:

- transparent information is included in the NIR and CRF (including information regarding the used methodology, activity data and emissions in tables);
- notation keys are used according to the IPCC guidelines;
- recommendations of inventory reviews regarding transparency are taken into account as far as possible;
- documentation regarding quality control check is indicated;
- information regarding the changes since the last inventory in relation to transparency is provided in the NIR under relevant subchapters.

In order to ensure consistency:

- recommendations received during inventory reviews regarding consistency is taken into account after evaluation as far as possible;
- information regarding consistency and recalculations is provided in the NIR;
- an explanation for a decline or increase in emissions of time series is provided.

In order to ensure comparability:

- methodologies and formats used in the inventory meet comparability requirements;
- emissions and CO_2 removal is localized and distributed according to the IPCC.

In order to ensure completeness:

- emissions from all potential sources and gases is calculated;
- recommendations of review – international experts – regarding improvements is taken into account as far as possible;
- information regarding completeness is provided in the NIR;
- all reasons for recalculations and reasons why a designation NE (not evaluated) and IE (included elsewhere) is used instead of data is indicated;

In order to ensure accuracy:

- Tier 2 or a higher method is used for the main sources as far as possible;
- uncertainties are calculated and information is provided in the NIR;

In order to ensure timeliness:

- inventory reports reach their recipient (EU/UNFCCC) within the set time.

1.2.3.1 Quality Control procedures

The general and category-specific QC procedures are performed by sectoral experts during inventory calculation and compilation according to the QA/QC and verification plan.

MEPRD as national entity is responsible for overall QC procedures and quality assurance of national system, including UNFCCC and EU reviews.

For submission 2016, QC activities were carried out at the various stages of the inventory compilation process - processing, handling, documenting, cross checking, and recalculations. These activities are implemented by sectoral experts and quality manager in LEGMC who is responsible for QC procedures before inventory submission for overall QC procedures and final approving in MEPRD.

The centralized archiving system (common FTP folder) is created where experts have to upload and download all necessary information for inventory preparation, inter alia spreadsheets which need to be filled for quality control and quality assurance. Instruction for experts how to prepare NIR to ensure comparability of NIR and CFR is prepared and available to experts.

QC system includes various activities set to ensure transparent data flow through all inventory process:

- Assumptions and criteria for the selection of activity data and emission factors are documented;
- Transcription errors in data input and references;
- Correctness of calculations of emissions;
- Correctness of emission parameters, units, conversion factors;
- Integrity of database files;
- Consistency in data between source categories.

The QC procedures comply with the 2006 IPCC Guidelines. General inventory QC checks include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies and documentation and archiving of inventory data and quality control actions.

For Submission 2016:

-) The sectoral experts entered data in CRF Reporter software either manually or by importing MS Excel spreadsheets. Sectoral experts prepared quality control procedures according to 2006 IPCC Guidelines. All findings were documented by using check-lists and introduced in GHG inventory. All corrections are archived;

-) The sectoral experts prepared relevant NIR chapters and sent to LEGMC. Sectoral experts before sending chapter of NIR have checked if all information is consistent with information filled in the CRF Reporter. It is checked if recalculations and methodological changes are explained in NIR and CRF Reporter. Final NIR is compiled by LEGMC according to UNFCCC reporting guidelines;

-) Emission consistency with other EU MMR requirements are performed according to European Commission Implementing Regulation (EU) No 749/2014 (MMR IR). GHG emission data are checked with the data used to prepare inventories of air pollutants under EU

Directive 2001/81/EC, the actual or estimated allocation of the verified emissions reported by installations and operators under Directive 2003/87/EC, and the energy data reported pursuant to Article 4 of, and Annex B to, Regulation (EC) No 1099/2008.

-) LEGMC quality manager and MEPRD performed cross-checking for all sectors to verify that no mistakes occurred during input/import process. CRF completeness and consistency checks were carried out. During QA/QC procedures it was observed that there are still internal technical problems in CRF Reporter under Energy, IPPU, Agriculture and KP-LULUCF sectors;

-) Quality meetings between sectoral experts were held in order to discuss problems and possible improvements in GHG inventory as well as to ensure consistency between activity data used by experts in emission estimation for different sectors;

-) Detailed QA/QC procedures were done by institutions involved in the GHG inventory preparation (MoA, MEPRD, CSB). Meetings between sectoral experts and involved institutions were held according to comments received and improvements needed in NIR;

-) Experience exchange events with Norway GHG inventory experts were held within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy" in purpose to elaborate QA/QC procedures in sectors, improve uncertainty evaluation and improve overall quality of GHG inventory. Useful experience from Lithuanian experts regarding expert judgment documentation as well as uncertainty evaluation was also gained within previous mentioned project;

Main activity data provider for Latvia's GHG inventory – CSB – has established Quality Guidelines[9] that is an informative document describing the CSB and the main aspects of its activity: stages, methods and organizational principles of producing the national statistics, policy of data protection and dissemination. The purpose of the Guidelines is to ensure higher quality to a maximum extent from both ethical and professional aspect, national statistics similarly to the Community statistics must follow the principles of impartiality, reliability, relevance, cost-effectiveness, statistical confidentiality and transparency.

As a general rule the statistics are revised according to a fixed, coherent and published plan, called a revision cycle. This plan determines when the individual statistics are revised, and the periods that are subject to revision:

- CSB Revision Policy is available in the CSB website;
- Database of Macroeconomic statistics data revision analysis established.

Detailed source specific QC descriptions are included under each sub sector relevant chapter.

Quality control of EU Member States submissions` are performed in web-based tool hosted by the European Environmental Agency (EEA) to facilitate quality checks and reviews of national emission inventories reported by EU Member States under the EU MMR. From 2015 onwards the tool is used in the annual review process under the EU ESD. In 2015 voluntary review under EU ESD was carried out. Findings on errors and deficiencies are taking into account before Latvia submits final annual inventory to the UNFCCC.

[9] *Central Statistical Bureau Quality Guidelines (http://www.csb.gov.lv/en/dokumenti/quality-guidelines-30868.html).*

1.2.3.2 Quality Assurance procedures

Quality Assurance (QA) activities include a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. According to Regulation No. 217 MEPRD is responsible for ensuring QA procedures for GHG inventory.

The QA reviews are performed after the implementation of QC procedures to the finalised inventory. The inventory QA system comprises reviews to assess the quality of the inventory.

A basic review of the draft GHG emission and removal estimates and the draft report takes place before the final submissions to the EU and UNFCCC (January to March) by the involved institutions on GHG inventory preparation process.

The draft of National inventory report (NIR), which was submitted to EU on 15th of January, was sent to CSB, MoE, MoA and MoT for checking and approving.

Improvements for GHG inventory are compiled based on the findings of the UNFCCC, EC, internal reviews and recommendations from third part experts (periodically all sectors are revised by third part experts. In previous submission LULUCF, LULUCF KP sectors were checked by international third part reviewer. Results are implemented in this report (Chapter 6 and Chapter 11)).

1.2.3.3 Documentation and Archiving

As part of general QC procedures, it is good practice to document and archive all information that is used for emission estimates. Documentation has a significant role in the inventory quality management.

All institutions involved in GHG inventory preparation process are responsible for archiving the collected data and estimated emissions.

<u>Documentation system in CSB:</u>

- Survey and calculations documentation system;
- Quality indicators documentation system;
- Thesaurus;
- 2 sub-systems – internal & external.

CSB a Document Storage System (ADS):

- In 2008, ADS was developed in the CSB;
- Starting with 2009, each year all fundamental processes performed for each statistical survey as well as for calculations have to be described in detail;
- All quality indicators have to be described;
- ADS provides also a technical possibility to attach a number of supporting documents;
- ADS is made accessible for external users on the CSB website.

Revisions of data are defined as any changes to statistics that have already been published.

CSB uses integrated statistical data management system (ISDMS) for data processing. It is a metadata driven system based on metadata and standardisation of data processing, which in essence does not require individual programming. This system is used for processing surveys of business (mainly) and social statistics. Data collected by means of questionnaires which are not included in the ISDMS are processed by the CSB using other especially developed data processing applications. Detailed information is given in the Annex 5.

The expert organizations have archives located in their own facilities. Experts keep all information (all disaggregated emission factors, activity data, and documentation about how these factors and data have been generated and aggregated for the preparation of the inventory) on the hard disks of the individual expert's desktops.

Every annual inventory (CRF tables, XML, SQL Databases, NIR and Registry information) is archived.

Latvia has a centralized archiving system - all information (including corresponding letters, internal documentation on QA/QC procedures, external and internal reviews, documentation on annual key sources and key source identification, planned inventory improvements) used for inventory compilation are collected on the special server and the backup of data are made periodically. All information is archived at LEGMC. Common, password protected FTP folder is used for information storage and exchange.

Printed copies of NIR are stored in LEGMC and MEPRD archives in May each year, after completion and submission of the inventory. All information is archived on CDs as well.

1.2.3.4 Verification activities

In the CSB data are verified in two data processing stages: on raw data level (processing of individual information) and on aggregated data level (verifying prepared aggregates).

CSB uses several methods for data verification at the raw data level:

- arithmetical connections;
- logical connections;
- comparison with data of previous periods;
- mutual coherence verification with other statistical questionnaires;
- statistical registers and administrative data.

Aggregates are made and different groupings are formed from the raw data produced. CSB uses similar methods for verification of aggregates to ones, which are applied in the verification of raw data.

1.2.3.5 Treatment of confidentiality issues

For Latvia's GHG Inventory mainly confidentiality is related to activity data provided to LEGMC by CSB. The data then is used for emission estimation and can't be reported further. If the data that could be considered as confidential is provided to LEGMC by production plan or other enterprise then the data is not considered as confidential and can be reported within GHG Inventory.

Data of CSB

Legal, technical and administrative measures:

Legal:

"Law on State Statistics"

"Law on State Information Systems"

"Personal Data Protection Law"

"Information Publicity Law".

Technical:

Physical Security (environmental (temperature fluctuations, etc.), technical (voltage reduction, etc.) and human factors (theft, deliberate or unintentional damages, etc.).

Logical Security (security measures provided by IT: user names and passwords, antivirus, firewalls etc.).

Administrative:

Information Security Management Coordination Council (ISMCC) ensure and implement in the CSB security policy, security means and principles of data storage, information classification and confidentiality, principles of granting access rights.

Information Security Policy developed (2008).

CSB ensures confidentiality and protection of information supplied by the respondents, as well individual information received from other sources pursuant to the requirements of national legislation in force.

The CSB takes the necessary organisational, administrative and technical measures to ensure confidentiality.

Technical: described in internal regulations and procedures on security and use of Information Systems.

Organisational and administrative:

- "Confidentiality Statement" signed by every employee, laying down the personal data non-disclosure obligation;
- Confidentiality Council established to ensure that individual information possessed by the CSB is used for scientific and research purposes according to the provisions of the Official Statistics Law and other legal acts and to deal with legally unregulated confidentiality issues.
- Handbook of statistical confidentiality developed (2009) that provides explanations of the methods used by the CSB for ensuring data confidentiality.

It is strictly determined in Law of Statistics what information could be provided to other institutions even though the information is needed in emission estimation and reporting under international conventions. CSB can't give the information of amount of production if one or two companies produce up to 95% from total market production in particular sector.

Due to small market of Latvia almost all industrial production data is classified as confidential with some exceptions in food and drink sector. LEGMC has interdepartmental agreement with CSB to receive confidential information for the emission estimation but these activity data has to be reported as "C" in CRF Tables and in NIR.

Data of EU ETS

As all Latvia's industrial processes sector's companies are participating in EU ETS then data from these companies can be obtained from their annual GHG report within compliance obligations within EU ETS. These activity data used emission factors and used emission estimation methodologies can be reported in NIR and in CRF Tables as the data of EU ETS can't be confidential and all companies' annual GHG reports are published in LEGMC webpage.

ETR documentation

As no significant changes were done in Latvia's ETR then ITL Initialization documentation wasn't changed either.

1.2.4 Changes in national inventory arrangements since previous annual GHG inventory submission

There are no changes to arrangements with institutions involved in the GHG inventory preparation. The agreements regarding responsibilities are maintained and continue to be in force according to the national legislation (Regulations of the Cabinet of Ministers No. 217 adopted on 27 March 2012 "The National Inventory System of Greenhouse Gas Emission Units").

1.3 Inventory preparation, data collection, processing and storage

1.3.1 GHG inventory and KP-LULUCF inventory

Each sector has an assigned one or more responsible sectoral experts who are responsible for conformity with the relevant reporting guidelines, selection of appropriate methods and data sources and activity data collection, processing and updating of data.

For the Energy (excluding Transport), IPPU and Waste – data collection and emission estimation is done by LEGMC experts from Air and Climate Division, Chemicals and Hazardous Waste Division and Inland Waters Division.

For Transport activity data is collected and emissions are calculated by expert from Institute of Physical Energetics.

For Agriculture, data collection and emission estimations are done by Latvia University of Agriculture in collaboration with Ministry of Agriculture.

Land-use, land use change and forestry data and KP- LULUCF data are collected and emissions/removals are calculated in Latvian State Forest Research Institute "Silava" in collaboration with Ministry of Agriculture and Latvia University of Agriculture.

All experts responsible for data collection and processing in a particular sector are preparing their data (activity data, emission factors) for import into CRF Reporter software.

1.4 Brief general description of methodologies and data sources used

1.4.1 GHG inventory

Latvia's GHG emissions inventory is based on:

- 2006 IPCC Guidelines;
- 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (IPCC Wetlands Supplement);
- 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (IPCC KP Supplement);
- EMEP/CORINAIR Guidebook 2007 and EMEP/EEA 2009;
- EMEP/EEA air pollutant emission inventory guidebook 2013.

The main sources for emission factors are guidelines mentioned above as well as national studies for country specific parameters and emission factors (e.g. CO_2 emission factors, aspects influencing SO_2 emission factors, distribution of animal waste management systems, average N excretion and etc.).

For 2016 submission (NIR and CRF tables) compilation the CRF Reporter version 5.14 was used. To calculate GHG emissions, supplemental locally developed database in Excel format was used for all sectors except for Road Transport where COPERT IV was used.

Where data of bottom – up method were available and plants had reported estimated data using plant specific emission factors and estimation methodologies for Energy sector, these data were used in the submission. If these data were not available, Tier 1 method from 2006 IPCC Guidelines was used to estimate emissions. Emissions for the whole country fuel consumption were estimated by adding up fuel consumption of individual sectors multiplied by appropriate emission factors.

Emissions from Road Transport sector were estimated by using COPERT IV model for 1990–2014 (Tier-2 method). Emissions for other transport sub-sectors were estimated according to IPCC Tier 1 and Tier 2 methodologies (Tier 2 method for diesel oil CO_2 emission calculation in railway and navigation and Tier 2 method for jet kerosene emission calculation in aviation (civil and international). Rest of emissions have been calculated by Tier 1 method).

Emissions from Industrial Processes and Product Use were estimated according to 2006 IPCC Guidelines, EMEP/CORINAIR 2007 Guidebook, EMEP/EEA 2009, EMEP/EEA air pollutant emission inventory guidebook 2013 as well as using expert research and judgment about activity data and emission factors.

Emissions from Agriculture sector were estimated according to methodologies from 2006 IPCC Guidelines, IPCC Wetlands Supplement additionally using local researches related some parameters.

2006 IPCC Guidelines, IPCC KP Supplement and IPCC Wetlands Supplement for CO_2, CH_4 and N_2O emissions from drained and rewetted soils were used to estimate emissions from LULUCF and KP-LULUCF sector.

2006 IPCC Guidelines were used to estimate emissions from Waste sector.

The Table 1.3 presents the main data sources used for activity data as well as information on actual calculations:

Table 1.3 Main data sources for activity data and emission values

Sector	Data Sources for Activity Data	Emission Calculation
Energy	Energy balance from Latvian Central Statistical Bureau (CSB); IEA/ OECD – EUROSTAT – UNECE Annual questionnaires; LEGMC "2-AIR" database; Research of experts.	LEGMC Air and Climate division, plant operators
Transport	Energy balance from Latvian CSB; IEA/AIE – EUROSTAT – UNECE Annual questionnaires; Data of Road Traffic safety Directorate; Research of experts.	IPE according to agreement with the Ministry of Environmental Protection and Regional Development
Industrial Processes and Product Use	National production and sales statistics; Direct information from enterprises operating with pollutants; Central Statistical Bureau; Chemicals Register; Assumptions by experts; State Agency of Medicines; Research by experts; LEGMC "2-AIR" database	LEGMC Air and Climate division, plant operators LEGMC Chemicals and Hazardous Waste division
Agriculture	National agricultural statistics obtained from CSB; National studies.	Latvia University of Agriculture in collaboration with Ministry of Agriculture
LULUCF; LULUCF KP	National forest inventory State forest service Ministry of Agriculture of Republic of Latvia Central Statistical Bureau State Firefighting & Rescue Service National studies and expert judgment	Latvian State Forest Research Institute "Silava" in collaboration with Ministry of Agriculture and Latvia University of Agriculture
Waste	Latvian Environment, Geology and Meteorology Centre "3-Waste" and "2-Water" databases; Methane recovery installations; CSB.	LEGMC Chemicals and Hazardous Waste division, LEGMC Inland Waters Division

1.4.2 KP-LULUCF inventory

The land use matrix is based on the results of land use changes to forest derived from the NFI of the period 2004-2008 and 2009-2013. Methodology for estimation of earlier land use changes, including deforestation activities is under development in the LSFRI Silava as a part of National Forest inventory (NFI). The assessment methods at the NFI grid points are described in Annex 1 of Report on improvement of QA/QC system in LULUCF sector in Latvia[10]. Estimation of afforested and deforested area in 2009-2013 is based on of the NFI data, 2014 is extrapolated for the 5 years average of previous years.

Historical figures of deforestation were estimated using remote sensing methods based on evaluation of LANDSAT satellite image series from 1990, 1995 and 2000 using ERDAS Imagine software. The NFI is the main data provider for the GHG reporting in LULUCF sector

[10] https://drive.google.com/open?id=0Bxv4jQ_04jXZdEhJVFJ4OVRPTkE

and Kyoto protocol Article 3, paragraph 3 and Article 3, paragraph 4 (Article 3.3 and 3.4) activities.

Forest soil properties (carbon stock in litter and mineral soil) in forest lands were determined in permanent 16 x 16 km grid of 95 sample plots of the 1st level forest monitoring programme. No soil carbon stock changes are considered in afforested lands, according to research data demonstrating insignificant carbon stock differences in forest land and grassland.

Methods for estimating carbon stock changes in forests (for Article 3.3 afforestation, reforestation, deforestation and Article 3.4 forest management) are the same as those used for the LULUCF inventory reported under the UNFCCC. Estimations of carbon stock changes in living biomass on forest land remaining forest in the 1st cycle of the NFI are based on measurements of radial increment of growing trees and calculation of actual potential increment of timber volume of all living trees; in the second and third, "floating" period increment is calculated as stock difference of living trees; mortality is accounted as the stock of trees changing status (destiny) from living trees to dead and left in the stand; harvesting stock is accounted as stock of trees changing status (destiny) to dead and extracted. The NFI data are harmonized with the State forest service data provided information by application of linear factor (+26 %) to the whole accounting period.

Since research data are available, historical figures (before 2004) on mortality are recalculated and provided in the inventory considering 20 years decay period for dead biomass, respectively; calculations are done for the period 1970-2014. Removals of CO_2 in living biomass on afforested areas are calculated on the base of weighted average of timber stock changes in 1-25 years old forest stands on non-forest lands.

No harvesting takes place in lands converted to forests; therefore no artificial emissions in living biomass are reported in this category. However if by some reasons (for instance, thinning) harvesting took place on afforested area it is also reported in national statistics and is included in Forest management related carbon stock changes.

Losses in living biomass due to deforestation are reported based on average growing stock figures were used to extrapolate average losses in living biomass due to deforestation. All biomass, including stem, branches and below-ground biomass is considered instantly oxidized.

Carbon stock changes in dead wood, litter and soils are reported under deforestation assuming that average carbon stock on forest lands remaining forest in dead biomass pools is instantly oxidizing during conversion, but carbon soil in mineral soils stabilizes in 20 years. For conversion to settlements it is assumed that 20 % of carbon in 0-30 cm deep soil layer turns into emissions in 20 years.

1.4.3 European Union Emission Trading Scheme (EU ETS) data

Latvia has fully implemented the Directive 2003/87/EC[11] of the European Parliament and of the Council establishing a scheme for greenhouse gas emission allowance trading within the Community.

[11] *http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02003L0087-20140430&from=EN*

The European Union Emission Trading System (EU ETS) data obtained from annual emission reports submitted by operators to competent authority is used as source of activity and emission data for the GHG inventory particularly in Energy and Industrial Processes and Product use sectors. All emission reports for all years 2005-2015 are publicly available on the web page of competent authority and are fully available for the GHG inventory.

Latvia has implemented EU ETS and set all the requirements in 2003 and 2004 when amendments in Law On Pollution were made and all necessary Cabinet of Ministers regulations were approved for the stationary combustion installations – monitoring, reporting, verification and compliance obligations, setting the possibility of voluntary participation for the installations not exceeding thermal input of 20MW. In 2005 Latvia's Emission Trading Registry was developed and launched. Since that time 93 installations have received GHG permits. Operation of EU ETS in Latvia is ensured mainly by Ministry of Environmental Protection and Regional Development (MEPRD) and institutions under the supervision of MEPRD – State Environmental Service and its Environment State Bureaus that are responsible for approval of monitoring plans, issuance of permits, and approval of annual emission reports for stationary installations, Latvian Environment, Geology and Meteorology Centre that is Latvia's National Administrator of Emission Trading Registry (Union Registry since 2012).

Starting 2008 for Kyoto Protocol 1st period the EU ETS was linked to the international emissions trading under the Kyoto Protocol. The scope of EU ETS was enlarged still in Latvia no new installation was included in EU ETS due to enlarged scope.

Since 2012 the aviation activities were also included in EU ETS regarding all aircraft operators that perform flights to/from EU. Still in 2013 the exemptions were applied to the flights to/from countries outside European Economic Area (EEA) so in 2013-2016 only internal flights to/from EEA countries as well as to/from aerodromes in the same outermost region are included in EU ETS scope. Civil aviation agency (institution of Ministry of Transport) is main competent authority responsible for approval of monitoring plans and approval of annual emission reports for aircraft operators still MEPRD is fully responsible regarding the implementation of the requirements for the aviation activities in EU ETS.

Latvian National Accreditation Bureau (the institution of Ministry of Economy) is responsible for accreditation and monitoring of verifiers.

Starting 2013 in EU ETS Phase 3 the scope was again extended and one installation of Latvia was included in EU ETS. Starting this period, the emission allowances are mainly auctioned. New harmonised requirements for the calculation and allocation of EU allowances were developed by European Commission in 2011 as well as harmonised requirements for monitoring, reporting, accreditation and verification were developed by European Commission in 2012. Harmonised templates for monitoring plan, emission report (and tonnkilometer reports for aircraft operators), verification report as well as templates for emission allocation calculation and reporting were developed by European Commission. Latvia uses these developed harmonised templates. Since 2013 the calculation of EU allowances as well as the monitoring and control of annual allocation is done by MEPRD.

In 2014 there were 66 EU ETS installations in Latvia and 15 aircraft operators were set as administered by Latvia (only 2 aircraft operators were not exempted and was set as aircraft operators of EU ETS).

Unified emission trading registry system was developed and launched in 2012 so all EU Member States use the same registry for EU ETS compliance activities.

Latvia`s verified ETS emissions in 2014 were 2354,247 kt CO_2 eq.

1.5 Brief description of key categories, including for KP-LULUCF

1.5.1 GHG inventory

This section provides an overview of key categories. The identification of key categories is described in the 2006 IPCC Guidelines Chapter 4: Methodological Choice and Identification of Key Categories.

Key sources are the emissions/removals, which have a significant influence on the total inventory in terms of the absolute level of emissions and the trend of emissions or both. Level Assessment identify source category whose level has a significant effect on total national emissions. Trend Assessment identifies sources that are the key because of their contribution to the total trend of national emissions.

It is important to identify key source categories so that the resources available for inventory preparation may be prioritized and the best possible estimates prepared for the most significant source categories.

IPCC methodologies offer two different methods for identifying key sources: Approach 1 and Approach 2. In the Approach 1 method, the emission sources are sorted according to their contribution to emission level or trend. In the Approach 2 method, the relative uncertainties of the source categories are also taken into account. The key sources are the emission categories, which represent together 95% of the inventory uncertainty if using level and trend assessment and 90% of the total value of the total trend assessment with uncertainty.

For 2016 submission both approaches are used to identify key sources for time period 1990-2014. The identification was divided in two parts, key sources excluding LULUCF and key sources including LULUCF source categories. The starting point for the choice of source categories with LULUCF is the list presented in the 2006 IPCC Guidelines, Chapter 4 Methodological Choice and Identification of Key Categories, Table 4.1. The base year for CO_2, CH_4, and N_2O greenhouse gas emissions was 1990.

Summary of key categories is shown in Table 1.4. Key categories are identified by Approach 1 and Approach 2 (level and trend) in order to provide additional insight into the reasons why particular categories are key. The mandatory, detailed reporting tables of the key categories (Tables 4.2 and 4.3 of volume 1 of the 2006 IPCC Guidelines, including and excluding LULUCF) are provided in Annex 1 of this submission.

Table 1.4 Key categories in 2016 submission identified using Approach 1 and Approach 2 level and trend assessment

IPCC category/Group	Gas	Identification criteria	with LULUCF	without LULUCF
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	L1,L2,T1,T2	X	X
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	T1,T2	X	X
1.A.1.a Public Electricity and Heat Production - Peat	CO_2	T1	X	X

IPCC category/Group	Gas	Identification criteria	with LULUCF	without LULUCF
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	T1,T2	X	X
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	L1,T1		X
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CO_2	T1		X
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	T1	X	X
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	T1		X
1.A.2.a Iron and Steel - Other fossil fuels	CO_2	T1		X
1.A.2.c Chemicals - Liquid Fuels	CO_2	T1,T2	X	X
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	T1	X	X
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	L1,T1	X	X
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	L1,T1,T2	X	X
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	T1,T2	X	X
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	L1,T1	X	X
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	T1,T2	X	X
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CO_2	L1	X	X
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	L1,L2,T1,T2	X	X
1.A.2.g Other - Biomass Fuels	N_2O	T2		X
1.A.2.g Other - Gaseous Fuels	CO_2	L1,T1,T2	X	X
1.A.2.g Other - Liquid Fuels	CO_2	L1,T1,T2	X	X
1.A.3.b Road Transportation - Diesel Oil	CO_2	L1,L2,T1,T2	X	X
1.A.3.b Road Transportation - Diesel Oil	N_2O	T2		X
1.A.3.b Road Transportation - Gasoline	CO_2	L1,L2,T1	X	X
1.A.3.b Road Transportation - LPG	CO_2	L1,T1,T2	X	X
1.A.3.c Railways - Liquid Fuels	CO_2	L1,T1	X	X
1.A.3.c Railways - Liquid Fuels	N_2O	L2		X
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	L1,L2,T2		X
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	L1,L2,T1	X	X
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	L1,L2,T1,T2	X	X
1.A.4.a Commercial/Institutional - Peat	CO_2	T1		X
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	L1,T1,T2	X	X
1.A.4.b Residential - Biomass Fuels	CH_4	L1,L2,T1,T2	X	X
1.A.4.b Residential - Gaseous Fuels	CO_2	L1,L2,T1,T2	X	X
1.A.4.b Residential - Liquid Fuels	CO_2	L1,L2,T1	X	X
1.A.4.b Residential - Solid Fuels	CO_2	L1,T1,T2	X	X
1.A.4.b Residential - Solid Fuels	CH_4	T2		X
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	L1,L2,T1,T2	X	X
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	L1,L2,T1	X	X
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	L1,L2,T1,T2		X
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	T1,T2	X	X
1.B.2.b Natural Gas	CH_4	L1,L2,T1,T2	X	X
1.B.2.c Venting and Flaring	CH_4	L1		X

IPCC category/Group	Gas	Identification criteria	with LULUCF	without LULUCF
2.A.1. Cement Production	CO_2	L1,L2,T1,T2	X	X
2.A.2. Lime Production	CO_2	T1,T2	X	X
2.A.4. Other process uses of carbonates	CO_2	T1,T2		X
2.C.1 Iron and Steel Production	CO_2	T1		X
2.D.3. Solvent Use	CO_2	L1		X
2.F.1. Refrigeration and air conditioning	HFCs	L1,L2	X	X
3.A.1 Enteric Fermentation - Cattle	CH_4	L1,L2,T1,T2	X	X
3.B.1.1 Manure Management - Cattle	CH_4	L1,L2,T1		X
3.B.2.1 Manure Management - Cattle	N_2O	L1,L2		X
3.B.5 Indirect N2O emissions from Manure Management	N_2O	L1,L2		X
3.D.1. Direct N2O emissions from managed soils	N_2O	L1,L2,T1,T2	X	X
3.D.2 Indirect N2O Emissions from managed soils	N_2O	L1,L2,T1,T2	X	X
3.G. Liming	CO_2	T1,T2	X	X
4. G. Harvested wood products	CO_2	L1,L2,T1,T2	X	
4.A.1 Forest Land remaining Forest Land – Carbon stock change, dead wood	CO_2	L1,L2,T1,t2	X	
4.A.1 Forest Land remaining Forest Land – Carbon stock change, living biomass	CO_2	L1,T1,T2	X	
4.A.1 Forest land remaining forest land - Controlled burning	CO_2	L1,L2,T1,T2	X	
4.A.1 Forest Land remaining Forest Land – Drained organic soil	CO_2	L1,L2,T1,T2	X	
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	N_2O	L1,L2,T1,T2	X	
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	L1,L2,T1,T2	X	
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	L2	X	
4.A.2 Land converted to Forest Land – Carbon stock change, grassland converted to forest land	CO_2	L1,L2,T1,T2	X	
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, dead wood	CO_2	L1	X	
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, litter	CO_2	L1	X	
4.B. Cropland remaining cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	L1,L2	X	
4.B.1 Cropland remaining Cropland – Carbon stock change – living biomass	CO_2	L2	X	
4.B.1 Cropland remaining Cropland – Drained organic soil	CO_2	L1,L2,T1,T2	X	
4.B.1 Land converted to Cropland – Carbon stock change – dead organic matter	CO_2	T1	X	
4.B.1 Land converted to Cropland – Carbon stock change – dead organic matter	CO_2	T2	X	
4.B.2 Land converted to Cropland – Carbon stock change, forest land converted to cropland	CO_2	T1,T2	X	
4.B.2 Land converted to Cropland – Drained organic soil	CO_2	L1,L2,T2	X	
4.B.2 Land converted to Cropland –Mineral soil	CO_2	T2	X	

IPCC category/Group	Gas	Identification criteria	with LULUCF	without LULUCF
4.C. Grassland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	L1	X	
4.C.1 Grassland remaining Grassland – Carbon stock change – living biomass	CO_2	T2	X	
4.C.1 Grassland remaining Grassland – Drained organic soil	CO_2	L1,L2,T1,T2	X	
4.C.2 Land converted to Grassland – Drained organic soil	CO_2	L1,L2,T1,T2	X	
4.C.2 Land converted to Grassland –Mineral soil	CO_2	L1,L2,T1,T2	X	
4.D.1 Wetlands remaining Wetlands – Carbon stock change – living biomass	CO_2	L1,L2,T1,T2	X	
4.D.1 Wetlands remaining Wetlands – Carbon stock change – organic soils	CO_2	L1,L2	X	
4.D.1. Wetlands, Peat extraction from lands, organic soils	CO_2	L1,L2	X	
4.E.1 Settlements remaining Settlements – Carbon stock change – living biomass	CO_2	L1,L2,T2	X	
4.E.2 Land converted to Settlements – Carbon stock change – dead organic matter	CO_2	L1,T1	X	
4.E.2 Land converted to Settlements – Carbon stock change – living biomass	CO_2	L1,L2,T1,T2	X	
4.E.2 Land converted to Settlements – Mineral soils	CO_2	L1,L2,T1,T2	X	
4.E.2 Land converted to Settlements – Organic soils	CO_2	L1,L2,T1,T2	X	
5.A.1. Managed Waste Disposal on Land	CH_4	L1,L2	X	X
5.A.2. Unmanaged Waste Disposal Sites	CH_4	L1,L2,T1,T2	X	X
5.B.1. Composting	CH_4	L2,T2		X
5.B.1. Composting	N_2O	L2,T2		X
5.D.1 Domestic Wastewater	CH_4	L1,L2,T1,T2	X	X
5.D.1 Domestic Wastewater	N_2O	L2,T2		X
5.D.2 Industrial Wastewater	CH_4	L1,L2,T1,T2	X	X

1.5.2 KP-LULUCF inventory

There were several key categories in KP-LULUCF. The most significant key source of emissions in KP-LULUCF is CO_2 in forest management and due to deforestation. Other key sources of emission are N_2O and CH_4 in forest management (forests on drained and rewetted organic soils).

1.6 General uncertainty evaluation

1.6.1 GHG inventory

This section provides an overview of the approach to uncertainty analysis for Latvia's inventory.

The uncertainty estimates of the 2016 submission have been done according to the Approach 1 method presented in 2006 IPCC Guidelines. The Approach 1 is based on emission estimates and uncertainty coefficients for activity data and emission factors. The mandatory, detailed reporting tables of the uncertainty analysis (Table 3.3 of volume 1 of the 2006 IPCC Guidelines with and without LULUCF) are provided in Annex 2 of this submission.

2016 submission total uncertainties are reflected in Table 1.5.

Table 1.5 Uncertainties of 2016 submission

	Uncertainty in total inventory %	Trend uncertainty %
With LULUCF	16%	11%
Without LULUCF	7%	2%

In many cases uncertainty coefficients have been assigned based on default uncertainty estimates according to 2006 IPCC Guidelines or on expert judgment, because there is a lack of the information. For each source, the uncertainty for activity data and emission factors was estimated and given in per cent.

Generally for activity data from CSB 2% uncertainty is used according to received information from CSB.

The uncertainty calculation is based on Excel file, which is send to sectoral experts for updating annually.

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

In the annual meeting at the beginning of the inventory cycle the experts are advised to go through the uncertainty ranges of activity data and emissions factors in order to prioritize inventory improvements. This year the uncertainty categories were reviewed and disaggregated according to 2006 IPCC Guidelines.

Detailed about uncertainty assessment is described under each subsector.

1.6.2 KP-LULUCF inventory

Tier 1 was implemented for estimating uncertainty rates related to activity data and emission factors employed in the estimates under Article 3.3. activities.

1.7 General assessment of completeness

1.7.1 GHG inventory

Latvia 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, SF_6 and NF_3), NMVOC, NOx, CO and SO_2. No additional sources and sinks identified.

In accordance with the IPCC Guidelines, international aviation and marine bunker fuel emissions are not included in national totals.

The notation keys presented below are used to fill in the blanks in all the tables in the CRF. Notation keys used in the NIR are consistent with those reported in the CRF.

NE (not estimated):

"NE" is used for existing emissions by sources and removals by sinks of greenhouse gases that have not been estimated.

IE (included elsewhere):

"IE" is used for emissions by sources and removals by sinks of greenhouse gases that have been estimated but included elsewhere in the inventory instead of the expected source/sink category.

NA (not applicable):

"NA" is used for activities in a given source/sink category that do not produce emissions or emissions are negligible.

C (confidential):

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

1.7.2 KP-LULUCF inventory

The National forest inventory as well as other statistical data sources covers the whole territory of Latvia, therefore, the GHG inventory represents the whole country. All sources and sinks included in the IPCC Guidelines are covered.

1.7.3 Completeness by timely coverage

Both direct GHGs as well as indirect GHGs are covered by the Latvia's inventory. A complete set of CRF tables are provided for all years and the estimates are calculated in a consistent manner.

2 TRENDS IN GREENHOUSE GAS EMISSIONS

Detailed information on emission trends is provided in the description of IPCC sectors in chapters 3-7 and in the CRF trend tables.

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

The aggregated greenhouse gas emissions include gases defined in the Kyoto protocol – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFC), perfluorocarbons (PFC) and nitrogen trifluoride (NF_3). The emission levels are presented in kt of carbon dioxide equivalents (kt CO_2 eq.).

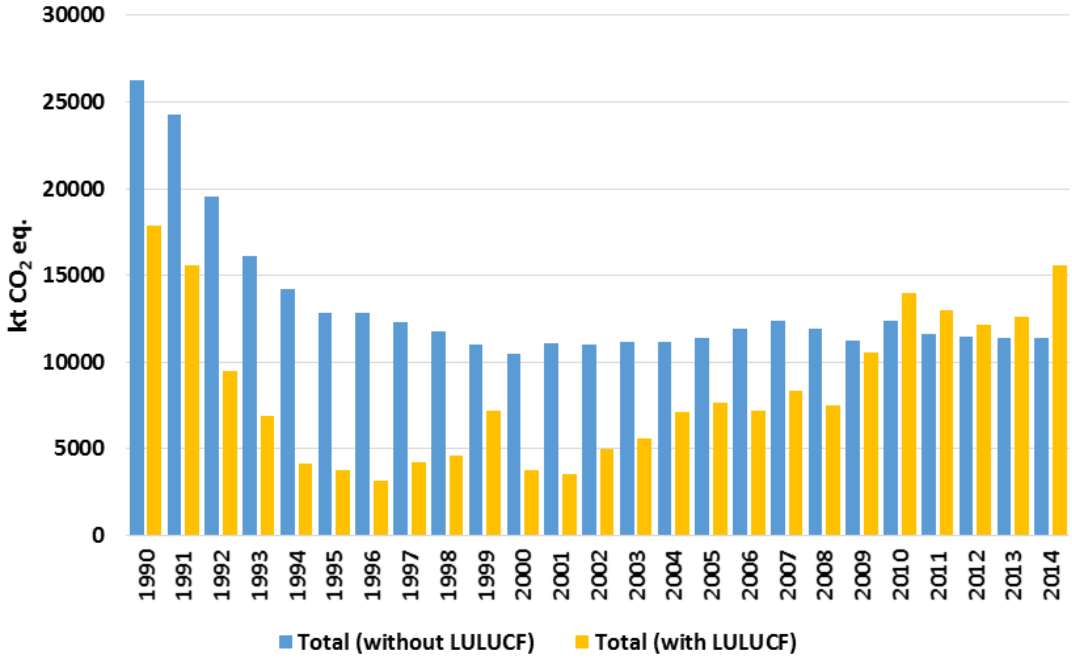

Figure 2.1 Latvia`s aggregated greenhouse gas emissions in 1990-2014 (kt CO_2 eq.)

As illustrated in Figure 2.1, since 1990 Latvia's GHG emissions have considerably decreased by 56.76% (excluding LULUCF) and by 12.68% including LULUCF. This decrease is influenced the economic situation in the country. In Latvia the transition period to market economy started after 1991. This process provoked essential changes in all sectors of national economy and resulted in the decrease of GHG emissions after 1990.

The GHG emissions in LULUCF sector, in contrast, continuously increased since 1990. These changes are driven mostly by reduction of CO_2 removals in living biomass due to ageing of forests, increasing of mortality in mature forests. If compared to 1990, both figures are doubled since 1990; respectively, average mortality rate in forest in 1990 was 1.61 m^3 ha^{-1} annually, now (in 2014) it is 2.31 m^3 ha^{-1} annually, but felling rate in 1990 was 6.3 mill. m^3 annually, now it is 16.6 mill. m^3 annually. LULUCF sector is also heavily affected by land use changes – in nineteenths considerable area of afforested lands were converted back to agricultural production, in the recent decade another trend is growing – conversion of forest land to settlements to build roads, industrial centers and other infrastructure.

2.2 Description and interpretation of emission trends by gas

Carbon dioxide (CO_2) is the main greenhouse gas causing the climate change. In 2014, CO_2 emissions constitute 62.9% of Latvia's total greenhouse gas emissions. In 2014, total CO_2 equivalent emissions without land use, land-use change and forestry had decreased by approximately 63.8% since 1990.

The most important source of CO_2 emissions (kt) in 2014 was fossil fuel combustion – 91.0%, including Energy Industries – 23.3%, Manufacturing Industries and Construction – 9.6%; Transport – 40.5%, Other sectors (Agriculture, Forestry, etc.) – 17.5%.

Other anthropogenic emission sources of CO_2 are Industrial Processes and Product Use – 8.6%, Agriculture 0.3% and Waste 0.01 %.

Main sources of CH_4 emissions in Latvia are Enteric Fermentation of Livestock, Solid Waste Disposal Sites and Energy sector. Other important sources of CH_4 emissions are leakage from natural gas pipeline systems and combustion of biomass. CH_4 emissions in 2014 contribute approximately 18.3% of total GHG emissions (excluding LULUCF). The methane emissions (kt) decreased by 43.3% in 2014 since 1990.

Agricultural soils are the main source of N_2O emissions in Latvia generating 86.8% of all N_2O emissions (kt) in 2014. Other N_2O emission sources are transport and biomass, combustion of liquid and other solid fuels in sectors of energy conversion and industry, waste and sewage. Since 1990, total N_2O emissions had decreased by 34.0% in 2014, mainly due the decrease in the emissions from agriculture.

Emissions from HFCs and sulphur hexafluoride (SF_6) consumption are reported for the period 1995-2014. Total HFCs emissions (kt CO_2 eq.) increased by 3.8% in 2014 compared with 2013. Since 1995 HFC emissions have increased by 1744%. SF_6 emissions from electrical equipment contribute 8.58 kt CO_2 eq in 2014. Emissions of the PFCs and NF_3 does not occur (NO) in Latvia for all time series.

Emissions by sources are illustrated in the following Figure 2.2.

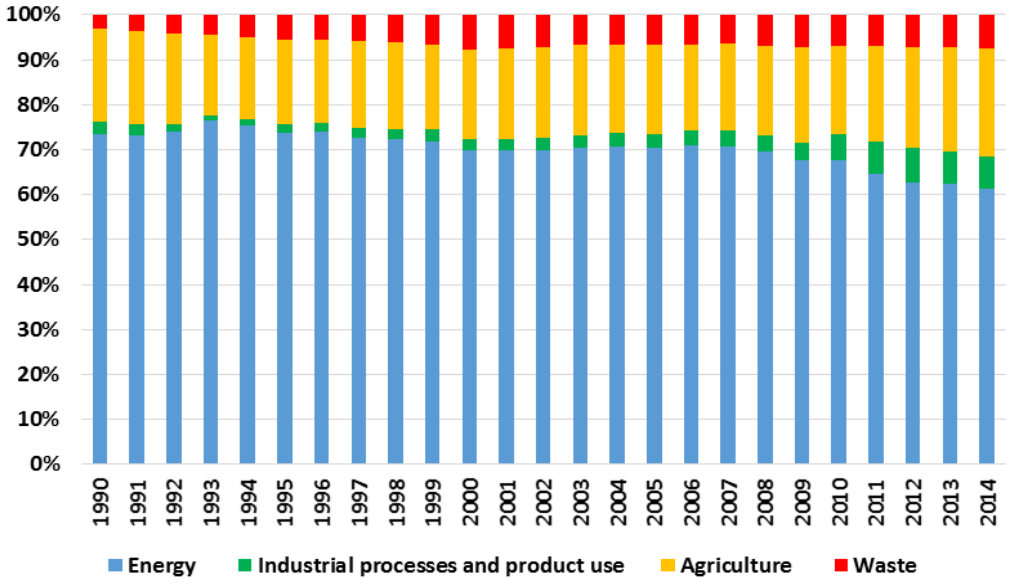

Figure 2.2 Latvia`s greenhouse gas emissions by source 1990-2014 excluding LULUCF

2.3 Description and interpretation of emission trends by category

2.3.1 Trends in ENERGY

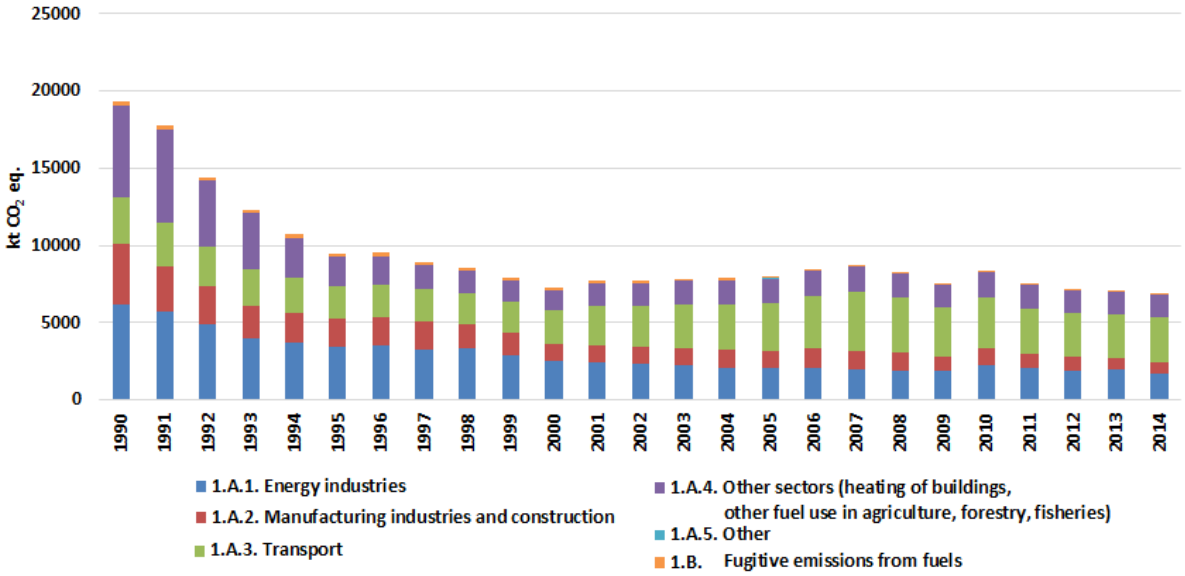

Figure 2.3 Trend in GHG emissions from Energy sector in 1990-2014 (kt CO_2 eq.)

There are two types of emission categories within Energy sector – fuel combustion, where emissions from Energy Industries (CRF 1.A.1), Manufacturing Industries and Construction (CRF 1.A.2), Transport (CRF 1.A.3), Other sector (CRF 1.A.4) and Other (military activities; CRF 1.A.5) sector are produced, and fugitive emissions (CRF 1.B) where leakages from oil distribution and natural gas are occurring. As it can be seen in Figure 2.3, the Energy sector (CRF 1.A, 1.B) is the most significant source of GHG emissions with 73.4% share of the total emissions in 1990 and 61.2% share in 2014. Most of Energy sector emissions (98.7% from total Energy emissions in 1990, and 98.1% in 2014) are produced by combusting fuels (CRF 1.A).

Emissions have decreased in all Energy subsectors – the largest decrease can be seen in Manufacturing industries and Construction (CRF 1.A.2), where emissions in 1990-2014 have decreased by 81.5%. Also in Other sector (CRF 1.A.4) which includes Commercial/Institutional, Residential and Agriculture/Forestry/Fisheries the decrease in GHG emissions is 75.4%, and in in Energy Industries GHG emissions have decreased by 72.9%. In Fugitive sector the decrease in GHG emissions is 45.3%.

After the decreasing in the period 1990 -1999, total GHG emissions from Transport (CRF 1.A 3) had the rapid growth in the period 2000 – 2007 (Figure 2.4). Peak of GHG emissions in transport sectors have been recognized in 2007 when emissions exceeded 1990 level by 27.1%. The main reason for this increasing of emissions was a sharp growth of economy and income of population resulting in rapid increasing of cars (mainly passenger cars).

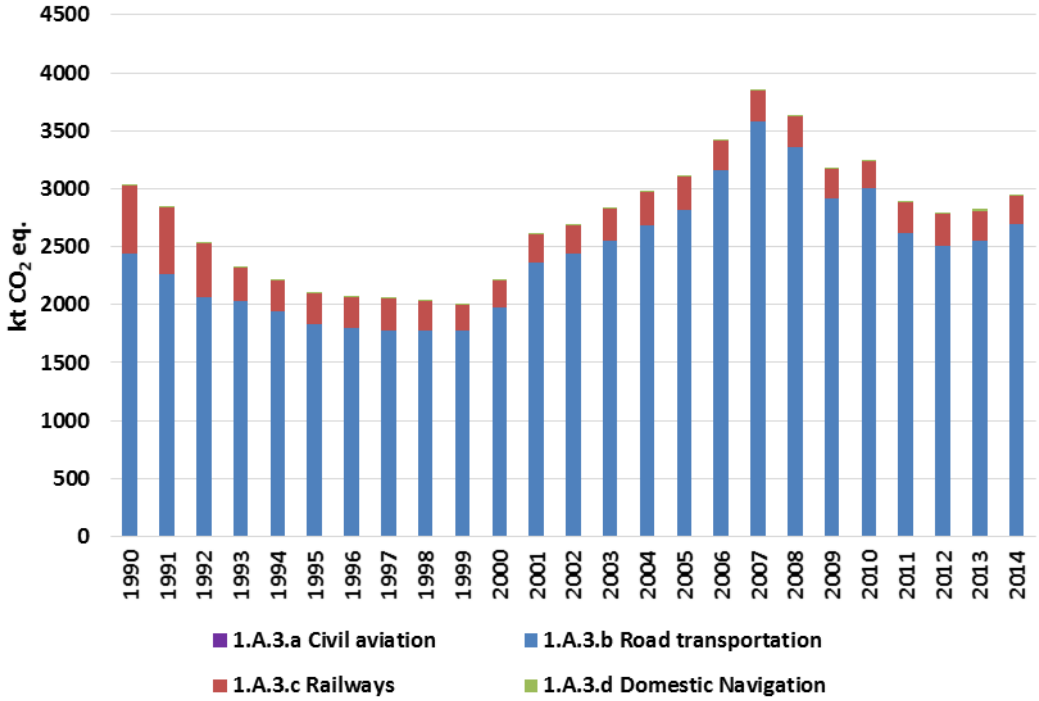

Figure 2.4 GHG emissions development in transport 1990 – 2014 (kt CO_2 eq.)

Recession of the national economy was the major reason for decreasing of transport activities – decrease of passenger km by passenger cars and ton km by freight transport - and corresponding GHG emission decreasing in the time period 2008 – 2009. We can recognize stability in GHG emission trend of transport sector in the last 3 years.

In 2014, total GHG emissions in the transport sector, compared 1990 level, have decreased by 2.6%, however emissions have increased by around 4.3% compared to 2013.

2.3.2 Trends in INDUSTRIAL PROCESSES AND PRODUCT USE

Figure 2.5 shows the GHG emission trend in IPPU sector.

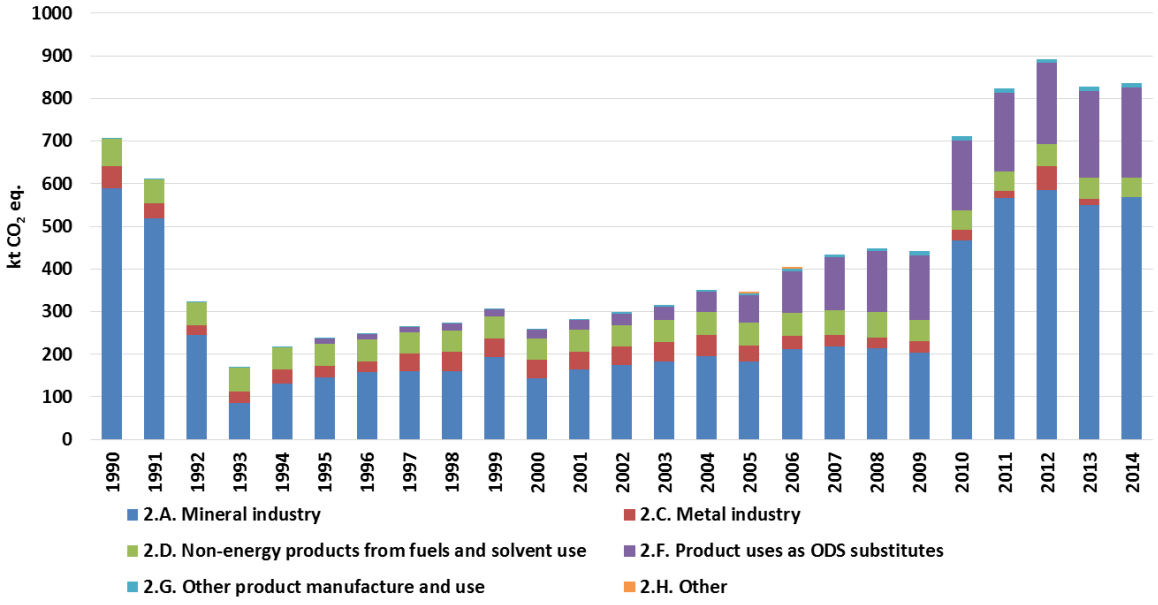

Figure 2.5 Trend in GHG emissions from IPPU sector in 1990-2014 (kt CO_2 eq.)

Largest part of GHG emissions in the Industrial Processes and Product Use (IPPU) sector constitute CO_2 emissions from 2.A Mineral industry (92.5 % of total CO_2 emissions from IPPU sector and 8.0% from total CO_2 emissions in 2014). The second largest source is 2.F Product Uses as ODS Substitutes causing 25.3% from all IPPU emissions and 1.9% from total GHG emissions in 2014. Considerably smaller are rest of IPPU emission sources – 2.G Other Product manufacture and use, 2.D Non energy products from fuels and solvents use and 2.C Metal industry constituting together 6.8% from entire IPPU emissions in 2014.

Compared to 2013 emissions from IPPU sector in 2014 have increased by about 1.0% and mainly it can be explained with different production and services demand in external market as well as with increasing consumption of refrigerants in refrigeration and air conditioning.

Data on emissions in IPPU sector are linked with the economic situation of the country as well as availability of statistical data. The largest decrease of emissions occurred between 1990 and 1993 when industry was affected by a crisis. It has to be noted that in the beginning of 1990s during the countrywide change in government system and national economy statistics was not well kept. Therefore there is a lack of statistical data regarding industry during this time period or they are vague.

As it is seen in Central statistics data, in 1998-2000 there were markably decreased export of products from Latvia to Commonwealth of Independent States (CIS) countries. GHG emissions from IPPU sector have increased from 260.31 kt CO_2 eq in 2000 to 892.51 kt CO_2 eq in 2012. It can be explained with sharp development of Latvian industry when construction activities increased and industrial production of building materials also increased.

Due to Latvia's economic features since 2007–2008 the industry development was slowing down as the financing and real estate sectors started dominating in national economy. In 2009-2010 emissions increased in mineral industry sector due to cement production plant switched the production technology and installations and increased its capacity by approximately 2.4 times.

2.3.3 Trends in AGRICULTURE

Agricultural GHG emissions in Latvia consist of CH_4 emissions from enteric fermentation of domestic livestock, CH_4 and N_2O emissions from manure management, N_2O emissions from agricultural soils and CO_2 emissions from liming and urea application. The trend of emissions in CO_2 eq. by category is presented in

Figure 2.6. Generally emissions from the agricultural sector have declined by 50.0% compared to 1990, due to the decrease of livestock population, crop production and amounts of synthetic fertilizer consumption.

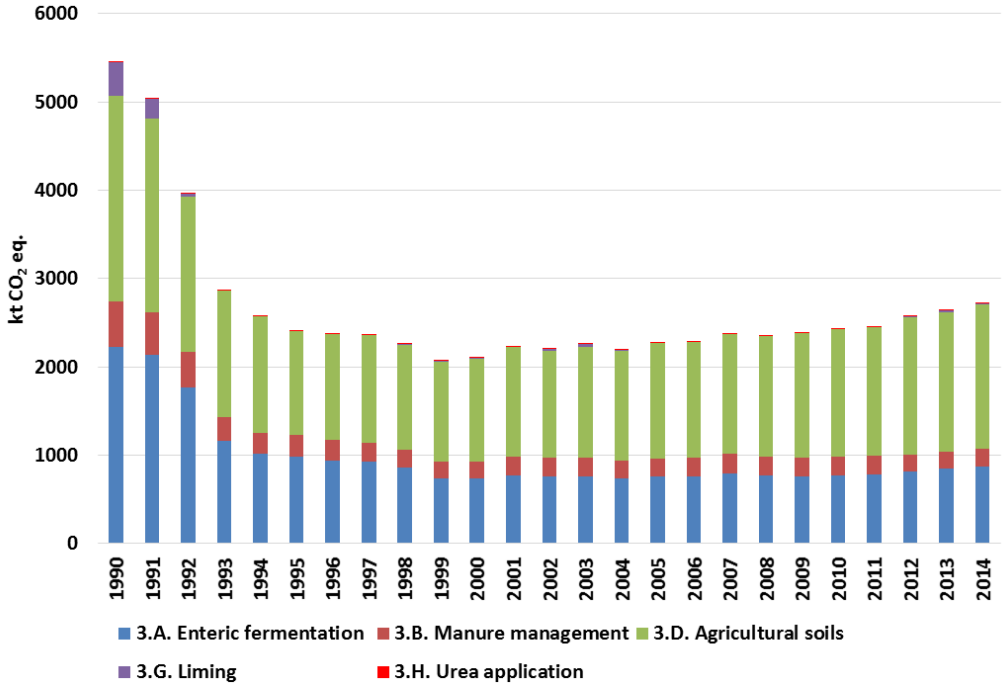

Figure 2.6 Trends of emissions by category within the sector, 1990-2014 (kt CO_2 eq.)

In 2014, agriculture sector contributed 24.0% of the total GHG emissions originated in Latvia or 2726.4 kt CO_2 eq. Emissions from agricultural soils contributed major share of the total emissions from the sector – 59.6%, enteric fermentation emissions was second largest source from the sector – 32.0%. The share of manure management emissions was evaluated as 7.5% of total emissions in the sector, remaining 0.9% of emissions refer to liming and urea application. GHG emissions increased in 2014 by 3.3% comparing to 2013 due to increase of cattle, sheep and fur animal numbers. Statistics also showed increase of synthetic N fertilizer consumption (+4.6%), sown area (+0.3%) and lime application to soils (+42.9%).

2.3.4 Trends in LULUCF

Net aggregated emissions in LULUCF sector considerably increased since 1990 due to growth of economic activity in forest sector and due to conversion of forest lands to settlements and croplands. The land use conversion to cropland is associated mostly to removal of woody vegetation from naturally afforested farmlands abandoned in 1980s. Although the increment of living biomass in forest land remaining forest and afforested land is still larger than the carbon losses due to commercial felling and natural mortality, the gap between gains and losses is decreasing, causing reduction of the net removals of CO_2 in forest land. Hence the total growing stock of living biomass is still increasing in forest lands. Summary of the net emissions including harvested wood products is shown in Figure 2.7. Increase of the GHG emissions in 2014 is associated with increase of the harvesting rate, increase of mortality and reduction of increment in forest lands as well as implementation of floating NFI cycle included in the calculations in 2014.

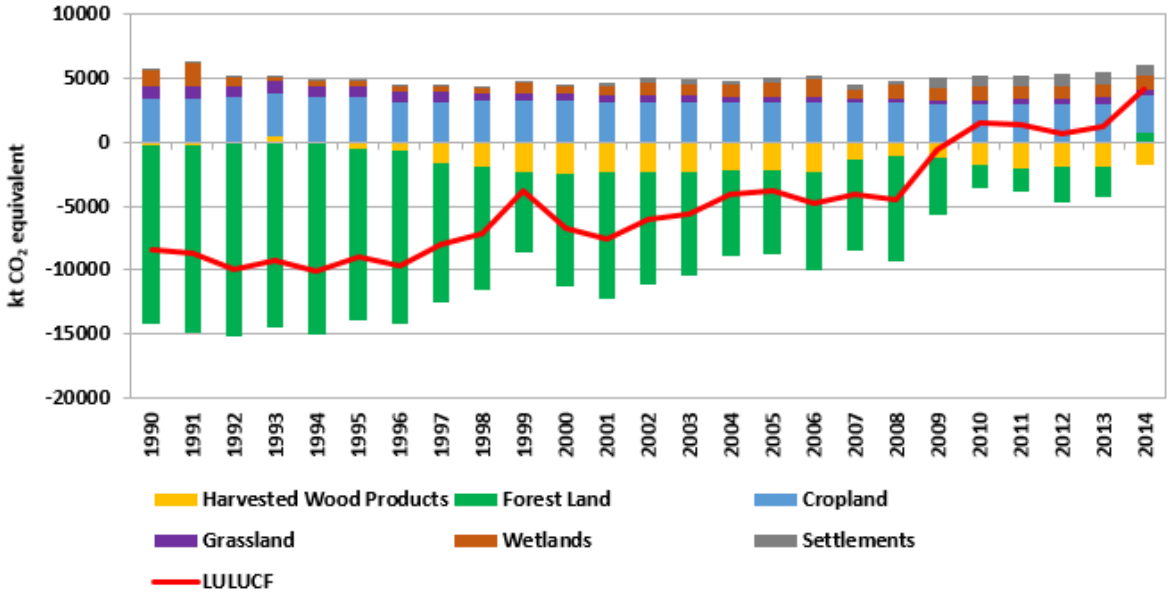

Figure 2.7 Summary of the net emissions in LULUCF sector (kt CO_2 eq.)

Absolute increase of the net annual GHG emissions in LULUCF sector in 2014 if compared to 1990 is 12641.77 kt CO_2 eq., mostly because of reduction of the net CO_2 removals in living biomass in forest lands (by 14752.66 kt CO_2 eq. between 1990 and 2014). Emissions increased also in settlements – by 783.84 kt CO_2 eq. between 1990 and 2014. In cropland, grassland and wetlands emissions decreased by, respectively 528.97, 484.58 and 232.77 kt CO_2 eq. annually between 1990 and 2014. Reduction of emissions in cropland is caused by conversion of cropland to grassland. Net decrease of annual removals in LULUCF sector in 2014 in compare to 1990 is 150 %.

2.3.5 Trends in WASTE

GHG emissions from Waste sector have been fluctuated from 1990-2014. Fluctuations in total GHG emissions in waste sector could be explained with changes of economic situation in last 20 years (Figure 2.8).

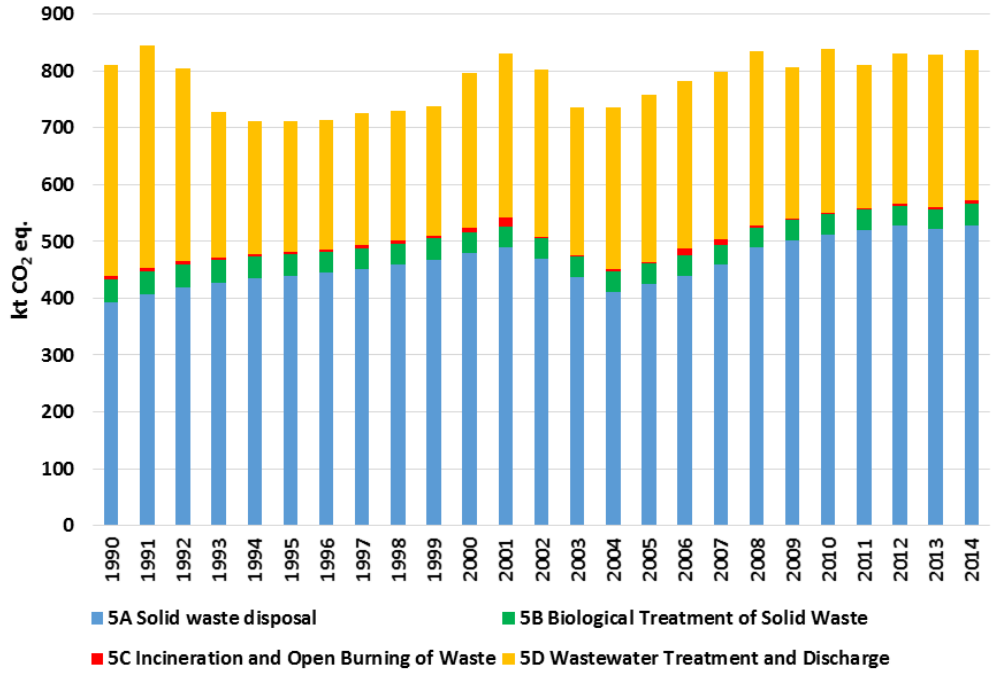

Figure 2.8 Trend in GHG emissions from Waste sector in 1990-2014 (kt CO_2 eq.)

Some industry sectors were almost closed in the middle of 1990s. Emissions from Biological treatment of solid waste and Incineration and open burning of waste are very small in comparison to 5.A. and 5.D.

In 2014, emissions were approximately 3.2% higher than in 1990. In 2014, emissions from the Waste sector were 836.99 kt CO_2 equivalent; it contributes about 7.4% of total GHG emissions (excluding LULUCF).

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

The emissions trends of the indirect greenhouse gases, sulphur dioxide, nitrogen oxides, carbon monoxide and non-methane volatile organic compounds, are presented in Figure 2.9.

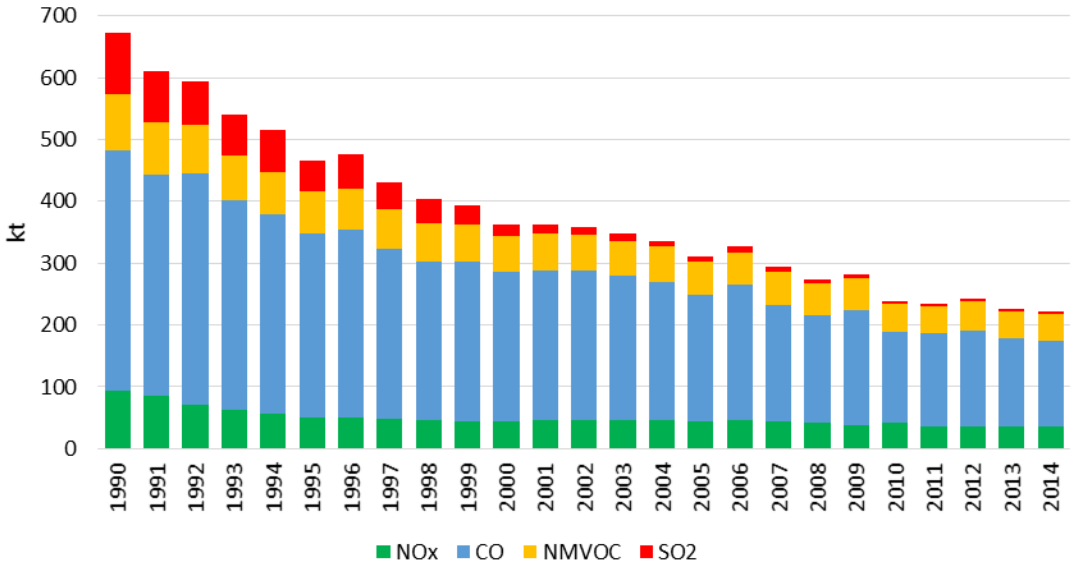

Figure 2.9 Total indirect greenhouse gas emissions trend 1990-2014 (kt)

In 2014, the **sulphur dioxide emissions** were 3.76 kt from which 96% originated in the Energy sector and 4% from IPPU. Since 1990 to 2014 the total SO_2 emissions have decreased by 96%. The reduction is mainly due to use of fuels with lower content of sulphur as well as fuel switching from solid and liquid types of fuel to natural gas and biomass.

Emissions from nitrogen oxides were 35.20 kt in 2014. 86% of NOx emissions generated in the Energy sector, 8% in Agriculture and 5% in IPPU. The Transport sector was responsible for 45% of the total NO_x emissions. The total NOx emissions have decreased by 62% from 1990 to 2014. Generally the reduction is due to decrease of total fuel consumption that was caused by transformation of national economy as well as energy efficiency and control measures and also solid fuels and heavy liquid fuels replacement with natural gas and biomass fuels.

Carbon monoxide emissions were 138.44 kt, being produced generally in the Energy sector (91%). Other sectors (include heating of buildings, other fuel use in agriculture, forestry, fisheries) generate the biggest part of the total CO emissions – 71%. The CO emission trend shows a decrease of emissions for period 1990 – 2014 by 64%.

Total emissions of **non-methane volatile organic compounds** were 44.69 kt from which 48% are generated in Energy sector (mainly residential stationary plants)) and 36% comes from IPPU (mainly from Non-energy products from fuels and solvent use which constitute 33% from total NMVOC emissions in 2014).

Emission consistency with the data used to prepare inventories of air pollutants under EU Directive 2001/81/EC and CLRTAP are checked.

2.5 Description and interpretation of emission trends for KP-LULUCF activities

Coverage of reporting of carbon pools and emission sources with regard to activities afforestation (A), reforestation (R) and deforestation (under Article 3.3) and optional activity forest management (FM) (under Article 3.4) are presented in Table 2.1. All mandatory carbon pools and sources are reported.

Table 2.1 Information table relating to Article 3.3 and elected activities under Article 3.4

Activity		Change in carbon pool reported					GHG sources reported						
		Above-ground biomass	Below-ground biomass	Litter	Dead wood	Soil	Fertilization	Drainage of soils under forest management	Disturbance associated with land-use conversion to croplands	Liming	Biomass burning		
							N_2O	N_2O	N_2O	CO_2	CO_2	CH_4	N_2O
A 3.3	A/R	R	R	R	R	R	NO			NO	NO	NO	NO
	D	R	R	R	R	R			NO	NO	NO	NO	NO
A 3.4	FM	R	R	R	R	R	NO	R		NO	R	R	R
	CM	NA	NA	NA	NA	NA			NA	NA	NA	NA	NA
	GM	NA	NA	NA	NA	NA				NA	NA	NA	NA
	RV	NA	NA	NA	NA	NA				NA	NA	NA	NA

R (reported), NR (not reported), IE (included elsewhere), NO (not occurring), NA (not applicable)

The net emissions due to deforestation increases during the recent years due to active economic growth (building of roads and other infrastructure) in Latvia. Afforestation rate has decreased during recent years, however, accumulation of carbon in afforested areas continues to grow due to higher increment rates. The net CO_2 removals due to forest management decreased considerably during recent years due to increase of farvesting stock (by about 14 % in 2014 in comparison to 2013) and natural mortality (by 17 % in 2014 in comparison to 2009-2013) as well as due to decrease of increment of living trees (by 3 % in 2014 in comparison to 2009-2013). The changes in mortality and increment are mainly associated with ageing of forests. Considering predominance of mature forests declining of increment and increase of the natural mortality is predicted also in the following decades.

3 ENERGY (CRF 1)

3.1 OVERVIEW OF SECTOR

3.1.1 Quantitative overview

Energy sector is the main emission source in Latvia`s GHG inventory in 2014 (Figure 3.1). In total, Energy has created 61.2% of all GHG emissions (excluding LULUCF), and largest part of it contributes to Transport sector (almost half of Energy GHG emissions). As Latvia is located on temperate climate zone, heat production is an essential part of Latvia's economy, thus having an impact on GHG and air pollutant emissions.

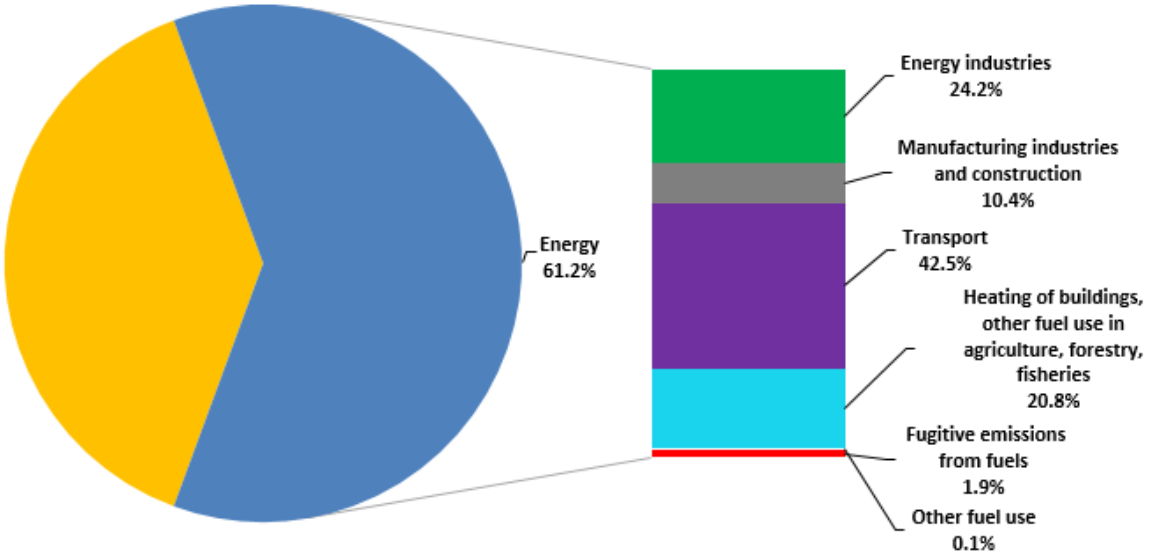

Figure 3.1 Emissions from the Energy sector compared with the total emissions in 2014

Energy consists of two subsectors – fuel combustion (98.1%) including stationary combustion and transport emissions, and fugitive emissions (1.9%), where emissions from non-combustion processes of fuels are reported, e.g., leakages from natural gas and diffuse emissions from gasoline.

In fuel combustion, the largest part of GHG emissions is generated in Transport sector (CRF 1.A.3; 42.5%). Stationary combustion contributes to 55.6% of all Energy emissions: 24.2% are produced by Energy industries (CRF 1.A.1), 20.8% - by Other sectors (CRF 1.A.4) where heating of buildings (small combustion installations in institutions and households) and other fuel use in agriculture, forestry and fisheries are included, and 10.4% by Manufacturing industries and construction (CRF 1.A.2). There are also emissions from offroad vehicles in military sectors, and these are reported under Other (CRF 1.A.5; in the figure above depicted as Other fuel use). These emissions contribute to 0.1% from all Energy emissions.

In the following sections of Energy chapter both emissions from fuel combustion and fugitive emissions are described.

As it can be seen in Figure 3.2, the share of subsectors in the Energy sector has changed, especially in 1.A.3 Transport sector, 1.A.4 Other sectors and 1.A.1. Energy industries and these changes are explained in the corresponding sub-chapters.

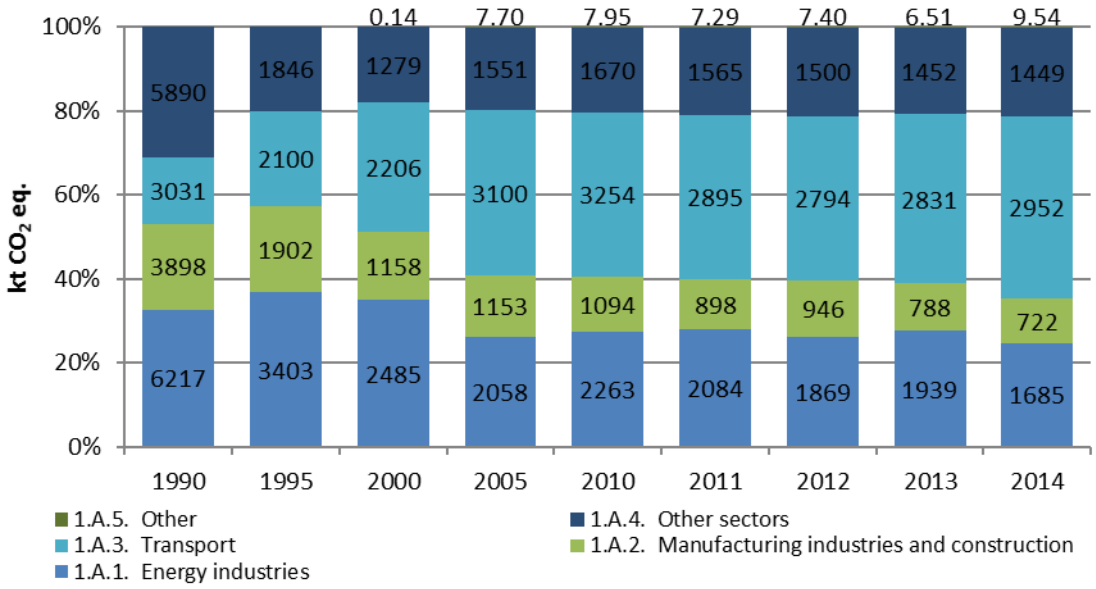

Figure 3.2 Share of emissions in the Energy sector in 1990-2014 (%; kt CO_2 eq.)

In 1990 the biggest share of GHG emissions was held by Energy industries with 32.7% as well as Other sectors with 30.9% from all emissions produced in Energy sector. 20.5% of emissions occured also in Manufacturing industries and construction sector, and the smallest share of emissions was held by Transport sector with only 15.9%. Emissions in military sector (1.A.5) were not produced until 1996.

However, starting from 1990, the share of Transport emissions have constantly grown, reaching 39.4% in 2005. Since then, the Transport sector have been the largest emissions' producer in Energy sector, which can be generally explained with the increase of population's income and growth of economy and also with restrictions related with use of fossil fuels in stationary combustion.

In 2014, the biggest share of GHG emissions in Energy sector is held by Transport sector with 43.3% of total Energy sector's GHG emissions. The second largest subsector with 24.7% share is Energy Industries, and a quite significant part of emissions – 21.3% – is produced within 1.A.4 Other sectors (small combustion in commercial and residential subsectors). Emissions from Military sector (1.A.5) have a 0.1% share from Energy emissions.

Table 3.1 GHG emissions from Energy sector in 1990–2014 (kt)

	A Fuel combustion			B Fugitive emissions from fuels		Aggregate GHGs
	CO_2	CH_4	N_2O	CO_2	CH_4	CO_2, CH_4, N_2O
	kt			kt		kt CO_2 equivalent
1990	18610.69	10.04	0.59	0.0115	9.9033	19283.59
1991	17069.02	10.86	0.63	0.0111	9.5390	17767.42
1992	13825.39	9.61	0.51	0.0101	8.6967	14434.58
1993	11751.15	10.13	0.43	0.0097	8.3172	12339.12
1994	10145.15	9.97	0.38	0.0094	8.1275	10710.49
1995	8888.66	10.11	0.36	0.0092	7.9150	9447.74
1996	8952.46	10.33	0.38	0.0089	7.6267	9513.29
1997	8407.06	9.80	0.38	0.0083	7.1182	8943.56
1998	8026.27	8.95	0.36	0.0079	6.8299	8528.63

	A Fuel combustion			B Fugitive emissions from fuels		Aggregate GHGs
	CO_2	CH_4	N_2O	CO_2	CH_4	CO_2, CH_4, N_2O
	kt			kt		kt CO_2 equivalent
1999	7409.80	8.81	0.34	0.0076	6.5111	7893.77
2000	6824.57	8.18	0.33	0.0070	6.0255	7278.72
2001	7223.51	9.06	0.36	0.0073	5.8433	7703.47
2002	7226.14	8.75	0.37	0.0074	6.1026	7707.29
2003	7403.02	8.94	0.40	0.0055	4.7631	7863.85
2004	7419.38	9.19	0.42	0.0055	4.7148	7892.21
2005	7514.06	9.07	0.44	0.0062	5.3272	8003.77
2006	7987.58	8.75	0.44	0.0044	3.8209	8433.73
2007	8304.80	8.73	0.46	0.0046	3.9225	8758.30
2008	7882.52	7.78	0.43	0.0047	4.0278	8305.10
2009	7154.60	8.43	0.42	0.0044	3.8050	7584.11
2010	7983.97	7.15	0.42	0.0043	3.6642	8379.65
2011	7143.86	7.04	0.43	0.0054	2.5212	7511.33
2012	6791.66	7.64	0.45	0.0049	3.1843	7195.26
2013	6700.16	7.14	0.46	0.0080	4.0400	7117.63
2014	6499.67	7.02	0.48	0.0138	5.4127	6952.97
2014 vs 2013	-3.0%	-1.8%	3.4%	72.2%	34.0%	-2.3%
2014 vs 1990	-65.1%	-30.1%	-18.2%	19.8%	-45.3%	-63.9%

Decrease of emissions depends on economic and social situation in the beginning and ending of the 1990s. The emissions have decreased from 1990 to 2014 with some fluctuations in between. From 2000 to 2010, fuel consumption as well as emissions from fuel combustion increased due to development of national economy, and after 2010 the emissions decreased (Table 3.1).

GHG emissions from the Energy sector in the latest years (since 2000) are fluctuating with a peak point in 2007 that is explained with an increase of national economy (Figure 3.3). GHG emissions in the Energy sector increased by 20.3% in 2000-2007. In the second half of 2008, a recession of the national economy started, caused by the global economic crisis. Decrease in economic output is the main reason why all GHG emissions in Energy sector decreased by 13.4% in 2007-2009. Starting with 2010, total GHG emissions increased again by 10.6% compared with 2009 as consumption of fuel increased; also due to the relatively warm winter – in 2009 the number of heating degree days[12] was 4184, while in 2010 – 4671. However, the emissions decreased again by 10.5% in 2011 compared to 2010 because of warm weather – the number of HDD was 3989. In 2012 fuel consumption decreased even more as well as the amount of GHG emissions produced – by 4.1% from 2011 level, however, the number of HDDs was considerably larger (HDD = 4385), which could be explained with better heat insulation in buildings. In 2013, the emissions were by 1.1% lower than in 2012, and also the number of HDDs was lower. In 2014 there can be seen the same trend as in 2013 – the emissions were by 2.3% lower and the number of HDDs were by 1.9% lower.

[12] *Heating degree day (HDD) is a proxy for the energy demand needed to heat a home or a business; it is derived from measurements of outside air temperature. The heating requirements for a given structure at a specific location are considered to be to some degree proportional to the number of HDD at that location. HDD are defined relative to a base temperature (18°C, according to EUROSTAT), the outside temperature below which a building is assumed to need heating (http://www.eea.europa.eu/data-and-maps/indicators/heating-degree-days-1).*

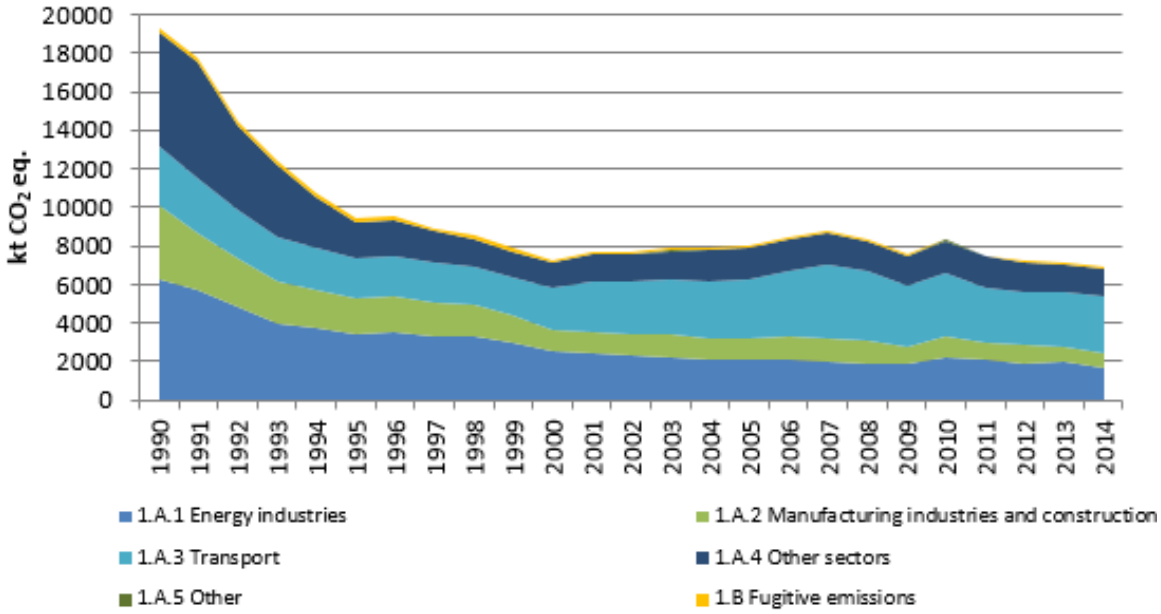

Figure 3.3 GHG emissions from Energy sector 1990–2014 (kt CO_2 eq.)

In CRF 1.A.1 Energy industries sector GHG emission decrease in 2008-2009 can be explained with the recession in national economy caused by global financial crisis, also the winter in 2009 was quite warm, therefore in 2009 GHG aggregated emissions in 1.A.1 were 2.6% less than in 2008, but in 2009-2010 an increase of emissions by 20.5% in Energy industries was observed, mostly because of the ending of the global crisis and also the average temperature in winter was lower than in year 2009. As year 2011 was warmer than previous year, the fuel consumption, as well as the emissions decreased by 7.9% if compared with year 2010. However, the average temperature in 2012 was less than in 2011, but the amounts of consumed energy resources continued to decrease as well as the emissions which decreased by 10.3% comparing to 2011. In 2013 emissions from Energy industries increased by 3.8%, if compared to 2012, but in 2014 emissions decreased by 13.1%.

The decrease of industrial production (CRF 1.A.2) was influenced by economic situation when development of national economy was made in financial and real estate sectors but the import dominated over export. Increase of costs and prices as well as total inflation led to a total decrease of local industry. Therefore GHG emissions from CRF 1.A.2 sector decreased by 19.9% in 2008-2009, but in 2010 emissions increased by 22.6% as fuel consumption increased. In year 2011 emissions decreased by 17.9% which can be explained with great reconstructions in the steel and iron enterprise "Liepājas Metalurgs" under 1.A.2.a sector where the fuel consumption decreased significantly. In 2012 in comparison to 2011 the GHG emissions increased by 5.3% mainly due to intensified steel melting in „Liepājas Metalurgs". However in 2013 decrease in 1.A.2. emissions by 16.7% can be observed, which is related to activities in "Liepājas Metalurgs". "Liepājas Metalurgs" went bankrupt in 2013. Emissions continue to decrease also in 2014 by 8.3 %.

For Transport sector (CRF 1.A.3) emissions decreased from 2008 to 2009 by 12.4% that was influenced by sharp increase of fuel price and economy crisis. Decrease is also explained with improvement of car park in country, where old cars were replaced with new ones. Starting from 2010 growth of emissions from transport sector is observed by 2.1% comparing to

2009, although in year 2011 the emissions decreased again and compared to 2010 the decrease was 11.0%. Decrease in emissions can be observed also in 2011-2012 by 3.5%, but in 2013 emissions had increased by 1.3%. In 2014 the increase in emissions has been 4.3%.

Emissions in CRF 1.A.4 Other sectors are constantly decreasing since 1990, with fluctuations in emissions in the time scale which mostly depend on the temperatures in winter. In 2013 in comparison to 2012 emissions had decreased by 3.1%, but in 2013-2014 GHG emissions increased by 0.2%.

The emissions in 1.A.5 Other have increased by 46.5% in 2013-2014, and it is not related to financial circumstances nor weather conditions.

Fluctuations of fugitive emissions can be explained with a constant improvement of natural gas supply infrastructure.

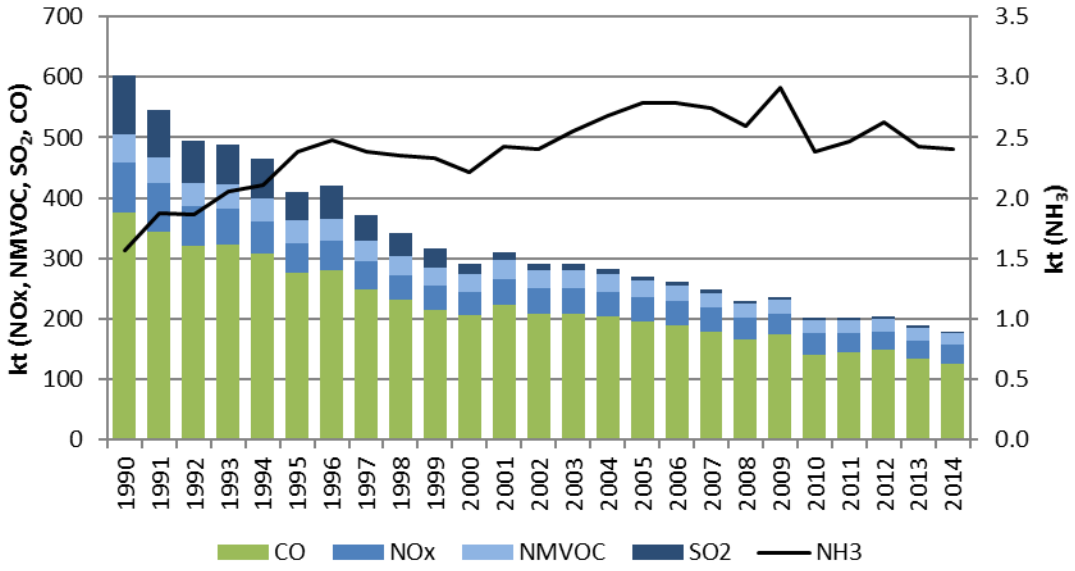

Figure 3.4 Total indirect GHG emissions from Energy sector in 1990–2014 (kt)

In 2014, the largest part of indirect emissions contributes CO then NMVOC and NOx emissions (Figure 3.4). Most CO and NMVOC emissions come from wood combustion in the Residential sector while the largest share of NOx emissions comes from Transport sector.

The biggest decrease is observed in SO_2 emissions where emissions decreased from 96.41 kt in 1990 to 3.61 kt in 2014. It is explained with changes in type of fuels combusted in Energy sector as well as with implementation of national legislations for sulphur content in liquid fuels used for transport.

The indirect emissions in general are lower in 2014 if compared to 2013: CO emissions have decreased by 5.6%, NO_x emissions have decreased by 1.4%, and SO_x emissions – by 1.0%, while NMVOCs have decreased by 3.2%. It can be explained mainly with smaller amounts of fuel combusted in Energy sector.

There are also ammonia emissions calculated and reported in Energy. According to EMEP/EEA 2013, ammonia emissions arise from biomass combustion and in Transport sector. In 1990-2014, NH_3 emissions have increased by 52.8% that can be explained with

increased amounts of biomass burned in Manufacturing industries, as well as in Other (heat production in institutions, households, agriculture, forestry, fisheries).

3.1.2 Description

Activity data

Both the imported (natural gas, liquid gas, oil and oil products, coal) and local fuels (wood, peat, hydro resources) are used in the Energy sector in Latvia (Table 3.2). Mainly the imported fuels (natural gas, coal) are used in heat generation. Smaller boiler houses burn local fuel (wood) and coal as well.

Table 3.2 Consumption of energy resources in Latvia (TJ)[13]

	1990	1995	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Energy consumption	***318570***	***176159***	***143524***	***170096***	***174022***	***178707***	***183588***	***186027***	***179338***	***178015***	***185740***	***173188***	***175848***	***176162***	***175134***
Liquid fuels, total[14]	*161209*	*81674*	*53518*	*63509*	*65802*	*68093*	*71073*	*75890*	*72810*	*70659*	*72127*	*64486*	*64456*	*64721*	*65592*
Gasoline	26771	18130	14837	15225	15358	15138	16769	18307	16680	13945	12667	11926	10146	9286	9023
Diesel oil	48021	18274	20906	32230	34484	36791	39208	43862	41066	39141	42013	38520	38958	39433	40769
RFO	76326	41290	9462	9298	9013	10231	7634	6581	7795	10272	8661	6541	6942	6852	6821
LPG	3691	1548	2095	2323	2460	2552	2688	2414	2186	2003	2102	2414	3280	3840	4235
Jet fuel	3068	1171	1142	1728	2134	2525	2875	3438	4137	4320	4946	4943	5033	5209	4646
Other kerosene	647	432	43	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	2684	749	2593	1435	1146	269	1155	1038	866	774	1072	64	58	100	97
Petroleum coke	NO	NO	NO	956	1088	429	627	132	NO	165	627	NO	NO	NO	NO
Shale oil	NO	78	2440	314	118	157	117	118	79	39	39	79	39	NO	NO
Solid fuels, total	*26249*	*7225*	*2785*	*2674*	*2596*	*3199*	*3439*	*4248*	*4225*	*3409*	*4378*	*4509*	*3645*	*2905*	*2473*
Coal	25984	7172	2759	2647	2569	3145	3407	4248	4225	3409	4378	4509	3563	2878	2473
Coke	237	53	26	27	27	54	32	NO	NO	NO	NO	NO	NO	NO	NO
Anthracite	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	82	27	NO
Oil shale	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat products, total	*3216*	*3836*	*2392*	*673*	*80*	*80*	*70*	*90*	*51*	*26*	*46*	*43*	*34*	*64*	*35*
Peat briquettes	867	401	31	NO	NO	NO	NO	1	1	6	6	3	4	4	5
Peat	2349	3435	2361	673	80	80	70	89	50	20	40	40	30	60	30
Natural gas	*99517*	*41304*	*44962*	*55666*	*55247*	*56685*	*58627*	*56588*	*55478*	*50742*	*61044*	*53528*	*50301*	*49994*	*44798*
Biomass, total	*27501*	*42120*	*39774*	*46957*	*49574*	*49678*	*50032*	*48913*	*46372*	*53017*	*47647*	*49871*	*56535*	*57364*	*60958*
Wood and wood products	27501	42102	39695	46670	49136	49120	49518	48402	45749	52291	45376	46594	52169	52676	55531
Bioethanol	NO	NO	NO	NO	NO	NO	43	NO	1	108	350	318	279	264	257
Biodiesel	NO	NO	NO	NO	NO	107	60	73	82	73	808	749	659	631	741
CH_4 from sludge gas	NO	18	41	43	78	90	76	80	79	100	114	100	105	97	91
CH_4 from landfill gas	NO	NO	NO	162	242	251	259	271	290	323	331	349	347	371	348
CH_4 from other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	37	465	1629	2140	2535
Straws	NO	NO	NO	NO	NO	NO	11	16	14	29	60	43	38	58	99
Charcoal	NO	NO	NO	NO	30	60	30	45	60	60	60	60	59	90	90
Municipal	NO	NO	37	82	89	49	34	26	98	33	510	1193	1250	1035	1266

[13] *Excluding electricity.*

[14] *Including fuel consumption for international aviation and international navigation.*

	1990	1995	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
wastes (biomass fraction)															
Other fuels, total	*879*	*NO*	*94*	*617*	*722*	*972*	*348*	*299*	*401*	*162*	*499*	*752*	*877*	*1115*	*1279*
Industrial wastes (used tires)	NO	NO	94	208	224	125	85	65	58	15	84	331	242	379	335
Municipal wastes	NO	NO	NO	NO	NO	NO	NO	NO	80	30	320	332	577	707	915
Waste oils	879	NO	NO	409	498	847	263	234	263	117	95	88	58	29	29

Liquid fossil fuels have an important place in the Latvian energy resource market; their market share is about 37% in 2014, including residual fuel oil. The share of residual fuel oil consumption has a significant decrease - in 1990 it was 24% from total fuel consumption, but in 2014 it is 3.9%. The essential decrease of heavy oil share in energy balance is explained with increase of costs due to increasing fuel costs because of implementation of the EU Directive 1999/32/EC prescribing that sulphur content of heavy oil shall not exceed 1%. The biggest part from liquid fuel consumption contributes to gasoline and diesel oil with approximately 75.9% from total liquid fuel consumption in 2014 where gasoline is mostly consumed in transport sector and only a small part is used in off-roads. Diesel oil consumption divides by combusted in transport sector – 76.2%, and combusted in stationary combustion installations – 23.8% from total diesel oil consumption in 2014. The total consumption of liquid fuels in 2014 has decreased by 59.3% since 1990.

Total share of *solid fuels* in national market is quite low – approximately 1.4% in 2014. The solid fuel consumption in recent years is stable although the consumption have decreased by 90.6% since 1990. A decrease in solid fuel consumption (-19.3%) can be seen in 2008-2009 due to global economic crisis. However, from 2009 to 2011 it increased by 32.3% that can mainly be explained with an increase of coal consumption, but in years 2011-2014 there can be seen a decrease in solid fuel consumption by 45.2% due to reduced use of coal.

Peat and *peat briquettes* are local fuels quite widely used in Latvia in 1990 with 1.0% of total energy consumption. However, nowadays amounts of peat products used have decreased and have reached 0.02% of total share in 2014.

The largest consumers of *natural gas* are combined heat and power plant, and heat generation enterprises as well as industrial enterprises. Natural gas has a stable place in total fuel consumption where its share is 31.2% in 1990 and 25.6% in 2014. Natural gas consumption has decreased by 55.0% in 1990-2014. Recent years until 2011 the consumption of natural gas had an increasing trend – from 2009 to 2010 it increased by 20.3%, but in 2010-2014 there can be seen a decrease of natural gas consumption by 26.6%.

Biomass fuels are wood and wood products, straw, charcoal and liquid biofuels – bioethanol and biodiesel. In the total fuel consumption the share of firewood and other wood products is quite substantial and has reached its peak with 31.7% of total energy consumption in 2014, comparing with 1990 when firewood consumption was only about 8.6% from total energy consumption. In 2010-2014 wood and wood products' use increased by 22.4%. In latest years liquid and gaseous biofuels are becoming more popular and their share from 0.25% in 2005 has reached 2.27% in 2014 from total fuel consumption. Recently also such

biomass fuels as straws are used, and it has an increasing trend with fluctuations, especially in 2010-2011 and 2013-2014, which can mainly be explained with significant temperature differences in winter.

There are also *industrial* and *municipal waste*[15] consumed in the latest years, and the most significant increase can be observed in 2010 – comparing with 2009 the consumption of waste has almost 12-fold increase, and it reached 0.49% from total share. However, in the following years the increase of other fuels consumed was not as rapid as in previous 2009-2010, and the increase in particular fuels' use in 2013-2014 was by 19%, and the share of total was 1.44% in 2014. Also used oils are reported as other fuels, however, this fuel type has a decreasing trend.

Hydroelectric power plants (HPP) and combined heat and power plants (CHP) produce part of the electrical power, while part is imported (Table 3.3, Table 3.4). Volume of electricity generation directly depends on the through-flow of the river Daugava. Also the import of electricity from Russia, Estonia and Lithuania has a quite substantial role in the electricity supply.

Table 3.3 Heat production and consumption in Latvia (TJ)

	Production	Own use and losses	Final consumption		
			CRF 1.A.2	CRF 1.A.4	TOTAL
1990	99439	15171	32929	51339	84268
1995	46112	7156	1969	36987	38956
2000	31867	6815	659	24393	25052
2001	33937	7038	641	26258	26899
2002	33048	6541	630	25877	26507
2003	33516	6409	626	26481	27107
2004	31093	6174	608	24311	24919
2005	31144	5886	684	24574	25258
2006	30056	5454	634	23968	24602
2007	28685	4911	554	23220	23774
2008	26402	4010	356	22036	22392
2009	26308	4099	298	21911	22209
2010	28662	4590	387	23685	24072
2011	25000	4104	268	20628	20896
2012	26857	4464	259	22134	22393
2013	26249	4551	479	21219	21698
2014	25747	4608	890	20249	21139

Table 3.4 Electricity production and consumption in Latvia (TJ)

	Production	Own use and losses	Import	Export	Final consumption			
					CRF 1.A.2	CRF 1.A.3	CRF 1.A.4	TOTAL
1990	23933	6883	25700	12798	11484	918	17550	29952
1991	20318	6682	15217	7	10807	785	17255	28847
1992	13803	5645	14688	7	8316	745	13777	22838
1993	14126	6102	9619	612	5440	688	10904	17032
1994	15984	6681	9533	2988	5076	670	10102	15848

[15] *For reporting purposes municipal waste has been divided into fossil and non-fossil fractions, but in the particular paragraph it is described as whole.*

	Production	Own use and losses	Import	Export	Final consumption			
					CRF 1.A.2	CRF 1.A.3	CRF 1.A.4	TOTAL
1995	14324	6372	9529	1408	5130	677	10267	16074
1996	11254	7989	12377	760	4975	641	9266	14882
1997	16218	7694	6566	4	5519	634	8935	15088
1998	20869	6559	3290	1382	5296	612	10310	16218
1999	14796	5774	9349	2311	5130	554	10375	16059
2000	14890	5202	7589	1159	5159	547	10411	16117
2001	15408	5688	8424	1645	5562	623	10314	16499
2002	14310	5188	10217	1764	5494	518	11563	17575
2003	14310	5065	9616	137	5778	490	12456	18724
2004	16881	4975	9839	2290	5882	500	13072	19454
2005	17658	4767	10278	2545	6120	533	13972	20625
2006	17607	4522	10116	1087	6332	540	15242	22114
2007	17176	4194	17870	7070	6538	504	16740	23782
2008	18987	4198	16715	7643	6066	497	17298	23861
2009	20048	4032	15333	9378	5421	436	16114	21971
2010	23857	4626	14303	11160	5724	453	16197	22374
2011	21938	4133	14432	9950	6012	446	15829	22287
2012	22202	3636	17766	11678	7175	464	17015	24654
2013	22352	3556	18018	13140	6509	446	16719	23674
2014	18508	3146	19221	10883	6003	421	17276	23700

Types of fuels used for combustion in Latvia:

Liquid fuels are mainly imported from Latvia's neighbouring countries – Lithuania, Belarus, Russian Federation, Norway and others and consist of:

- shale oil;
- liquefied petroleum gas;
- motor gasoline and aviation gasoline;
- kerosene type jet fuel;
- other kerosene;
- gasoline type jet fuel;
- motor diesel oil and heating gas oil;
- residual fuel oil (RFO);
- other liquids;
- petroleum coke.

Solid fuels consist of coal and coke imported from Commonwealth of Independent States (countries of former Union of Soviet Socialist Republics), as well as local fuel – peat briquettes – that are mainly produced inside country but not imported;

Peat is 100% produced inside of the country;

Gaseous fuels (natural gas) are 100% imported from Russian Federation;

Biomass fuels:

- solid biomass – wood and other wood products, charcoal, straw, is mainly produced and used inside of the country,

- methane obtained from biogas that is 100% produced inside of the country – landfill gas that is used since 2002 when first landfill started to collect and combust biogas with energy recovery, and sludge gas that is combusted with energy recovery since 1993 in one sewage purification plant, and also other biogases from anaerobic fermentation,
- liquid biofuels – biogasoline and biodiesel, which are mainly imported from Latvia's neighbourhood countries.

Other fuels are municipal waste (ecofuel) and industrial waste – used tires, different types of industrial ecofuel collected by and combusted in cement production plant in Latvia, as well as used oils.

Methodological issues

Table 3.5 Methods and emission factors used in Energy sector

	CO_2		CH_4		N_2O	
CATEGORIES	**Method applied**	**Emission factor**	**Method applied**	**Emission factor**	**Method applied**	**Emission factor**
1. Energy	T1, T2, T3	CS, D, OTH, PS	T1, T2	CR, CS, D, OTH	T1, T2	CR, D, OTH
A. Fuel combustion	T1, T2, T3	CS, D, OTH, PS	T1, T2	CR, CS, D, OTH	T1, T2	CR, D, OTH
1. Energy industries	T1, T2	CS, D	T1	D	T1	D
2. Manufacturing industries and construction	T1, T2, T3	CS, D, PS	T1	D	T1	D
3. Transport	T1, T2	CS, D, OTH	T1, T2	CR, D, OTH	T1, T2	CR, D, OTH
4. Other sectors	T1, T2	CS, D	T1, T2	CS, D	T1	D
5. Other	T1	D	T1	D	T1	D
B. Fugitive emissions from fuels	T2	CS	T2	CS	*NA, NO*	*NA, NO*
1. Solid fuels	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
2. Oil and natural gas	T2	CS	T2	CS	*NA*	*NA*
C. CO_2 transport and storage	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*

The main methods and emission factors can be seen on Table 3.5. It can be seen that in fuel combustion for CO_2 emission calculations there are methods from Tier 1 to Tier 3 used, generally Tier 2, while for CH_4 and N_2O Tier 1 and Tier 2 are used, generally Tier 1. In stationary combustion, CO_2 emission factors are country-specific (CS), but for CH_4 and N_2O – default values (D) from 2006 IPCC Guidelines, while in transport country-specific, default, Corinair (CR) and other (OTH) values are used. For fugitive emissions, Tier 2 method and country-specific emission factors are used. As there are no GHG emissions from solid fuels, but there are particulate matter emissions reported, there can be seen a notation key "NA", while for CO_2 transport and storage there are no operations, therefore "NO" is used.

Key categories

Key categories of Energy sector are presented in Table 3.6. Key categories are estimated using Approach 1 and Approach 2 both by level and trend with and without taking LULUCF sector into account.

Table 3.6 Key categories in Energy sector in 2014

IPCC category/Group	Gas	Identification criteria	with LULUCF	without LULUCF
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	L1,L2,T1,T2	X	X
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	T1,T2	X	X
1.A.1.a Public Electricity and Heat Production - Peat	CO_2	T1	X	X
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	T1,T2	X	X
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	L1,T1		X
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CO_2	T1		X
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	T1	X	X
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	T1		X
1.A.2.a Iron and Steel - Other fossil fuels	CO_2	T1		X
1.A.2.c Chemicals - Liquid Fuels	CO_2	T1,T2	X	X
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	T1	X	X
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	L1,T1	X	X
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	L1,T1,T2	X	X
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	T1,T2	X	X
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	L1,T1	X	X
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	T1,T2	X	X
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CO_2	L1	X	X
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	L1,L2,T1,T2	X	X
1.A.2.g Other - Biomass Fuels	N_2O	T2		X
1.A.2.g Other - Gaseous Fuels	CO_2	L1,T1,T2	X	X
1.A.2.g Other - Liquid Fuels	CO_2	L1,T1,T2	X	X
1.A.3.b Road Transportation - Diesel Oil	CO_2	L1,L2,T1,T2	X	X
1.A.3.b Road Transportation - Diesel Oil	N_2O	T2		X
1.A.3.b Road Transportation - Gasoline	CO_2	L1,L2,T1	X	X
1.A.3.b Road Transportation - LPG	CO_2	L1,T1,T2	X	X
1.A.3.c Railways - Liquid Fuels	CO_2	L1,T1	X	X
1.A.3.c Railways - Liquid Fuels	N_2O	L2		X
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	L1,L2,T2		X
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	L1,L2,T1	X	X
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	L1,L2,T1,T2	X	X
1.A.4.a Commercial/Institutional - Peat	CO_2	T1		X

IPCC category/Group	Gas	Identification criteria	with LULUCF	without LULUCF
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	L1,T1,T2	X	X
1.A.4.b Residential - Biomass Fuels	CH_4	L1,L2,T1,T2	X	X
1.A.4.b Residential - Gaseous Fuels	CO_2	L1,L2,T1,T2	X	X
1.A.4.b Residential - Liquid Fuels	CO_2	L1,L2,T1	X	X
1.A.4.b Residential - Solid Fuels	CO_2	L1,T1,T2	X	X
1.A.4.b Residential - Solid Fuels	CH_4	T2		X
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	L1,L2,T1,T2	X	X
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	L1,L2,T1	X	X
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	L1,L2,T1,T2		X
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	T1,T2	X	X
1.B.2.b Natural Gas	CH_4	L1,L2,T1,T2	X	X
1.B.2.c Venting and Flaring	CH_4	L1		X

3.2 FUEL COMBUSTION (CRF 1.A)

Emissions from fuel combustion comprise all in-country fuel combustion, including point sources, transport and other fuel combustion. Emissions from fuel combustion in the Energy sector are divided into following subcategories:

- 1.A.1 Energy Industries;
- 1.A.2 Manufacturing Industries and Construction;
- 1.A.3 Transport – road transport, civil aviation, railways and domestic navigation;
- 1.A.4 Other Sectors (Commercial/Institutional, Residential, Agriculture/Forestry/Fisheries);
- 1. A.5 Other (Not elsewhere specified) – military transport.

Reported greenhouse gas emissions are listed in Table 3.7.

Table 3.7 Reported emissions from fuel combustion in Latvia in 2014

Source	Fuel Type	Emissions						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1.A.1 Energy Industries								
a. Public Electricity and Heat Production								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	√	√	√	√	√	√	√
	Peat	√	√	√	√	√	√	√
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
b. Petroleum Refining								
	Liquid Fuels	NO	NO	NO	NO	NO	NO	NO
	Solid Fuels	NO	NO	NO	NO	NO	NO	NO
	Peat	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	NO	NO	NO	NO	NO	NO	NO
	Biomass	NO	NO	NO	NO	NO	NO	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO

Source	Fuel Type	Emissions						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
c. Manufacture of Solid Fuels and Other Energy Industries								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	NO	NO	NO	NO	NO	NO	NO
	Peat	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	NO	NO	NO	NO	NO	NO	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
1.A.2 Manufacturing Industries and Construction								
a. Iron and Steel								
	Liquid Fuels	NO	NO	NO	NO	NO	NO	NO
	Solid Fuels	√	√	√	√	√	√	√
	Peat	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	NO	NO	NO	NO	NO	NO	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
b. Non-Ferrous Metals								
	Liquid Fuels	NO	NO	NO	NO	NO	NO	NO
	Solid Fuels	NO	NO	NO	NO	NO	NO	NO
	Peat	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	NO	NO	NO	NO	NO	NO	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
c. Chemicals								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	NO	NO	NO	NO	NO	NO	NO
	Peat	√	√	√	√	√	√	√
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
d. Pulp, Paper and Print								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	NO	NO	NO	NO	NO	NO	NO
	Peat	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
e. Food Processing, Beverages and Tobacco								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	√	√	√	√	√	√	√
	Peat	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
f. Non-metallic minerals								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	√	√	√	√	√	√	√
	Peat	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	√	√	√	√	√	√	√
g. Other								

Source	Fuel Type	Emissions						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	√	√	√	√	√	√	√
	Peat	√	√	√	√	√	√	√
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
1.A.3 Transport								
a. Civil Aviation								
	Aviation Gasoline	√	√	√	√	√	√	√
	Jet Kerosene	√	√	√	√	√	√	√
b. Road Transportation								
	Gasoline	√	√	√	√	√	√	√
	Diesel Oil	√	√	√	√	√	√	√
	LPG	√	√	√	√	√	√	√
	Other Liquid Fuels	√	√	√	√	√	√	√
	Gaseous Fuels	NA	NA	NA	NA	NA	NA	NA
	Biomass	√	√	√	NO	NO	NO	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
c. Railways								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	NO	NO	NO	NO	NO	NO	NO
	Biomass	√	√	√	√	√	√	√
	Other Fuels	NA	NA	NA	NA	NA	NA	NA
d. Navigation								
	Residual Oil (Residual Fuel Oil)	NO	NO	NO	NO	NO	NO	NO
	Gas/Diesel Oil	√	√	√	√	√	√	√
	Gasoline	√	√	√	√	√	√	√
	Other Liquid Fuels	NA	NA	NA	NA	NA	NA	NA
	Gaseous Fuels	NA	NA	NA	NA	NA	NA	NA
	Biomass	NO	NO	NO	NO	NO	NO	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
e. Other Transportation								
	Liquid Fuels	IE	IE	IE	IE	IE	IE	IE
	Solid Fuels	IE	IE	IE	IE	IE	IE	IE
	Gaseous Fuels	IE	IE	IE	IE	IE	IE	IE
	Biomass	IE	IE	IE	IE	IE	IE	IE
	Other Fuels	IE	IE	IE	IE	IE	IE	IE
1.A.4 Other Sectors								
a. Commercial/Institutional								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	√	√	√	√	√	√	√
	Peat	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
b. Residential								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	√	√	√	√	√	√	√
	Peat	NO	NO	NO	NO	NO	NO	NO

Source	Fuel Type	Emissions						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
c. Agriculture/Forestry/Fisheries								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	√	√	√	√	√	√	√
	Peat	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
1.A.5 Other								
a. Stationary								
	Liquid Fuels	NO	NO	NO	NO	NO	NO	NO
	Solid Fuels	NO	NO	NO	NO	NO	NO	NO
	Peat	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	NO	NO	NO	NO	NO	NO	NO
	Biomass	NO	NO	NO	NO	NO	NO	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
b. Mobile – Military navigation and aircrafts								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	NO	NO	NO	NO	NO	NO	NO
	Peat	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	NO	NO	NO	NO	NO	NO	NO
	Biomass	NO	NO	NO	NO	NO	NO	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO

CO_2 emissions from fuel combustion were 6499.67 kt (including Transport sector) in 2014 and accounted for 91.0% of the total CO_2 emissions.

CH_4 emissions from fuel combustion were 7.02 kt (including Transport sector) in 2014 and accounted for 8.4% of total CH_4 emissions. The biggest part of CH_4 emissions contributes to Other sectors (CRF 1.A.4) – 5.89 kt.

N_2O emissions from fuel combustion were 0.48 kt (including Transport sector) and accounted 7.5% of the total N_2O emissions in 2014.

3.2.1 Comparison of the sectoral approach with the reference approach (CRF 1.A (b), 1.A(c))

Reference approach (RA) is carried out using import, export, production and stock change data as well as data of fuel consumption in international aviation and international marine reported as bunkering from the CSB online database where Energy balance is available.

Difference between fuel consumption estimated with RA and SA for liquid fuels is quite high – from 3.54% in 1995 to -18.77% in 2010 (Table 3.8). Difference for solid fuels is smaller from 0.60% in 1992 to -0.01% in 1995 and 2014. Difference for gaseous fuels fluctuates from 3.10% in 1993 to 0.14% in 1990. For other fuels the fluctuations are from 1.2% in 2014 to -0.14% in 2004. For peat the fluctuations are more remarkable – from 130.43% in 2010 to 0% in 2002, 2011 and 2012.

Table 3.8 Difference (%) between Sectoral and Reference approach data (PJ) and CO_2 emissions (kt)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Fuel consumption - Liquid fuels											
SA	138.39	123.94	103.92	96.87	91.09	74.33	80.21	68.90	67.76	63.13	52.05
RA	139.69	123.02	104.06	96.47	93.03	76.96	78.52	67.31	66.34	55.09	44.94
Diff., %	0.94	-0.75	0.13	-0.41	2.13	3.54	-2.11	-2.30	-2.10	-12.74	-13.66
CO_2 emissions - Liquid fuels											
SA	10272.41	9184.73	7702.74	7181.04	6781.17	5523.57	5977.26	5111.69	5020.72	4670.44	3814.53
RA	10437.39	9140.65	7732.14	7183.80	6953.17	5747.36	5883.10	5022.08	4958.06	4151.16	3342.76
Diff., %	1.61	-0.48	0.38	0.04	2.54	4.05	-1.58	-1.75	-1.25	-11.12	-12.37
Fuel consumption - Solid fuels											
SA	26.25	22.51	18.76	17.09	12.17	7.22	6.85	5.63	4.18	3.64	2.79
RA	26.36	22.63	18.87	17.15	12.17	7.22	6.86	5.63	4.18	3.64	2.79
Diff., %	0.44	0.51	0.60	0.36	0.01	-0.01	0.03	0.01	0.08	0.05	0.06
CO_2 emissions - Solid fuels											
SA	2486.39	2129.65	1774.29	1618.24	1152.55	684.11	648.95	533.22	395.54	344.65	263.81
RA	2502.91	2151.66	1799.14	1635.33	1172.45	700.97	666.06	561.51	424.11	373.07	292.24
Diff., %	0.66	1.03	1.40	1.06	1.73	2.46	2.64	5.31	7.22	8.25	10.78
Fuel consumption - Gaseous fuels											
SA	99.52	98.84	70.75	46.15	33.62	41.30	35.22	43.12	42.22	40.44	44.96
RA	99.65	100.47	72.23	47.58	34.62	42.28	36.22	44.15	43.25	41.44	45.74
Diff., %	0.14	1.64	2.09	3.10	2.98	2.36	2.84	2.39	2.44	2.47	1.72
CO_2 emissions - Gaseous fuels											
SA	5458.95	5421.63	3952.80	2578.92	1863.43	2285.06	1965.95	2404.37	2357.14	2252.13	2490.55
RA	5469.25	5513.98	4038.03	2660.67	1920.09	2340.56	2023.08	2463.47	2416.34	2309.25	2535.05
Diff., %	0.19	1.70	2.16	3.17	3.04	2.43	2.91	2.46	2.51	2.54	1.79
Fuel consumption - Peat											
SA	3.22	3.24	3.85	3.62	3.37	3.84	3.50	3.47	2.45	1.36	2.39
RA	3.29	3.27	3.86	3.66	3.37	3.84	3.50	3.47	2.46	1.37	2.45
Diff., %	2.21	0.68	0.26	0.86	0.02	0.07	0.05	0.08	0.45	0.71	2.52
CO_2 emissions - Peat											
SA	328.50	333.01	395.57	372.95	347.99	395.92	360.29	357.78	252.88	140.49	248.21
RA	337.34	336.22	397.72	376.89	348.52	396.74	361.06	358.52	254.32	141.62	254.67
Diff., %	2.69	0.96	0.55	1.06	0.15	0.21	0.21	0.21	0.57	0.80	2.60
Fuel consumption - Other fuels											
SA	0.88	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	0.03	0.09
RA	0.88	NO	NO	NO	NO	NO	NO	NO	NO	0.03	0.09
Diff., %	0.00	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	0.00	0.00
CO_2 emissions - Other fuels											
SA	64.43	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	2.09	7.46
RA	64.46	NO	NO	NO	NO	NO	NO	NO	NO	1.56	5.58
Diff., %	0.05	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	-25.30	-25.30

Continuation of Table 3.8

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Fuel consumption - Liquid fuels														
SA	52.28	52.07	53.97	55.31	54.74	60.06	65.06	60.14	54.94	56.70	50.59	49.40	49.77	51.30
RA	47.95	44.00	48.78	50.81	49.68	54.15	59.47	55.70	47.02	46.06	43.76	47.37	43.94	48.14
Diff., %	-8.28	-15.50	-9.62	-8.13	-9.25	-9.85	-8.59	-7.37	-14.42	-18.77	-13.49	-4.11	-11.72	-6.16
CO_2 emissions - Liquid fuels														
SA	3818.74	3807.08	3958.28	4055.69	3997.20	4386.09	4741.54	4380.09	4010.00	4152.26	3683.99	3590.57	3613.00	3721.72
RA	3551.95	3259.55	3621.81	3752.90	3649.40	4008.04	4383.09	4105.11	3457.54	3414.85	3234.14	3504.74	3252.58	3515.40
Diff., %	-6.99	-14.38	-8.50	-7.47	-8.70	-8.62	-7.56	-6.28	-13.78	-17.76	-12.21	-2.39	-9.98	-5.54
Fuel consumption - Solid fuels														
SA	3.64	2.93	2.67	2.60	3.20	3.44	4.25	4.23	3.41	4.38	4.51	3.65	2.91	2.47

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
RA	3.64	2.93	2.68	2.60	3.20	3.44	4.25	4.25	3.41	4.38	4.51	3.65	2.91	2.47
Diff., %	0.06	0.06	0.04	0.04	0.04	0.03	0.00	0.54	0.00	0.00	0.00	0.00	0.03	-0.01
CO_2 emissions - Solid fuels														
SA	344.46	277.36	253.28	245.91	303.26	325.71	401.85	399.71	322.48	414.17	426.54	345.12	274.91	233.95
RA	372.93	303.32	267.74	263.25	317.73	339.63	413.32	416.21	336.84	422.72	435.12	362.36	280.58	233.95
Diff., %	8.27	9.36	5.71	7.05	4.77	4.27	2.85	4.13	4.45	2.07	2.01	4.99	2.06	0.00
Fuel consumption - Gaseous fuels														
SA	52.25	53.50	55.67	55.25	56.69	58.63	56.59	55.48	50.74	61.04	53.53	50.30	49.99	44.80
RA	53.16	54.07	56.41	55.79	56.85	58.89	56.92	55.81	51.38	61.31	54.03	50.81	50.54	45.39
Diff., %	1.74	1.07	1.33	0.97	0.29	0.45	0.59	0.61	1.26	0.44	0.95	1.00	1.10	1.31
CO_2 emissions - Gaseous fuels														
SA	2889.47	2960.08	3075.07	3055.18	3133.27	3242.42	3129.73	3066.38	2807.04	3372.02	2956.18	2772.75	2710.99	2430.72
RA	2941.45	2993.55	3118.03	3086.86	3144.49	3259.24	3150.21	3087.00	2844.35	3389.23	2986.19	2802.53	2742.72	2464.34
Diff., %	1.80	1.13	1.40	1.04	0.36	0.52	0.65	0.67	1.33	0.51	1.02	1.07	1.17	1.38
Fuel consumption - Peat														
SA	1.25	1.01	0.67	0.08	0.08	0.07	0.09	0.05	0.03	0.05	0.04	0.03	0.06	0.03
RA	1.25	1.01	0.91	0.09	0.08	0.07	0.09	0.09	0.04	0.11	0.04	0.03	0.08	0.04
Diff., %	0.06	0.00	35.80	13.75	1.12	1.14	0.83	78.08	38.46	130.43	0.00	0.00	31.25	0.42
CO2 emissions - Peat														
SA	129.24	104.39	69.91	8.31	8.32	7.29	9.37	5.30	2.66	4.74	4.45	3.51	6.62	3.59
RA	129.41	104.46	95.00	9.46	8.42	7.38	9.45	9.45	3.70	10.98	4.45	3.51	8.73	3.60
Diff., %	0.13	0.07	35.89	13.83	1.19	1.21	0.90	78.30	39.13	131.66	0.08	0.08	31.85	0.20
Fuel consumption - Other fuels														
SA	0.55	1.03	0.62	0.72	0.97	0.35	0.30	0.40	0.16	0.50	0.75	0.88	1.12	1.28
RA	0.55	1.03	0.62	0.72	0.97	0.35	0.30	0.40	0.16	0.50	0.75	0.88	1.12	1.29
Diff., %	0.00	0.00	0.00	-0.14	0.10	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	1.20
CO_2 emissions - Other fuels														
SA	41.60	77.25	46.48	54.30	72.00	26.07	22.30	31.05	12.41	40.77	72.70	79.71	94.63	109.70
RA	38.08	72.49	42.32	49.74	69.30	24.16	20.85	26.37	10.80	22.40	34.68	36.28	59.71	58.75
Diff., %	-8.46	-6.15	-8.95	-8.40	-3.76	-7.33	-6.50	-15.08	-13.04	-45.07	-52.30	-54.48	-36.90	-46.44

The biomass consumption in the comparison is not included as this type of fuel is assumed as CO_2 neutral and CO_2 emissions from biomass combustion are taken into account in the CO_2 emission estimation from Energy sector.

Amount of used tires combusted in cement production plant is reported as Other fuels as well as municipal waste combusted in the same cement production plant. According to 2006 IPCC Guidelines, used oils are also reported under Other fuels.

3.2.1.1 Explanation of the difference

Energy balance

In the Annual questionnaires, as well as in CSB online database statistical differences, distribution losses and interproduct transfer are reported for certain fuels, whereas in the Reference Approach (RA) table only stock changes are possible to insert. These data are not taken into account and are not put in stock changes' cells of the CRF Reporter RA tables. Therefore the difference in liquid fuels and peat have been quite significant for many years. For example, distribution losses for peat are quite visible, in comparison with total consumption, especially in 2010. To improve the transparency of reporting, the statistical differences, distribution losses, as well as interproduct transfers for the whole time series are presented in Annex A.3.1 of this report.

CSB estimates total consumption data by taking production, import, export, international bunkering and stock changes data into account. Final consumption data is estimated by taking into account sectoral consumption data reported by fuel consumers excluding reported distribution losses data. Transformation and Energy sectors are not included in final

consumption data. For several fuel types difference between these two estimation approaches is reported as statistical difference that is quite significant for some fuel types – diesel oil, gasoline, residual fuel oil. For peat amount of distribution losses is also quite significant but this amount is not taken into account in RA reporting.

CSB reports the amount of fuel that was used in interproduct transfer but this amount is not reported in RA tables therefore the consumption of fuel in RA tables is reported although the fuel was not consumed in Latvia, for example, for other kerosene in 2004-2008.

The changes larger than 5% between fuel consumption in RA and Sectorial Approach (SA) are explained below for each fuel type.

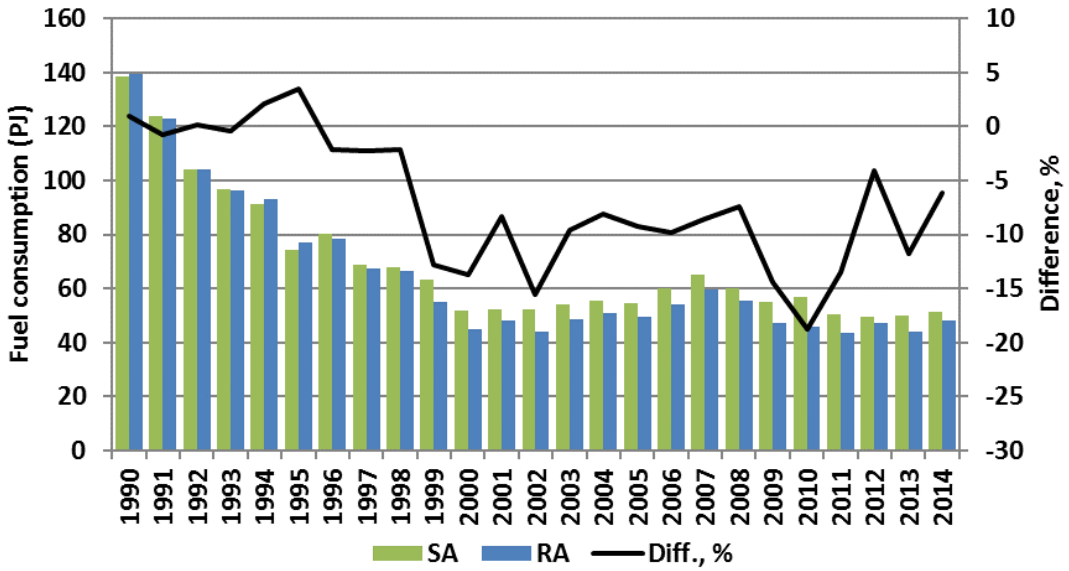

Figure 3.5 Difference in fuel consumption of Liquid fuels between Reference and Sectoral Approach

The difference between fuels varies from -2% to 4% until 1998, and with up to -18.77% difference in 2010 (Figure 3.5). The differences after 1998 can be generally explained with statistical differences in diesel oil energy balance which are not taken into account when calculating RA, and also with interproduct transfers of RFO, shale oil, jet fuel and kerosene. In 1999, there are also large statistical differences in gasoline consumption (-6.38 PJ).

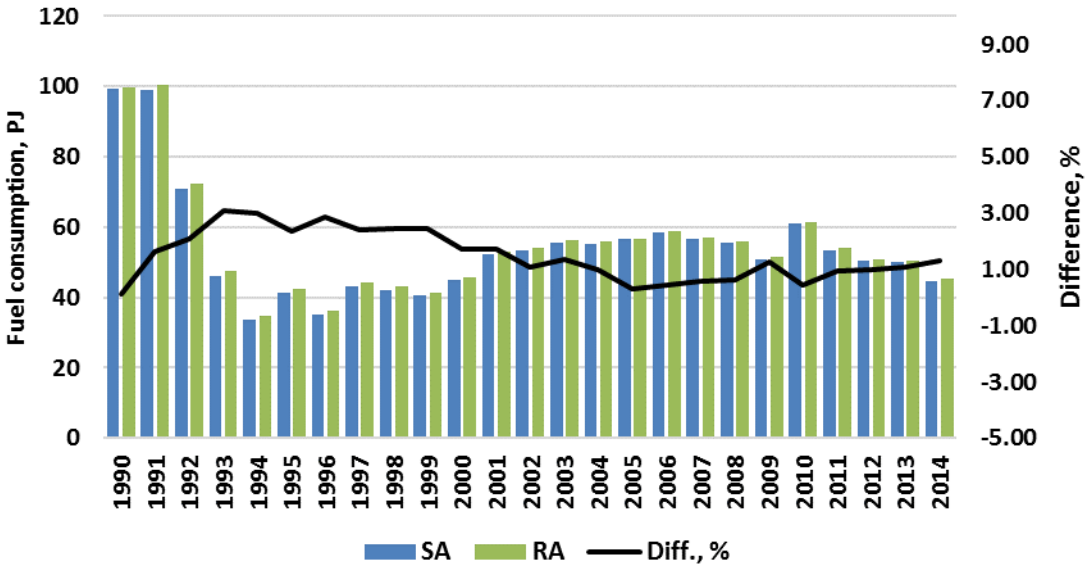

Figure 3.6 Difference in fuel consumption of Gaseous fuels between Reference and Sectoral Approach

The differences in natural gas consumption between both approaches are mainly due to distribution losses that occur every year (Figure 3.6).

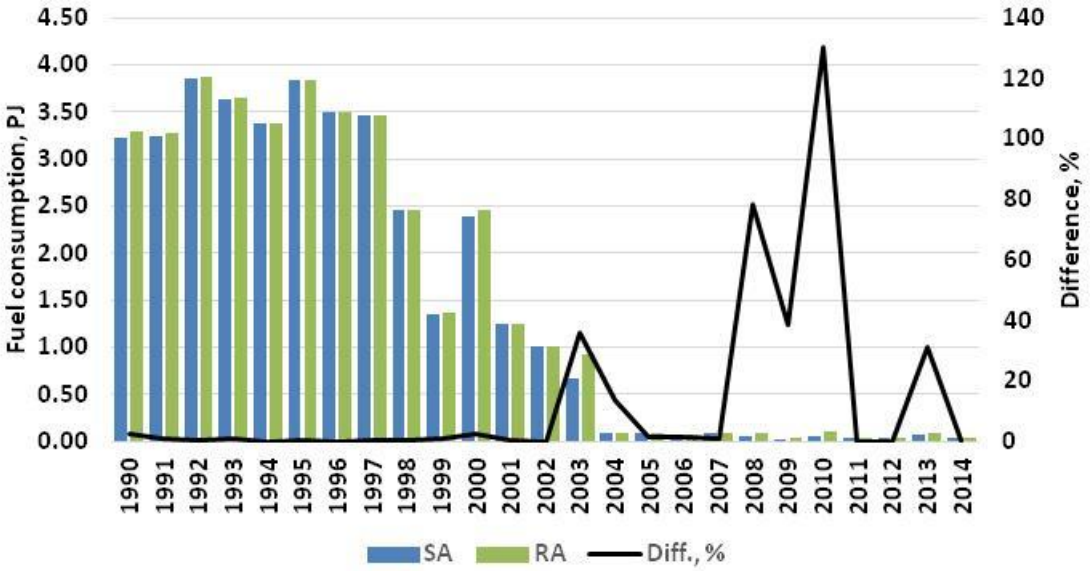

Figure 3.7 Difference in fuel consumption of Peat (including Peat briquettes) between Reference and Sectoral Approach

Among all fuel types, for peat and peat briquettes the differences are the most remarkable (Figure 3.7). It is because in the recent years there are significant losses of peat reported by CSB, for example, in 2003, there are 241 TJ reported by CSB as peat losses, and it can be clearly seen in difference of RA and SA - while the total consumption according to RA is 914 TJ, within SA only 673 TJ are reported. The same applies to years 2008-2011 and 2013, where losses of peat are around 10-60 TJ.

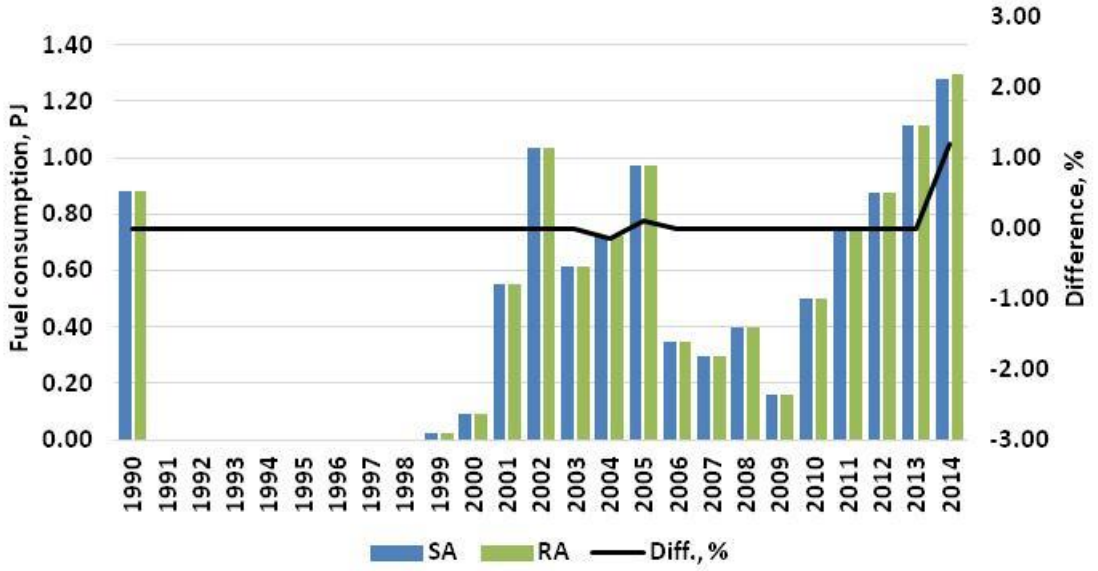

Figure 3.8 Difference in consumption of Other fuels between Reference and Sectoral Approach

The differences for Other fuels are not larger than ±5% (Figure 3.8), therefore not analysed.

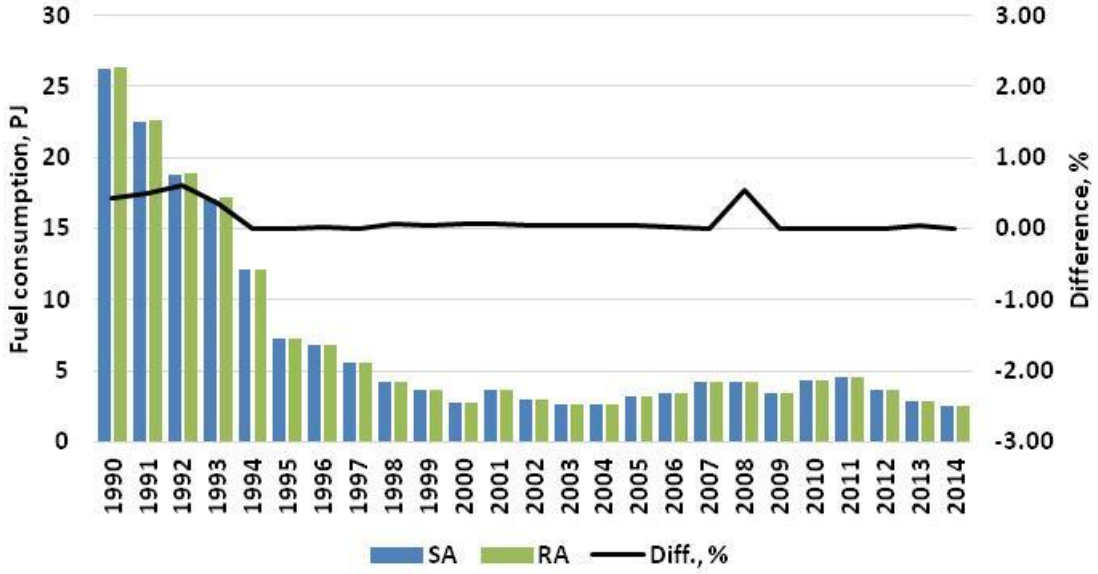

Figure 3.9 Difference in consumption of Solid fuels between Reference and Sectoral Approach

The differences for solid fuels are not larger than ±5% (Figure 3.9), therefore not analysed.

3.2.1.2 Explanation of the fluctuations

Fluctuations of emissions estimated with SA and RA are more or less equal. All fuels had decreased in 1990-1995 due to continued changes of national economy structure, inflation and collapse of national industry. Still in 1995-1996 the government adopted strict rules to cut back the inflation and downward of industry so the fuel consumption since 1995-1996 also was restructured. Since 1996 the natural gas consumption is increasing but other fuel consumption are increasing only after 2000 due to development of national economy that was prepared for joining European Union. In the recent years there can be seen the

influence of global economic crisis in 2007-2009 and a recovery after that in 2010-2014 with a decreasing trend of emissions.

3.2.1.3 Methodological issues

2006 IPCC Guidelines Reference approach for the CO_2 emission estimations and comparison of CO_2 emissions were used. CRF Reporter software was used to report emission data. Annual import, export, production, international bunkers and stock changes data divided by fuel types are put in the RA tables of CRF Reporter as well as carbon emission factor (EF) and coefficient of fraction of carbon oxidized.

Generally emissions are calculated by multiplying fuel consumption with country specific, plant specific or IPCC default carbon EF taking into account fraction of carbon oxidized.

Carbon emission factors were estimated by taking into account net calorific values and the molecular weight ratio of the carbon and CO_2. Net calorific values (NCV) of the fuels are taken from Energy Balance prepared by CSB. The fuel consumers reported the NCV of the used fuels to CSB according to national legislation that obliges the enterprises that do any fuel use activities report it to CSB. The consumption of fuels is taken from CSB on-line database due to more precise data as in Annual Questionnaires, therefore, in order to improve transparency of the reporting, it was decided to use data from Energy Balance instead of Annual Questionnaires.

For peat, gasoline, diesel oil, RFO, shale oil, jet fuel, kerosene, wood, used oils and natural gas carbon emission factor is assumed as country specific. For several fuels NCV changes once in whole time series in 2003-2004 or 2002-2003 but for natural gas and municipal waste NCV and also carbon emission factor changes for every year in whole time series. NCV and carbon emission factor (C_{EF}) of other liquid fuels changes in every year in time series are explained with the fluctuation of other oil fuel structure (biogasoline, biodiesel, other liquid biofuels – bioethanol). Municipal waste structure also influenced carbon emission factor change in 2008-2013.

Table 3.9 Carbon emission factors (t/TJ)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Peat	28.925	28.925	28.925	28.925	28.925	28.925	28.925	28.925	28.925	28.925	28.925	28.925	28.925
Gasoline	18.893	18.893	18.893	18.906	18.906	18.906	18.906	18.906	18.906	18.906	18.906	18.906	18.906
Diesel oil	20.400	20.400	20.400	20.400	20.400	20.400	20.400	20.400	20.400	20.400	20.400	20.400	20.400
RFO	21.113	21.113	21.113	21.113	21.113	21.113	21.113	21.113	21.113	21.113	21.113	21.113	21.113
Shale oil	21.047	21.047	21.047	21.047	21.047	21.047	21.047	21.047	21.047	21.047	21.047	21.047	NO
LPG	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126
Jet fuel	19.718	19.718	19.718	19.713	19.713	19.713	19.713	19.713	19.713	19.713	19.713	19.713	19.713
Kerosene	19.715	19.715	19.715	19.715	19.715	19.715	19.715	19.715	19.715	19.715	19.715	19.715	19.715
Wood	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015
Used oils	20.012	20.012	20.012	28.659	28.659	28.659	28.659	28.659	28.659	28.659	28.659	28.659	28.659
Natural gas	15.043	15.174	15.193	15.160	15.169	15.169	15.160	15.173	15.151	15.148	15.120	14.874	14.883
Landfill gas, sludge gas, other biogas	NO	13.953	13.953	13.953	13.953	13.953	13.953	13.953	13.953	13.953	13.953	13.953	13.953

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Industrial waste	NO	NO	16.515	15.536	15.536	15.536	16.624	16.624	13.647	15.565	14.994	15.743	16.532
Municipal waste (non-biomass)	NO	NO	NO	NO	NO	NO	12.052	11.961	9.581	7.640	8.849	13.767	10.552
Petroleum coke	26.600	26.600	26.600	26.600	26.600	26.600	26.600	26.600	26.600	26.600	26.600	26.600	NO
Anthracite	NO	NO	NO	NO	NO	NO	NO	NO	NO	26.800	26.800	26.800	NO
Peat briquettes	26.600	26.600	26.600	26.600	26.600	26.600	26.600	26.600	26.600	26.600	26.600	26.600	26.600
Waste oils	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
Straws	27.300	27.300	27.300	27.300	27.300	27.300	27.300	27.300	27.300	27.300	27.300	27.300	27.300
Charcoal	30.500	30.500	30.500	30.500	30.500	30.500	30.500	30.500	30.500	30.500	30.500	30.500	30.500
Oil shale	29.100	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	25.800	25.800	25.800	25.800	25.800	25.800	25.800	25.800	25.800	25.800	25.800	25.800	25.800
Coke	29.200	29.200	29.200	29.200	29.200	29.200	29.200	29.200	29.200	29.200	29.200	29.200	NO
Other oil	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
Biogasoline, biodiesels	NO	NO	NO	19.300	19.300	19.300	19.300	19.300	19.300	19.300	19.300	19.300	19.300

Carbon emission factors for petroleum coke, anthracite, peat briquettes, waste oils, straws, charcoal, oil shale, coal, coke, other oil, biogasoline, biodiesels and other liquid biofuels taken from 2006 IPCC Guidelines were used (Table 3.9). Carbon emission factor for industrial and municipal waste was estimated based on CO_2 emission factor reported by cement production plant within ETS.

3.2.1.4 Time-series consistency

Time series of the estimated emissions are consistent and complete because the same methodology, emission factors and data sources are used for sectors for all years in time series. Emissions from all sectors are estimated or reported as not occurring / not applicable therefore there are no "not estimated" sectors.

3.2.1.5 Category-specific QA/QC and verification

The best way to check RA data is to compare them with SA data that is done already in CRF Reporter. The difference between these two emission estimation and reporting methodologies has to be double-checked and explained.

There are several ways to do the checks of the activity data:

- Energy sector data is taken from the Energy Balance that CSB prepares annually, and it has the internal QA/QC procedures based on mathematical model and analysis to avoid logic mistakes.
- Data of RA are verified by CSB within National Inventory System Quality assurance process and in case of inconsistency of data reported in NIR and in CRF with the data in Energy balance of CSB and data reported to EUROSTAT by CSB all the information of data mismatch is reported to LEGMC. After that Energy sector's sectoral expert check all again the reported data and incorporate necessary changes in CRF and in

NIR. If the sectoral expert doesn't agree with reported data mismatch and considers that no changes are necessary the information of this is again sent to CSB with detailed explanation.

Estimated CO_2 emissions are checked:

- By comparing the emissions estimated with Reference Approach and Sectoral approach. All significant differences (more than 5%) are double-checked. Difference has to be explained and agreed with CSB. This verification step is done for total fuel combustion sector.
- By comparing used carbon emission factor with CO_2 emission factors used in Sectoral Approach.

3.2.2 International bunker fuels

International bunkers cover international aviation and navigation according to the 2006 IPCC Guidelines. Emissions from international aviation and navigation are not included into national total emissions. Taking into consideration the fact that ports in Latvia are focused on transit cargo transport, navigation activities have big fluctuations and depend on neighbouring countries' economical and international trading activities and competitiveness of Latvian ports' with other neighbouring ports in Baltic Sea. At the same time emissions from aviation are more stable, and recent trend depicts a persistent increase. In 2014, total GHG emissions of International Bunkering (see Figure 3.10), compared to 2013 level has decreased by 4.3%. In different subsectors various changes have taken place in 2014. In international aviation the GHG emissions has decreased by 10.9%, whereas in the international navigation it has decreased by 1.1 %. In different subsectors various changes have taken place in 2014. In international aviation GHG emissions have decreased by 10.9%, whereas in the international navigation it has decreased by 1.1 %.

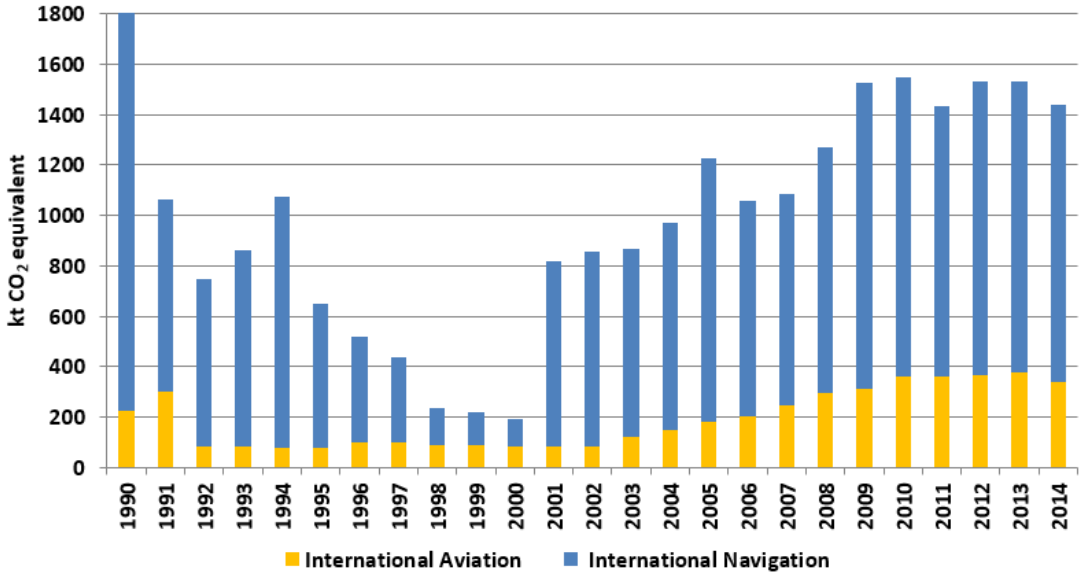

Figure 3.10 Emissions from International Bunkers (kt CO_2 eq.)

Data about international bunker fuel consumption is provided by CSB (Table 3.10). CSB split of fuel for national and international navigation/aviation is based on EUROSTAT and IEA guidelines on data collection. Defined approach about energy consumption allocation for

international and national navigation/aviation fully is in line with the defined criteria in IPCC GPG 2000 (for more details see "Energy Statistics Manual", IEA, EUROSTAT (2005)). In Latvia's case there are no situations when international marine/aviation transport departs from port in Latvia and arrives in port in Latvia to drop-off and picks up passengers or freight and then departs for a final destination in other country. Therefore, implemented data collections of fuel consumption in international and national navigation/aviation fully ensure a correct allocation between national and international mode.

To provide consistent allocation of fuel consumption between domestic and international mode in the navigation and aviation, CSB each month collects and summarizes the information which is submitted by every enterprise which performs fuel bunkering; For this purpose, the particular statistical report format is elaborated in which the enterprises have to fill in the data regarding amount of fuel sold respectively in domestic and international navigation and aviation.

Table 3.10 Energy consumption in international transport[16] (TJ)

	Aviation	Navigation	
	Jet Kerosene	Diesel Oil	Residual Fuel Oil (RFO)
1990	3067	5014	14738
1995	1080	1105	5156
2000	1123	340	-
2001	1123	4249	3938
2002	1166	3612	4994
2003	1685	3102	4750
2004	2031	3187	5278
2005	2463	3824	7064
2006	2765	2762	5481
2007	3371	2507	4953
2008	4051	1912	6699
2009	4278	2592	8851
2010	4907	2932	7592
2011	4921	3187	5800
2012	4984	3697	6374
2013	5142	3148	6658
2014	4580	2932	6780

In 2014, CO_2 emissions from international aviation, compared to 2013 level, have decreased by 10.9% (Figure 3.10) due to decreasing fuel consumption. These changes in fuel consumption directly related to decreasing flights in Riga airport (decreasing around 2.5%) and by using more efficient airliners.

CO_2 emissions from the international navigation are affected by fuel consumption, which depends on several factors:

[16] *CSB. Annual Eurostat Energy Questionnaire, 2014*

- On the one hand it is affected by the port activity indicators (loaded, unloaded cargo). As shown in Figure 3.11, the total loaded and unloaded cargo volume in 2014 has increased by nearly 30% compared to 2001. At the same time the structure of the cargo handled has changed (see Figure 3.12). The main changes have affected the oil transshipment, whose share in handeled cargo volume has decreased from 18.7% to 0.2%. At the same time, the coal share in the total handled cargo volume has increased from 9.7% to 37.3 %.
- On the other hand, fuel consumption is affected by the number of vessels serviced in ports. As shown in Figure 3.11, in spite of the rapid increase in the volume of cargo at the port of Riga, the number of serviced ships has remained almost unchanged or even has decreased. The main reason for this trend is the increase in the gross tonnage of vessels. The most significant increase was registered in the average tanker gross tonnage, but also in other cargo carrier groups (container, dry bulk carriers). All this confirms the fact that the cargo owners continue to optimize transport costs including fuel costs and try to use larger vessels where possible.

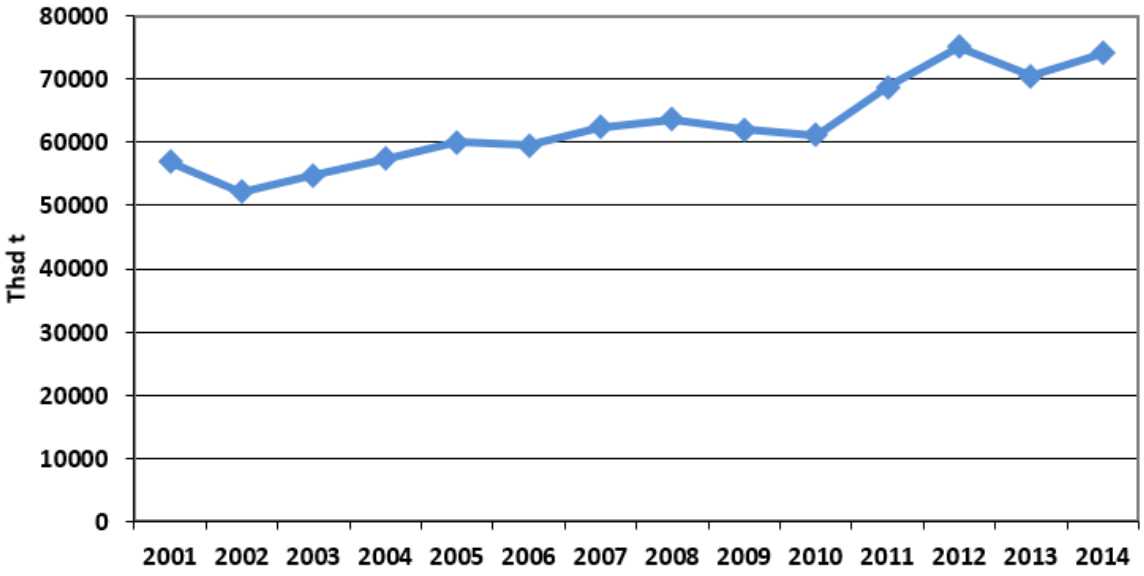

Figure 3.11 Loaded, unloaded cargo at ports in Latvia (Thsd t)

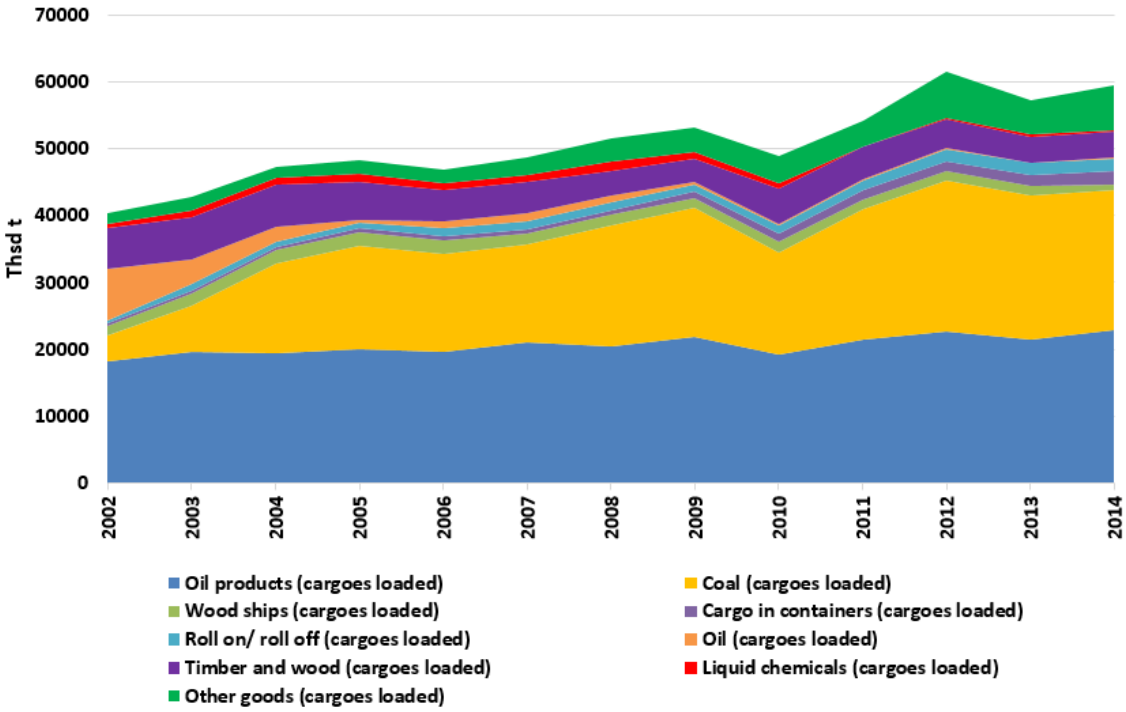

Figure 3.12 Structure of loaded goods at ports in Latvia (Thsd t)

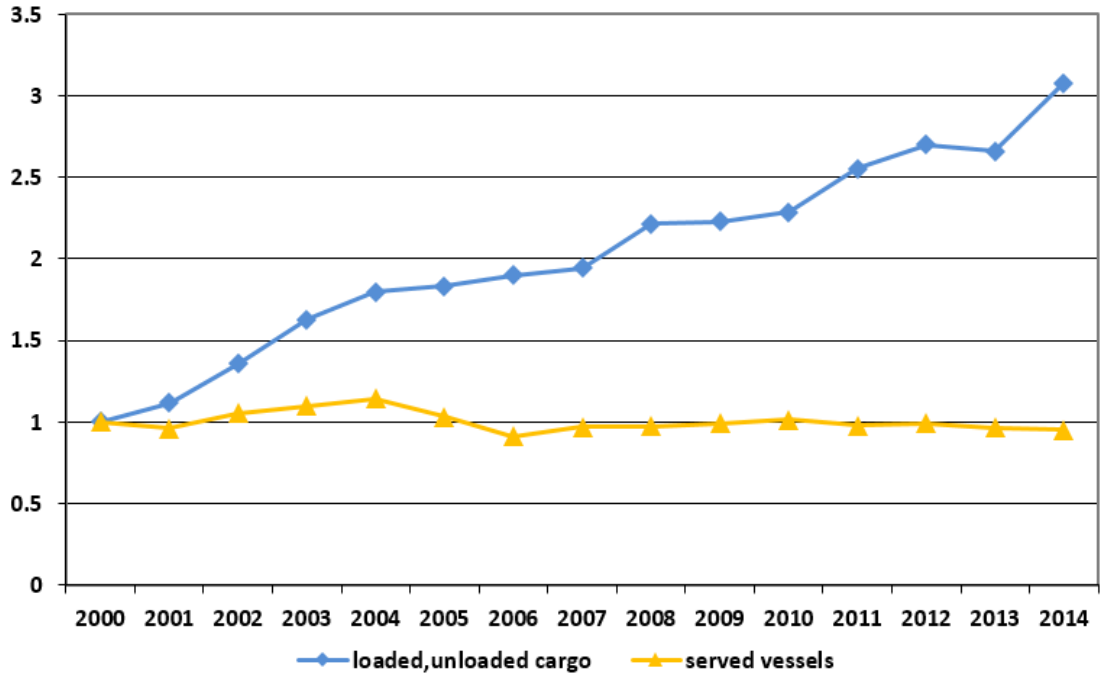

Figure 3.13 Loaded, unloaded cargo and served vessels at Riga port (2000 = 1)

The implemented emission factors for emission calculation from international navigation are shown in Table 3.13.

Table 3.11 Emission factors used in the calculation of emissions from International Bunkering

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	kt/PJ	kt/PJ	kt/PJ	kt/PJ	kt/PJ	kt/PJ
Diesel oil	74.0	0.004	0.03	1.8475	0.1742	0.0659
RFO	76.6	0.005	0.002	1.9532	0.1822	0.0665

The methodology used for calculation of emissions from international aviation corresponds to the 2006 IPCC Guidelines Tier 2 where the amount of LTO (landing and take-off)/cruises is crucial. Emissions from international navigation are calculated in pursuance with 2006 IPCC Guidelines Tier 1.

The relevant emission factors are taken from different sources. All of the international aviation and navigation emission factors (CO_2, CH_4 and N_2O) are derived from the 2006 IPCC Guidelines, while the remaining factors – from EMEP/EEA 2013 for determination of SO_2 EF country-specific sulphur content is applicable (see Table 3.12 and Table 3.13).

Table 3.12 SO_2 Emission factors used for diesel oil in the SO_2 calculation of emissions International Bunkering

Diesel oil	Fuel content	NCV	EF (kt/PJ)
1990-2002	0.2	42.49	0.094
2003-2004	0.05	42.49	0.024
2004-2007	0.2	42.49	0.094
2008-2014	0.1	42.49	0.047

Table 3.13 SO_2 Emission factors used for RFO in the SO_2 calculation of emissions International Bunkering

RFO	Fuel content	NCV	EF (kt/PJ)
1990-2007	2.8	40.6	1.352
2007-2014	1.5	40.6	0.74

3.2.3 Feedstocks and non-energy use of fuels (CRF 1.AD)

3.2.3.1 Category description

Under this category consumption of different types of fuels used as feedstock is reported. Emissions from these fuels are reported as "CO_2 not emitted" because it is assumed that in CO_2 emissions is captured and not emitted to the air.

Consumption of Bitumen, Lubricants, Coke, White spirits and Paraffin wax is reported in 1.D tables for all years in time series 1990–2014.

3.2.3.2 Methodological issues

Carbon emission factors used in 2006 IPCC Guidelines were taken for all fuel types – Bitumen (22 t/TJ), Lubricants (20 t/TJ), Coke (29.2 t/TJ), White spirits (20 t/TJ) and Paraffin waxes (20 t/TJ).

Activity data prepared by CSB and available on CSB on-line database were used (Table 3.14).

Table 3.14 Activity data for Feedstocks and Non-energy use of fuels in 1990–2014 (TJ)

	Bitumen	Lubricants	Coke	White spirits	Paraffin waxes
1990	1633	1633	53	84	NO
1991	544	1047	105	84	NO
1992	84	921	132	84	NO
1993	167	1088	105	84	NO
1994	544	1005	185	84	NO
1995	712	963	158	84	NO
1996	879	963	158	84	NO
1997	1633	879	264	84	NO
1998	2051	1005	264	126	NO
1999	2344	879	264	84	126
2000	2009	879	264	126	126
2001	1507	837	264	126	167
2002	2093	837	241	84	167
2003	2177	921	134	84	167
2004	2009	1005	161	126	251
2005	2512	1088	134	126	335
2006	3098	1088	129	126	251
2007	3349	1088	107	84	251
2008	3600	1047	134	84	209
2009	2218	628	134	42	293
2010	1967	586	80	40	461
2011	2930	795	80	42	293
2012	2888	922	161	42	251
2013	3181	880	52	42	377
2014	2930	632	0.17	42	335

Constant increase of bitumen use since 2004 until 2008 is explained with development of construction sector and availability of financial resources from European Union (Latvia is a member of European Union since 2004) for building and improvement of transportation infrastructure. However, during the economic crisis the funding reduced and the amounts of bitumen used decreased in 2008-2010. After the financial crisis increase in bitumen use can be observed. Lubricants are mainly used in transport sector.

Coke is used as ingredient in metallurgy to produce higher quality steel. Evident decrease in coke use can be explained with changes in metallurgy. Financial crisis in 2010 and bankruptcy of "Liepājas metalurgs" is the reason of reduced metal production and use of coke.

Paraffin waxes and white spirits mainly are used as feedstocks in chemical industry and wood processing.

3.2.4 Energy Industries (CRF 1.A.1)

3.2.4.1 Category description

CRF 1.A.1 Energy Industries sector includes emissions from fuel combustion in point sources in energy and heat production. According to 2006 IPCC Guidelines, emissions from autoproducers (undertakings which generate electricity/heat wholly or partly for their own

use, as an activity that supports their primary activity) are assigned to the sector where they were generated and not under CRF 1.A.1.

Emissions from combustion installations with NACE 2 codes 35.11 and 35.30 are reported in CRF 1.A.1.a sector. There are no petroleum refineries in Latvia therefore in CRF 1.A.1.b notation key „NO" is used. CRF 1.A.1 sector also includes the emissions from on-site use of fuel in the energy production facilities and emissions from manufacturing of solid fuels (peat briquettes and charcoal production plants) – these emissions are reported under 1.A.1.c Manufacture of solid fuels and other energy industries sector.

In Submission 2016, the CRF subsector 1.A.1. was split into subsectors which are in line with 2006 IPCC Guidelines/CRF Reporter structure. The GHG emissions were reported under following ones:

- 1. A.1. Energy industries:
- 1.A.1.a. Public electricity and heat production:
  - 1.A.1.a.i Electricity generation;
  - 1.A.1.a.ii Combined heat and power generation;
  - 1.A.1.a.iii Heat plants;
- 1.A.1.c. Manufacture of solid fuels and other energy industries:
  - 1.A.1.c.i Manufacture of solid fuels.

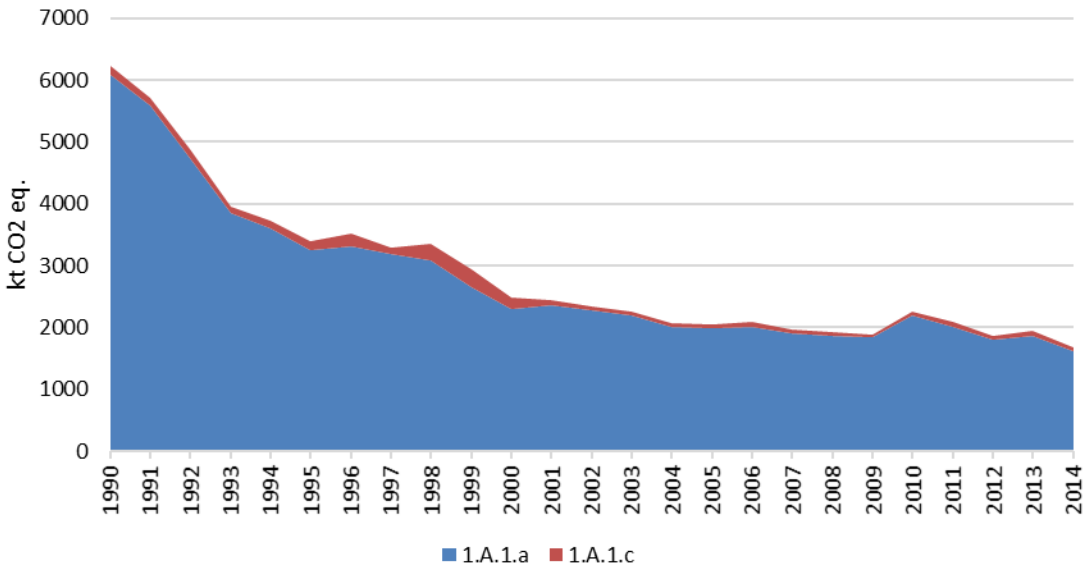

Figure 3.14 GHG emissions in CRF 1.A.1. Energy industries by subsectors (kt CO_2 eq.)

In Figure 3.14, there can be seen the distribution of GHG emissions in CRF 1.A.1. sector. The largest part of emissions consists of CRF 1.A.1.a Public electricity and heat production (96.0% in 2014), while CRF 1.A.1.c Manufacture of solid fuels and Other energy industries contribute to 4.0% of Energy industry emissions. As mentioned above, there are no emissions in CRF 1.A.1.b Petroleum refining.

Table 3.15 Emissions from Energy industries (CRF 1.A.1) in 1990–2014 (kt)

	CO_2	CH_4	N_2O	Aggregate GHGs	NO_x	CO	NMVOC	SO_2
	kt			kt CO_2 eq.	kt			
1990	6201.22	0.19	0.038	6217.15	10.54	2.61	0.22	36.39
1991	5692.55	0.17	0.033	5706.81	9.65	2.56	0.21	29.52
1992	4861.46	0.15	0.031	4874.39	8.34	2.09	0.17	26.86
1993	3939.64	0.14	0.030	3951.90	7.07	1.48	0.13	28.30
1994	3712.96	0.15	0.032	3726.19	6.92	1.28	0.13	32.20
1995	3391.71	0.12	0.026	3402.54	6.25	1.39	0.12	22.83
1996	3511.75	0.15	0.030	3524.56	6.54	1.32	0.13	28.61
1997	3275.72	0.19	0.032	3289.98	6.10	1.70	0.14	19.66
1998	3338.13	0.21	0.035	3354.03	6.11	1.75	0.15	20.84
1999	2919.47	0.19	0.030	2933.20	5.24	1.61	0.13	16.02
2000	2474.11	0.15	0.024	2485.18	4.40	1.56	0.12	7.64
2001	2421.19	0.17	0.025	2432.76	4.37	1.75	0.13	5.51
2002	2317.01	0.18	0.026	2329.19	4.23	1.75	0.13	5.22
2003	2246.23	0.20	0.028	2259.58	4.15	1.86	0.14	4.50
2004	2056.91	0.20	0.026	2069.73	3.78	1.78	0.13	3.12
2005	2047.02	0.17	0.023	2058.12	3.70	1.73	0.12	2.01
2006	2073.74	0.19	0.025	2085.85	3.77	1.85	0.13	1.37
2007	1944.72	0.19	0.024	1956.65	3.57	1.74	0.12	1.35
2008	1917.50	0.18	0.024	1929.12	3.51	1.73	0.12	0.78
2009	1866.76	0.18	0.024	1878.48	3.44	1.68	0.12	0.82
2010	2249.66	0.20	0.027	2262.68	4.10	2.02	0.14	0.89
2011	2071.47	0.19	0.025	2083.53	3.81	1.87	0.13	0.65
2012	1855.35	0.22	0.029	1869.28	3.62	1.85	0.13	0.60
2013	1918.68	0.32	0.043	1939.40	4.07	2.25	0.16	0.63
2014	1660.91	0.38	0.050	1685.30	3.82	2.29	0.17	0.60
Share of Energy total, 2014	25.4%	3.1%	13.5%	24.2%	12.8%	1.8%	0.8%	15.0%
2014 vs 2013	-13.4%	18.0%	17.5%	-13.1%	-6.3%	1.4%	2.8%	-4.4%
2014 vs 1990	-73.2%	101.3%	32.7%	-72.9%	-63.8%	-12.5%	-22.9%	-98.4%

CO_2 emissions from CRF 1.A.1 sector have a decreasing trend with a few fluctuations from which the most recent were in 2010 (Table 3.15). Since 1990, CO_2 emissions have decreased by 73.2% (biomass emissions excluded). In the beginning of the 90's the decrease of CO_2 emissions is explained with economic crisis caused by changes of political and social situation in the country when national economy was completely reorganized. Decrease in the end of 90's is explained with economic crisis in Russian Federation with which Latvia has close economic cooperation. Although heat and electricity production for public use was influenced by 2008-2009 economic crisis, although in smaller level than heat and electricity production for industrial sector, the emissions were decreasing as population was using less electricity and residential sector switched from central district heating to individual heating. Also, the following decrease of emissions can be explained with higher standards of physical specification of fuels and fuel switching to fuels with lower costs and emissions – natural gas and biomass. In recent years, an increase of CO_2 emissions in 2010 can be explained with extremely cold winter, and the decrease in 2011 – with much warmer one, which influenced the amounts of fuel used for heating. Since 2010 up to year 2014, the emissions of CO_2 have decreased by 26.2%.

Nevertheless, in CH_4 and N_2O emissions there can be seen an increase in recent years, starting from 2011, due to increased use of liquid solid and biomass fuel consumption. Since 2011 up to year 2014 the increase in CH_4 and N_2O emissions was 102.0% and 102.5%, respectively. If compared with decreasing CO_2 emissions, the increase in CH_4 and N_2O emissions is because of biomass use – as it is considered as CO_2 neutral, it does not take place in CO_2 balance, however, biomass combustion is accounted for CH_4 and N_2O emissions.

Indirect GHG emissions from CRF 1.A.1 Energy Industries were estimated as well. SO_2 had the biggest decrease by 98.4% in 1990–2014. It can be explained with fuel switching from coal, peat and heavy fuel oils to natural gas and biomass from what sulphur dioxide emissions are emitted in considerably smaller amounts. Also a strict national legislation was approved to improve the quality of used liquid fuels in country. NOx emissions have also decreased by 63.8% in 1990-2014, NMVOC emissions – by 22.9%, and CO emissions – by 12.5%. The decrease can also be explained with fuel switch from solid to natural gas and biomass, which have lower emission factors.

3.2.4.2 Methodological issues

2006 IPCC Guidelines' Tier 2 method was used to estimate CO_2 emissions from fuel combustion as country specific parameters were used to estimate CO_2 emission factor. However, for some fuels there are no country-specific emission factors, therefore 2006 IPCC Tier 1 method using default emission factors was used. 2006 IPCC Guidelines' Tier 1 method was used to calculate CH_4 and N_2O emissions from the CRF 1.A.1 sector.

As sludge gas consists approximately 35-44% of non-combustible components such as CO_2 sulphur and others and 56-65% of sludge gas is combustible, methane emissions from biogas were calculated only by taking into account the methane part of biogas. It means that under the biogas fuel the combustion of methane is reported. As methane is obtained from sludge it is considered as biomass combustion, hence CO_2 neutral. Therefore Tier 2 method from 2006 IPCC Guidelines was used to calculate CO_2 emissions from methane obtained from sludge gas as plant specific parameters were used to estimate CO_2 emissions from methane obtained from sludge gas.

Calculation of all emissions from fuel combustion is done with Excel databases developed by the experts from LEGMC. The general method for emission data preparation was used:

$$Em = EF \times B_q$$

where:
Em – total emissions (kt)
EF – estimated or default emission factor (t/TJ)
B_q – amount of fuel in thermal units (TJ)

NO_x and SO_2 emission data of 2005-2014 from combined heat and power plants as well as heat production only plants are taken from database "2-AIR" where enterprises that do any pollution activity and have A, B or C category pollution permits report their emission data, therefore these data are plant specific. Other indirect GHGs (CO, NMVOC) are calculated using Tier 1 method.

Emission factors and other parameters

The main sources for emission factors are:

- National studies for country specific parameters and emission factors;
- Data from only natural gas supplier company of natural gas physical characteristics;
- 2006 IPCC Guidelines;
- EMEP/EEA 2013.

Country specific emission factors were used to calculate carbon dioxide (CO_2) and sulphur dioxide (SO_2) emissions.

CO_2 emission factors

In 2004 a research by a local expert was made regarding CO_2 emission factors for Latvia in concern with IPCC 1996 and used fuel type of physical characteristics. National expert assessed indices that influences CO_2 emission factor and calculated CO_2 emission factor in the research "Methodological instructions for CO_2 emissions determination" (Annex A.3.2). This research was made considering United Nations framework convention of climate change recommendations of Intergovernmental Panel of Climate Change and physical characterizations of types of fuels used in Latvia.

Solid and liquid fuels and solid biomass

For calculating CO_2 emission factors for liquid and solid fuels following equation (Annex A.3.2) was used:

$$EF_{CO_2} = \frac{C^d \times M_{CO_2} \times 1000}{Q_d^z \times M_C \times 100}$$

where:
EF_{CO2} – emission factor for CO_2 (kg CO_2/MJ)
Q_z^d – net calorific value of fuel (MJ/kg (m^3))
C^d – carbon content in fuel (%)
M_{CO2} – molecule weight for CO_2 – 44. 0098 (g/mcl)
M_C – molecule weight for C – 12.011 (g/mcl)

For Submission 2016 CO_2 emission factors for certain types of fuels were recalculated according to CSB reported information of NCV changes in time period. NCV value was obtained from fuel consumers that have to report the used amount data and other fuel information to CSB within annual reporting (Table 3.16).

Table 3.16 Characteristics of liquid solid and solid biomass fuels and estimated CO_2 emission factors

Fuel type	Carbon content in working mass of fuel (C^d) %	NCV, GJ/t	Oxidation factor	Emission factor with oxidation factor (EF CO_2), t/TJ
Peat W_d=40%	29.07	10.05	0.98	103.8664
Motor gasoline (for off-roads)	83.13	44 (1990-2002) 43.97 (2003-2014)	0.99	68.5347 68.5815
Diesel oil	86.68	42.49	0.99	74.0010
RFO	85.72	40.6	0.99	76.5881
Shale oil	82.82	39.35	0.99	76.3477
LPG	77.99	45.54	0.995	62.4366

Fuel type	Carbon content in working mass of fuel (C^d) %	NCV, GJ/t	Oxidation factor	Emission factor with oxidation factor (EF CO_2), t/TJ
Jet fuel	85.18	43.2 (1990-2002) 43.21 (2003-2014)	0.99	71.5252 71.5087
Other kerosene	85.17	43.2 (1990-2000) 43.21 (2004) 43.2 (2005-2014)	0.99	71.5168 (NCV - 43.2) 71.5003 (NCV - 43.21)
Used oils	83.77	41.86	0.99	72.5930
Wood **W_d = 55%**	20.11	6.7	0.98	107.7789

For some fuels default CO_2 emission factors from 2006 IPCC Guidelines, Volume 2, Chapter 2 *Stationary combustion*, Table 2.2, were taken due to unavailability of country specific data:

- coal – 94.6ktg/PJ;
- coke – 107 kt/PJ;
- peat briquettes – 97.5 kt/PJ;
- biodiesel – 70.8 kt/PJ;
- straws – 100 kt/PJ;
- waste oils – 73.3 kt/PJ.

Natural gas

For calculating CO_2 emission factor for natural gas following equation (Annex A.3.2) was used:

$$EF_{CO_2} = \frac{C^d \times M_{CO_2}}{M_C \times 100} \times \rho$$

where:
EF_{CO2} – emission factor for CO_2 (kt/1000m^3)
C^d – carbon content in fuel (%)
M_{CO2} – molecule weight for CO_2 – 44.0098 (g/mcl)
Mc – molecule weight for C – 12.011 (g/mcl)
ρ – natural gas density – for transition from density to mass units (t/1000m^3)

Data of carbon content and natural gas density for 1990-2014 were obtained from only natural gas supplier JSC "Latvijas Gāze" that collects/measures these data by themselves (Table 3.17). NCV values to calculate data further in energy units were taken from CSB.

Table 3.17 Characteristics of natural gas and estimated CO_2 emission factors

	Carbon content in working mass of fuel (C^d) %	Oxidation factor (ρ)	Natural gas density (ρ) t/1000m^3	Emission factor with oxidation factor (EF CO_2) kt/1000m^3
1990	74.33	0.995	0.6867	1.8703
1991	74.33	0.995	0.6867	1.8703
1992	74.36	0.995	0.6923	1.8863
1993	74.15	0.995	0.6965	1.8924
1994	74.04	0.995	0.6914	1.8757

	Carbon content in working mass of fuel (C^d) %	Oxidation factor (p)	Natural gas density (ρ) t/1000m³	Emission factor with oxidation factor (EF CO_2) kt/1000m³
1995	74.26	0.995	0.6889	1.8745
1996	74.3	0.995	0.6859	1.8673
1997	74.39	0.995	0.6845	1.8658
1998	74.35	0.995	0.6857	1.8680
1999	74.31	0.995	0.6841	1.8627
2000	74.32	0.995	0.6879	1.8733
2001	74.36	0.995	0.6876	1.8735
2002	74.36	0.995	0.6858	1.8686
2003	74.38	0.995	0.6851	1.8672
2004	74.39	0.995	0.6839	1.8641
2005	74.4	0.995	0.6835	1.8633
2006	74.39	0.995	0.6838	1.8639
2007	74.38	0.995	0.6828	1.8609
2008	74.38	0.995	0.6833	1.8622
2009	74.37	0.995	0.686	1.8694
2010	74.42	0.995	0.6855	1.8692
2011	74.43	0.995	0.6856	1.8698
2012	74.31	0.995	0.6855	1.8665
2013	74.34	0.995	0.6884	1.8751
2014	74.36	0.995	0.6919	1.8852

Landfill gas

There are five landfills in Latvia that collect biogas from landfills – one landfill is collecting and combusting biogas since 2002 second from 2003 third from 2004. Fourth landfill started to combust biogas with energy recovery only in 2008, but fifth – in 2013.

As landfills were not able to provide information of carbon content percentage in working mass of fuel constant methane value was used instead and was estimated basing on molar mass of components. Following equation (Annex A.3.2) was used to calculate this methane number:

$$C^d = \frac{M_C}{(M_C + M_H)} \times 100$$

where:
C^d – carbon content in fuel (%)
Mc – molecule weight for C – 12.011 (g/mcl)
M_H – H molecule weight (1.008 g/mcl)
100 – estimation of percentage

For calculation of CO_2 emission factor of methane obtained from landfill gas, an equation basically the same as for natural gas was used, although methane carbon content, density and NCV from scientific literature was used[17] (Table 3.18). The same assumption refers to other biogas.

[17] http://dolgikh.com/index/0-31

$$EF_{CO_2} = \frac{C^d \times M_{CO_2} \times 1000}{Q_d^z \times M_C \times 100} \times \rho$$

where:
EF_{CO2} – emission factor for CO_2 (kg CO_2/MJ)
Q_z^d – net calorific value of fuel (MJ/kg (m^3))
C^d – carbon content in fuel (%)
M_{CO2} – molecule weight for CO_2 – 44. 0098 (g/mcl)
M_C – molecule weight for C – 12.011 (g/mcl)

Table 3.18 Characteristics of methane obtained from landfill gas and estimated CO_2 emission factors

Amount of methane in landfill gas (%)	Default carbon content in working mass of methane (C^d) %	NCV of methane (Q_z^d) TJ/1000m³	Oxidation factor (p)	Natural gas density (ρ) t/1000m³	Emission factor with oxidation factor (EF CO_2) kg/GJ
50%	74.867543%	35.88	0.995	0.6687	50.870474

Sludge gas

The CO_2 emission factor estimated below is estimated for pure methane that is obtained from collected sludge gas.

As wastewater treatment plant was not able to provide the information of carbon content percentage in working mass of fuel a constant carbon content in methane was used estimated on moll mass of components. Following equation was used for calculations:

$$C^d = \frac{M_C}{(M_C + M_H)} \times 100$$

where:
C^d – carbon content in fuel (%)
Mc – molecule weight for C – 12011 (g/mcl)
M_H – H molecule weight (1.008 g/mcl)
100 – estimation of percentage

For calculation of CO_2 emission factor of methane obtained from sludge gas the same equation as for natural gas was used. NCV numbers of methane obtained from sludge gas that is combusted with energy recovery for all years are obtained from wastewater treatment plant (Table 3.19).

Table 3.19 Characteristics of methane obtained from sludge gas and estimated CO_2 emission factors

Amount of methane in sludge gas (%)	Default carbon content in working mass of methane (C^d) %	NCV of methane (Q_z^d) TJ/1000m³	Oxidation factor (p)	Natural gas density (ρ) t/1000m³	Emission factor with oxidation factor (EF CO_2) kg/GJ
56-65%	74.867543%	35.88	0.995	0.6687	50.870474

SO_2 emission factors

SO_2 emissions factors were calculated by equation taken from EMEP/EEA 2013 and were calculated by national expert considering physical characterizations of types of fuels used in Latvia and national and international legislation. Percentage amount of sulphur content in used fuels is taken from national database "2-AIR" where polluters report the sulphur content data for certain types of fuels (Annex A.3.1).

Emission factors for SO_2 are calculated by using following equation:

$$2 \times \left(\frac{s}{100}\right) \times \frac{1}{Q} \times 10^6 \times \left(\frac{100-r}{100}\right) \times \left(\frac{100-n}{100}\right)$$

where:
EF – emission Factor (kg/TJ)
2 – SO_2 / S (kg/kg)
s – sulphur content in fuel (%)
r – retention of sulphur in ash (%)
Q – net calorific value (TJ/kt)
10^6 – (unit) conversion factor
n – efficiency of abatement technology and/or reduction efficiency (%)

Other emission factors

The default CH_4 and N_2O emission factors used in estimation of emission were taken from 2006 IPCC Guidelines, Volume 2, Chapter 2 *Stationary combustion*, Table 2.2.

Emission factors for NO_x, NMVOC and CO were taken from EMEP/EEA 2013, 1.A.1 Energy industries, Table 3-2 (coal, coke), Table 3-3 (peat, peat briquettes), Table 3-4 (natural gas, LPG, sludge gas), Table 3-5 (RFO), Table 3-6 (liquid fuels, including biodiesel). Emission factors used for 2015 Submission are listed in Table 3.20 below.

Table 3.20 CH_4, N_2O, NOx, CO, NMVOC emission factors used in CRF 1.A.1. Energy Industries (kt/PJ)

	CH_4	N_2O	NO_x	NMVOC	CO
Diesel oil	0.003	0.0006	0.065	0.0008	0.0162
RFO	0.003	0.0006	0.142	0.0023	0.0151
LPG	0.001	0.0001	0.089	0.0026	0.039
Jet fuel	0.003	0.0006	0.065	0.0008	0.0162
Other kerosene	0.003	0.0006	0.065	0.0008	0.0162
Other liquid	0.003	0.0006	0.065	0.0008	0.0162
Shale oil	0.003	0.0006	0.065	0.0008	0.0162
Coal	0.001	0.0015	0.209	0.001	0.0087
Coke	0.001	0.0015	0.209	0.001	0.0087
Peat briquettes	0.001	0.0015	0.247	0.0014	0.0087
Peat	0.001	0.0015	0.247	0.0014	0.0087
Natural gas	0.001	0.0001	0.089	0.0026	0.039
Wood	0.030	0.0040	0.081	0.00731	0.09
CH_4 from sludge gas	0.001	0.0001	0.089	0.0026	0.039
Landfill gas	0.001	0.0001	0.089	0.0026	0.039
Other biogas	0.001	0.0001	0.089	0.0026	0.039
Biodiesel	0.003	0.0006	0.065	0.0008	0.0162
Straws	0.030	0.0040	0.081	0.00731	0.09
Waste oils	0.030	0.0040	0.065	0.0008	0.0162

Activity data

Mainly emissions from fuel combustion are calculated using fuel consumption data from the national Energy Balance, prepared by CSB. In previous submissions the Annual Questionnaires sent to EUROSTAT were used, but after an internal third party review in 2014 an expert's conclusion was to use Energy Balance, if possible, to ensure more precise data. As in the EUROSTAT tables fuel consumption mainly is in natural units (kt, millions m^3) therefore net calorific values provided by CSB were used to calculate fuel consumption into terajoules. However, there were differences between Annual Questionnaires' and Energy Balance data due to rounding and conversion of units therefore it was decided to use Energy Balance data with accuracy up to 1 TJ (instead of Annual Questionnaire accuracy 1 kt). Data on fuel consumption in CRF 1.A.1 sector are presented in Annex A.3.1 , Table 1.

The CSB data collection system is based on detailed compulsory survey 2-EK (annual). Form 2-EK "Survey on acquisition and consumption of energy resources" is collected from about 6000 enterprises and organizations (with all kind of economic activity) that are included in the lists of suppliers of statistical information.

Approximately 6000 respondents were surveyed - all enterprises of the local and public administration employing 10 or more persons, other enterprises employing 80 and more persons, as well as enterprises with turnovers equal or more than 4 mln euro, and other enterprises that CSB considers to be significant enough to include in the energy balance, for example, with large imports of briquettes, coal and oil products. Enterprises and organizations that are not included in the above mentioned selection were surveyed by the random sampling and afterwards the acquired results were extrapolated. 2–EK represents the basic tool for creating energy balances at a country level.

The amounts of methane from landfill gas combusted are taken from Waste expert, therefore are consistent with numbers of recovered amounts of landfill gas in Waste sector. The amounts of methane from sludge gas combusted are consistent with numbers of gas, recovered from Wastewater handling sector.

In Figure 3.15 there can be seen fuel consumption by fuel types in 1990-2014 in Energy Industries sector. The largest amounts of fuel types consumed are gaseous fuels in the whole time series and liquid fuels in the beginning of 1990s. The amounts of biomass consumed are slightly increasing, while the consumption of solid fuels and peat has sharply decreased.

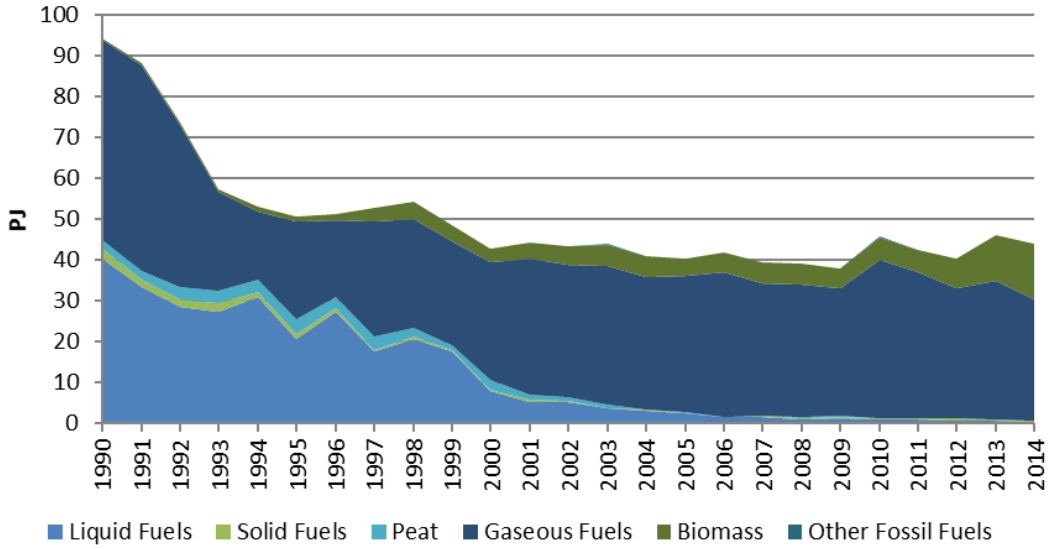

Figure 3.15 Fuel consumption in Energy Industries (CRF 1.A.1) for 1990-2014 (PJ)

The biggest decrease in time period 1990–2014 for the two sub-sectors of 1.A.1 Energy industries sector was for liquid fuel due to significant decrease of fuel consumption in 1.A.1.a subsector by 99.9%. It is explained with fuel switching processes when liquid fuels were switched to cheaper fuels. Also a stronger legislation contributed fuel switch to the type of fuels with lower level of emissions. It also explains why consumption of solid fuels decreased. However, in 2007-2013 the consumption of solid fuels increased that is explained with the increase of coal consumption in CRF 1.A.1.a subsector by 304% in 2006-2013. The increase of solid fuel consumption was promoted by increase of oil price in world when coal combustion became cheaper than combustion of residual fuel oil, diesel oil and natural gas. However, in 2013-2014 the consumption of coal in CRF 1.A.1.a reduced by 58.7%.

Consumption of biomass fuel has almost 30-fold increase in 1990–2014. Solid biomass is a local fuel and has lower costs therefore liquid and solid fuels were replaced with biomass and natural gas.

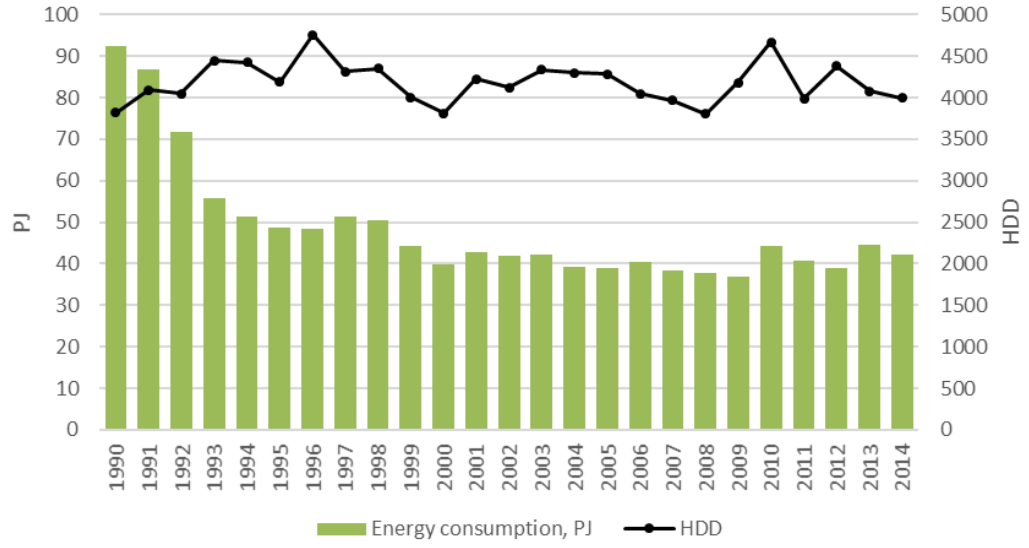

Figure 3.16 Fuel consumption in Main activity electricity and heat production (CRF 1.A.1.a) and heating degree days in Latvia

As it can be seen in Figure 3.16 the fuel consumption in 1.A.1.a sector can be related with the heating degree days with an exception of 1990s when Soviet Union collapsed and reorganizations took place in Latvia. However, for time period from 1997 to 2002 there can be seen that in years where energy consumption reduced, the HDD were also reduced. Years 2006-2008 had quite high average temperature therefore the fuel consumption of combined heat plants and heat plants for heat production decreased as there was limited need for heat production. In 2009-2010 the average temperature was lower and the use of fuel consumption increased. However, in year 2011 the fuel consumption decreased because of a relatively warm winter, and in year 2012 the consumption of fuel continued to decrease despite the fall of average temperature (hence the decrease in HDDs), which could be explained with better heat insulation in houses therefore less heat needed to be produced. In 2013 the fuel consumption increased, however, HDD were less than in 2012, while in 2014 it decreased, although the number of HDDs decreased.

3.2.4.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty in activity data of fuel combustion in 1.A.1 sector is ±2% in 2014. CSB gives approximately 2% statistical sample error for statistical data. According to CSB, as data are obtained using information given by respondents, this number is a variation coefficient which characterizes selection of respondents. Total variation coefficient for energy balance is within 2-3%. In Latvia all fossil fuels (oil, natural gas and coal) are imported and import and export statistics are fairly accurate.

Uncertainty of activity data for solid biomass combustion was assigned as 5% because biomass activity data were collected by CSB with questionnaires sent by enterprises consumed biomass. Also, according to 2006 IPCC Guidelines, Volume 2, Chapter 1, pg. 1.19, biomass data are generally more uncertain than other data in national energy statistics, because a large fraction of the biomass may be part of the informal economy, and the trade in these types of fuels is frequently not registered in the national energy statistics and balances. That was a reason for higher uncertainty for biomass than for other fuel types. Uncertainty of sludge gas stationary combusted in enterprises covered by 1.A.1 Energy Industries sector was assumed rather low – 2% because the combusted fuel amount is obtained directly from wastewater treatment plant that has precise measurement equipment for accounting of combusted fuel. Still the methane percentage amount in combusted sludge gas is given approximately, therefore final uncertainty of combusted sludge gas is assumed as 5%. The same applies to landfill gas.

CO_2 emission factor was estimated according physical characterization of used fuels in country basing on average NCV reported by fuel consumers and carbon content, hence the uncertainty for liquid fuels was assigned as quite low – about 10%. As emission factors for solid fuels were taken from 2006 IPCC Guidelines, the uncertainty was assumed 20%. Emission factor uncertainty for peat and peat briquettes was assumed 10% because peat emission factor is country specific. CO_2 emission factor for natural gas was assumed rather low – as 5% because annual plant specific fuel data is used to estimate emission factor.

CH_4 and N_2O emission factors used in estimation of emissions were taken according to 2006 IPCC Guidelines, Volume 2, Chapter 2 *Stationary combustion*, Table 2.12., which provides the range of default values for uncertainties. The uncertainty both for CH_4 and N_2O EFs of 50% was assigned similarly as in previous submissions – 50%.

Time series of the estimated emissions are consistent and complete because the same methodology, emission factors and data sources are used for sectors for all years in time series. Emissions from all sectors are estimated or reported as not occurring / not applicable, therefore there are no "not estimated" sectors.

3.2.4.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the Energy sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

All documentation and information received for inventory purposes are archived in FTP folder. All findings are documented by using check-lists, available on Regulations of the Cabinet of Ministers No. 217 adopted on 27 March 2012 "The National Inventory System of Greenhouse Gas Emission Units".

Activity data verification

All sources of energy data are presented in the corresponding NIR chapter (3.2.4.2 Methodological issues) as well as disaggregated data at the finest level possible are presented in the corresponding Annex A.3.1. Data completeness has been explained in the previous subchapter.

Activity data have been checked at the data provider – Central Statistical Bureau, which has its own internal QA/QC procedures based on mathematic model and analysis to avoid logic mistakes. When activity data have been received, the sectoral expert responsible for the emission estimation and reporting are comparing all data changes with the previous inventory, and all changes are explained in the corresponding subchapter. All fluctuations or changes in NCVs are double checked and agreed with CSB.

All activity data used in Sectoral Approach are also compared with activity data used in Reference Approach estimations. All significant differences (±5%) are explained in the corresponding subchapter.

Emission factor verification

For country-specific CO_2 emission factors, the sources of the calorific values, carbon content and oxidation factors, as well as these values are provided in 3.2.4.2 Methodological issues.

Country specific CO_2 values for year are compared with default ones available on 2006 IPCC Guidelines, Volume 2, Chapter 2 *Stationary combustion*, Table 2.2. Whether country specific CO_2 emission factor is or is not in the confidence interval can be seen in Table 3.21.

Table 3.21 Comparison of country specific and 2006 IPCC default CO_2 emission factor values (kt/PJ)

	Lower	CS	Upper	EU ETS
Gasoline	67.50	71.18	73.00	
Diesel oil	72.60	74.00	74.80	74.75

	Lower	CS	Upper	EU ETS
RFO	75.50	76.59	78.80	77.36
LPG	61.60	62.44	65.60	62.75
Jet fuel	69.70	71.51	74.40	
Other kerosene	70.80	71.50	73.70	
Other liquid	72.20	72.59	74.40	
Shale oil	67.80	76.35	79.20	74.75
Peat	100.00	103.87	108.00	105.99
Natural gas	54.30	54.26	58.30	55.44
Wood	95.00	107.78	132.00	
Sludge gas	46.20	50.87	66.00	
Landfill gas	46.20	50.87	66.00	
Other biogas	46.20	50.87	66.00	

Only natural gas country specific CO_2 emission factor is outside of confidence interval given by 2006 IPCC Guidelines. Main reasons are different carbon content in fuel, as well as different NCVs.

Emission verification:

To verify the CO_2 emissions, logical mistakes are checked by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogical changes in the activity data and emissions. The emissions for indirect GHGs in the database are cross-checked with emissions reported within Convention on Long-range Transboundary Air Pollution (CLRTAP) for verification purposes.

CO_2 emissions are compared with emissions in Reference Approach estimations, and all significant differences (±5%) are explained in the corresponding subchapter.

3.2.4.5 Category-specific recalculations

Recalculations have been done in CRF 1.A.1.a sector due to activity data corrections, therefore GHG emissions as well as indirect GHGs are recalculated. Regarding indirect GHGs, the EFs for NOx in 1A1a sector have been revised. For SO_2 EFs have been revised in every stationary combustion sector.

3.2.4.6 Category-specific planned improvements

It is planned to update CO_2 EFs for most widely used fuels in Latvia, update data for offroad installations (detailed fuel use, facilities) and estimate life cycle of lubricants and used oils.

3.2.5 Manufacturing Industries and Construction (CRF 1.A.2)

3.2.5.1 Category description

CRF 1.A.2 Manufacturing industries and construction sector includes emissions from fuel combustion in combustion installations for industrial production including emissions from off–road. CRF 1.A.2 sector also includes the emissions from on-site use of fuel in the industrial production facilities (autoproducers) – these emissions are reported under particular sub-sectors of CRF 1.A.2 according to 2006 IPCC Guidelines.

According to 2006 IPCC Guidelines, Volume 2, Chapter 2 *Stationary combustion*, Table 2.1., emissions arising from off-road and other mobile machinery in industry should be broken

out as a separate subcategory. These emissions are calculated together from all gasoline use in particular subsectors (Chemicals, Wood and wood products, Construction) within CRF 1.A.2. It also ensures the consistency between CLRTAP and UNFCCC data.

In Submission 2016, the CRF subsector CRF 1.A.2 Manufacturing industries was split into subsectors which are in line with 2006 IPCC Guidelines/CRF Reporter structure:

- 1.A.2.a Iron and steel;
- 1.A.2.b Non-ferrous metals;
- 1.A.2.c Chemicals;
- 1.A.2.d Pulp, paper and print;
- 1.A.2.e Food processing, beverages and tobacco;
- 1.A.2.f Non-metallic minerals;
- 1.A.2.g Other:
    - 1.A.2.g.i Manufacturing of machinery;
    - 1.A.2.g.ii Manufacturing of transport equipment;
    - 1.A.2.g.iii Mining (excluding fuels) and quarrying;
    - 1.A.2.g.iv Wood and wood products;
    - 1.A.2.g.v Construction;
    - 1.A.2.g.vi Textile and leather;
    - 1.A.2.g.vii Off-road vehicles and other machinery;
    - 1.A.2.g.viii Other.

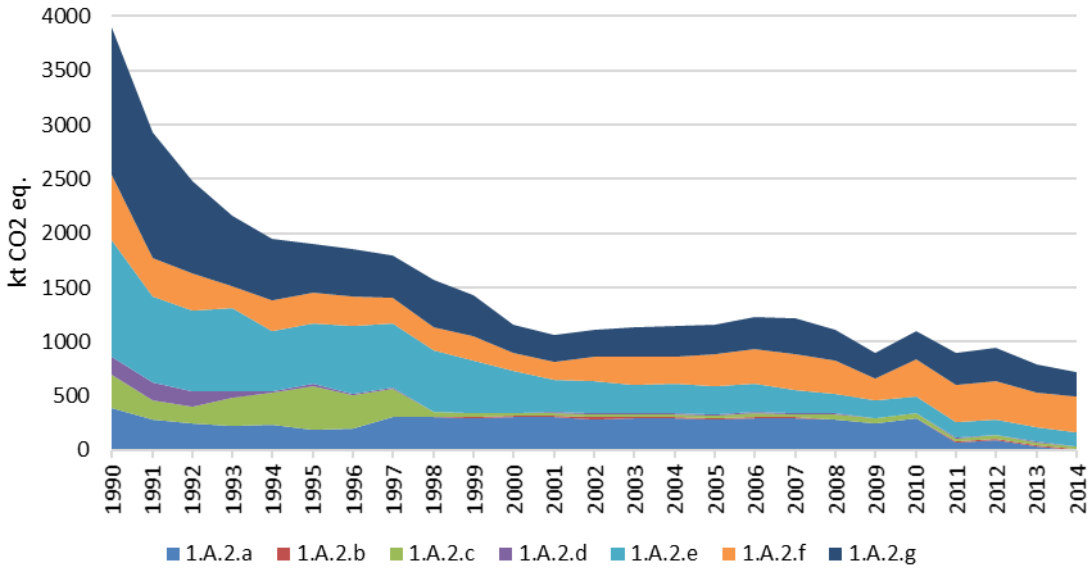

Figure 3.17 GHG emissions in CRF 1.A.2. Manufacturing industries and Construction by subsectors (kt CO_2 eq.)

In Figure 3.17, there can be seen the distribution of GHG emissions in CRF 1.A.2 sector. The largest part of emissions contributes to CRF 1.A.2.f Non-metallic minerals (45.1% in 2014) and CRF 1.A.2.g Other (32.1%), where emissions from Machinery, Transport equipment, Mining and quarrying, Wood processing, Construction, Textiles, Offroads and Other products are produced. In CRF 1.A.2.e Food processing, beverages and tobacco 17.4% of 1.A.2 GHG emissions are produced in 2014. Such sectors as CRF 1.A.2.a Iron and Steel, 1.A.2.b Non-

ferrous metals, 1.A.2.c Chemicals. 1.A.2.d Pulp, Paper and Print contributes to 0.1%, 0.5%, 4.0% and 0.8% from total 1.A.2 GHG emissions in 2014, accordingly.

Table 3.22 Emissions from Manufacturing industries and construction (CRF 1.A.2) in 1990–2014 (kt)

	CO_2	CH_4	N_2O	Aggregate GHGs (CO_2, CH_4, N_2O)	NO_x	CO	NMVOC	SO_2
	kt			kt CO_2 eq.	kt			
1990	3883.95	0.22	0.029	3898.20	17.58	19.16	3.14	24.33
1991	2924.64	0.12	0.019	2933.12	12.29	6.86	1.68	15.12
1992	2478.06	0.11	0.016	2485.61	10.47	6.61	1.51	13.96
1993	2148.02	0.13	0.021	2157.70	10.03	7.68	1.76	14.44
1994	1940.32	0.13	0.022	1950.07	9.59	6.12	1.62	15.67
1995	1892.17	0.14	0.022	1902.04	9.61	4.12	1.50	15.08
1996	1848.94	0.15	0.022	1859.31	9.35	5.63	1.71	14.68
1997	1789.75	0.15	0.022	1800.03	9.15	4.79	1.63	14.25
1998	1561.37	0.15	0.022	1571.73	7.65	4.80	1.68	11.02
1999	1413.35	0.14	0.021	1423.25	6.83	3.96	1.57	9.10
2000	1149.59	0.12	0.017	1157.74	4.87	3.29	1.36	4.70
2001	1050.07	0.16	0.022	1060.62	3.77	3.83	1.71	2.55
2002	1099.67	0.16	0.022	1110.08	3.62	3.99	1.66	2.07
2003	1118.65	0.15	0.020	1128.28	3.69	3.54	1.58	1.86
2004	1132.09	0.19	0.026	1144.48	3.73	5.05	2.08	1.42
2005	1138.69	0.22	0.031	1153.40	3.49	6.16	2.35	1.56
2006	1210.08	0.24	0.033	1225.76	3.92	7.09	2.65	1.79
2007	1205.25	0.20	0.029	1219.05	3.77	7.00	2.36	1.72
2008	1098.86	0.22	0.031	1113.56	3.39	7.18	2.44	1.38
2009	872.78	0.29	0.040	891.83	3.04	6.86	3.02	1.05
2010	1070.40	0.35	0.049	1093.75	3.20	7.12	3.36	0.99
2011	869.96	0.41	0.058	897.55	2.74	7.81	3.69	0.81
2012	914.14	0.47	0.066	945.51	3.06	8.89	4.24	0.94
2013	755.52	0.49	0.067	787.65	2.88	9.00	4.36	0.83
2014	685.67	0.55	0.075	721.97	2.82	10.03	4.89	0.89
Share of Energy total, 2014	10.5%	4.4%	20.4%	10.4%	9.5%	7.9%	22.6%	22.4%
2014 versus 2013	-9.2%	13.3%	12.8%	-8.3%	-2.2%	11.4%	12.0%	7.6%
2014 versus 1990	-82.3%	152.3%	156.2%	-81.5%	-84.0%	-47.7%	55.8%	-96.3%

Emissions from CRF 1.A.2 significantly decreased in 1990 to 2001, which can be explained with recession of Soviet Union and following reformations and reorganizations within Latvia after that. Since 2001, the emissions started to increase until 2006, because of development in national economy and industry, as well as growing demand of industrial production and increasing welfare of inhabitants (Table 3.22). Growth in GHG emissions in the given time period were caused by increased amounts of coal and natural gas consumed. Decrease of emissions in 2006-2008 were influenced by the features of national economy development when in-country industrial production already started to diminish due to increasing costs of the production and dominance of imported products. Crisis in national economy in the second part of 2008 also caused a significant decrease in total emissions. The increasing amounts of solid biomass consumption also caused a drop in CO_2 emissions. The crisis in national economy caused by global financial crisis in 2008-2009 influenced quite significant decrease of GHG emissions by 20%. The crisis and development of EU ETS influenced

biomass consumption for 2008-2009 in 1.A.2 sector – its amounts were growing, while amounts of almost all other fuels decreased. In 2010-2014 the emissions are fluctuating mainly due to reconstructions in 2011-2012 in the largest steel producer "Liepājas Metalurgs". As it replaced its furnace to electric one, the emissions decreased, however, in 2013 due to several reasons it initiated bankruptcy, therefore the amounts of production decreased significantly afterwards.

Due to the essential increase of biomass consumption non-CO_2 emissions increased in 2009-2014: CH_4 emissions increased by 93%, while N_2O emissions increased by 89%.

Also indirect GHG emissions from CRF 1.A.2 sector were estimated. In this sector almost all indirect emissions have decreased: NOx emissions have decreased by 84.0%, CO emissions – by 47.7%, and SO_2 emissions have a decrease by 96.3% in 1990–2014. The decrease in emissions is explained with fuel switching to natural gas and biomass from what sulphur dioxide emissions are not emitted, and there are less NOx and CO emissions from these fuels comparing with solid and liquid fuels. However, NMVOC emissions have an increasing trend and have increased by 55.8% since 1990 due to very high emission factors for biomass compared to other fuels.

3.2.5.2 Methodological issues

Methods

2006 IPCC Guidelines' Tier 2 method was used to estimate CO_2 emissions from fuel combustion as country specific parameters were used to estimate CO_2 emission factor. However, for some fuels there are no country-specific emission factors, therefore 2006 IPCC Tier 1 method using default emission factors was used. 2006 IPCC Guidelines' Tier 1 method was used to calculate CH_4 and N_2O emissions from the CRF 1.A.2 sector.

Calculation of all emissions from fuel combustion is done with Excel databases developed by the experts from LEGMC.

The general method for emission data preparation was used:

$$Em = EF \times B_q$$

where:
Em – total emissions (kt)
EF – estimated or default emission factor (t/TJ)
B_q – amount of fuel in thermal units (TJ)

Emission factors and other parameters

The main sources for emission factors are:

- National studies for country specific parameters and emission factors;
- Data from only natural gas supplier company of natural gas physical characteristics;
- EU ETS reports (for used tires and municipal waste);
- IPCC 2006 Guidelines;
- EMEP/EEA 2013.

Country specific emission factors were used to calculate carbon dioxide (CO_2) and sulphur dioxide (SO_2) emissions.

CO_2 emission factors

CO_2 emission factors for CRF 1.A.2 Manufacturing Industries and Construction sector are estimated with the same equations and using the same method as for CRF 1.A.1 Energy industries sector with the exception for industrial waste and municipal waste that are not combusted in CRF 1.A.1 sector.

For some fuels default CO_2 emission factors from 2006 IPCC Guidelines, Volume 2, Chapter 2 *Stationary combustion*, Table 2.3, were taken due to unavailability of country specific data:

- other liquid fuels – 73.3 kt/PJ;
- coal – 94.6 kt/PJ;
- coke – 107 kt/PJ;
- anthracite – 98.3 kt/PJ;
- oil shale – 107 kt/PJ;
- petroleum coke – 97.5 kt/PJ
- peat briquettes – 97.5 kt/PJ;
- biodiesel – 70.8 kt/PJ;
- straws – 100 kt/PJ;
- waste oils – 73.3 kt/PJ.

Municipal waste

CO_2 emission factors of municipal waste combusted in cement production plants are taken from plant's annual GHG report within EU ETS for 2008-2014. This CO_2 emission factors are estimated at the plant by using plant specific data about combustion installation as well as net calorific value and carbon content measured and obtained in the plant laboratory. 2006 IPCC Guidelines state to separate non-biomass and biomass parts of the municipal waste. It has been done in Submission 2016 as follows: CO_2 emissions to be reported to EU ETS have been taken from 2008-2014 for non-biomass part, because for EU ETS only non-biomass CO_2 emissions have to be reported. The emission factors given in the reports are for whole emissions and it is possible to calculate the emission factor for non-biomass fraction. The emission factors for total CO_2 emissions and for non-biomass fraction are provided in Table 3.23.

Table 3.23 CO_2 emission factors, carbon content and NCV for municipal waste by waste types (kt/PJ)

	2008	2009	2010	2011	2012	2013	2014
	Total CO_2 EF, kt/PJ						
Ecofuel 1	85.19	82.81					80.43
Ecofuel 2		120.95	82.69	113.22	95.24	85.98	88.517
	Fossil CO_2 EF, kt/PJ						
Ecofuel 1	44.16	43.03					38.524
Ecofuel 2		71.01	35.11	27.99	32.42	38.69	44.966
	C content, %						
Ecofuel 1	20.206	20.275					23.583
Ecofuel 2		33.009	22.567	30.9	25.993	23.465	24.158
	NCV, TJ/kt						
Ecofuel 1	22.779	23.514					19.352
Ecofuel 2		17.416	19.594	18.232	16.852	17.615	31.46
	Biomass content, %						

	2008	2009	2010	2011	2012	2013	2014
Ecofuel 1	48.16%	48.04%					55.42%
Ecofuel 2		58.70%	57.54%	75.28%	65.96%	41.33%	49.20%

For estimating biomass emissions the following equation was used:

$$E_{biomass} = E_{total} - E_{non-biomass}$$

where:
$E_{biomass}$ – CO_2 emissions from biomass fraction (kt)
E_{total} – total CO_2 emissions (kt)
$E_{non-biomass}$ - CO_2 emissions from biomass fraction (kt)

The calculated results for total CO_2 emissions from municipal waste, as well as from biomass and non-biomass fraction can be found in Table 3.24.

Table 3.24 CO_2 emissions from municipal waste non-biomass and biomass fractions by waste types in 2008-2014

	2008	2009	2010	2011	2012	2013	2014
	Fossil CO_2 emissions, Mg						
Ecofuel 1	6856	2284.5					77069
Ecofuel 2		304.63	26440	37606	54948	60808	2033.8
	Biomass CO_2 emissions, Mg						
Ecofuel 1	6369.7	2112.2					95801
Ecofuel 2		214.25	35835	114499	106458	74321	1969.8
	Total CO_2 emissions, Mg						
Ecofuel 1	13226	4396.7					172870
Ecofuel 2		518.88	62275	152105	161406	135129	4003.6

Industrial waste

Emission factors for CO_2 emission estimation for industrial waste – used tires, neutralised polluted soil, waste wood, fluffy tyre, wood processing residues and shredded rubber – combusted in CRF 1.A.2.f Non-metallic minerals (cement production) for years 1999–2014 are taken from GHG emission reports that plant submitted under ETS (Table 3.25). These CO_2 emission factors are estimated at the plant by using plant specific data about combustion installation as well as net calorific value and carbon content measured and obtained in the plant laboratory. Also for this fuel type biomass and non-biomass emissions have been calculated, as this fuel contains biomass.

Table 3.25 CO_2 emission factors, carbon content and NCV for industrial waste

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	Total CO_2 EF, kt/PJ															
Used tyres	79.44	79.44	79.44	79.44	79.44	79.44	79.44	79.44	79.44	85	85	85	85	85	85	85
NPS														79.43	80.602	85.034
Waste wood												117.6				
Fluffy tyres													81.13	81.13	87.01	
Wood processing residues													135.3	130.35		
Shredded															81.13	

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
rubber																
	Fossil CO_2 EF, kt/PJ															
Used tyres	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9
NPS														66.313	56.421	60.032
Waste wood												15.88				
Fluffy tyres													27.01	17.93	30.45	
Wood processing residues													37.58	41.47		
Shredded rubber															41.22	
	C content, %															
Used tyres	23.046	23.046	23.046	23.046	23.046	23.046	21.68	21.68	21.680	23.198	23.198	23.198	23.198	23.198	23.198	23.198
NPS														21.678	21.998	23.207
Waste wood												32.095				
Fluffy tyres													22.142	22.142	23.746	
Wood processing residues													36.926	35.575		
Shredded rubber															22.142	
	NCV (TJ/kt)															
Used tyres	26.21	26.21	26.21	26.21	26.21	26.21	26.21	26.21	26.21	26.21	26.21	26.21	26.21	26.21	26.21	26.21
NPS														14.3	14.999	16.232
Waste wood												13.182				
Fluffy tyres													28.500	42.937	28.961	
Wood processing residues													12.569	12.114		
Shredded rubber															31.315	
	Biomass content, %															
Used tyres	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%
NPS														17%	30%	29%
Waste wood												87%				
Fluffy tyres													67%	78%	65%	
Wood processing residues													72%	68%		
Shredded rubber															49%	

For estimating biomass emissions, the above mentioned equation for municipal waste was used.

Since 2005 the cement production plant is participating in EU Emission trading scheme therefore estimated CO_2 EF is verified by accredited verifiers and approved by Regional Environmental Board.

SO_2 emission factors

SO_2 emission factors for all fuels, except industrial and municipal waste, in CRF 1.A.2 Manufacturing Industries and Construction sector are estimated with the same equations and using the same method as for CRF 1.A.1 Energy industries sector.

For industrial and municipal waste SO_2 emission factors are taken from EMEP/EEA 2013, Chapter 5.C.1.b, Table 3-1 (0.0047 kg/Mg) and Chapter 5.C.1.a, Table 3-1 (0.087 kg/Mg).

Other emission factors

List of other emission factors can be seen in Table 3.26.

The default CH_4 and N_2O emission factors are taken from 2006 IPCC Guidelines, Volume 2, Chapter 2 *Stationary combustion*, Table 2.3. Gasoline emission factors are used for CH_4 and N_2O emission estimation from off-roads (2006 IPCC Guidelines, Volume 2, Chapter 3 *Mobile combustion*, Table 3.3.1.). As there is no information about distribution between 2-stroke and 4-stroke engines, it was assumed that 25% of consumed gasoline is combusted in 2-stroke engines, while 75% - in 4-stroke engines. Such assumption has been made, based on Danish data which are presented in EMEP/EEA 2013 for air pollutants' calculations.

NO_x, CO and NMVOC emission factors used in estimation of emission were taken from EMEP/EEA 2013, Chapter 1.A.2, Tables 3-2 to 3-5, with an exception of oil shale which has been taken from Estonian NIR 2015 as country specific. For industrial waste and municipal waste NO_x, CO and NMVOC emission factors are taken from EMEP/EEA 2013, Chapter 5.C.1.b, Table 3-1 and Chapter 5.C.1.a, Table 3-1 (Table 3.26).

Table 3.26 CH_4, N_2O, NOx, NMVOC, CO emission factors (kt/PJ[18])

		CH_4	N_2O	NO_x	NMVOC	CO
Gasoline	**2-stroke**	0.130	0.0004	2.765	242.197	620.793
	4-stroke	0.050	0.0020	7.117	17.602	770.368
Diesel oil		0.003	0.0006	0.513	0.030	0.070
RFO		0.003	0.0006	0.513	0.030	0.070
LPG		0.001	0.0001	0.074	0.023	0.029
Jet fuel		0.003	0.0006	0.513	0.030	0.070
Other kerosene		0.003	0.0006	0.513	0.030	0.070
Other liquid		0.003	0.0006	0.513	0.030	0.070
Petroleum coke		0.003	0.0006	0.513	0.030	0.070
Waste oils		0.030	0.0006	0.513	0.030	0.070
Shale oil		0.003	0.0006	0.513	0.030	0.070
Coal		0.000	0.0015	0.173	0.089	0.931
Coke		0.001	0.0015	0.173	0.089	0.931
Anthracite		0.001	0.0015	0.173	0.089	0.931
Oil shale		0.001	0.0015	0.110	0.050	0.087
Peat briquettes		0.001	0.0015	0.173	0.089	0.931
Peat		0.002	0.0015	0.173	0.089	0.931
Natural gas		0.001	0.0001	0.074	0.023	0.029
Wood		0.030	0.0040	0.091	0.300	0.570
Other biogas		0.001	0.0001	0.074	0.023	0.029
Biodiesel		0.003	0.0006	0.513	0.030	0.070
Industrial waste (used tires)		0.030	0.0040	0.870	7.400	0.070

[18] *For indirect GHGs for gasoline, industrial and municipal waste – kg/Mg*

	CH_4	N_2O	NO_x	NMVOC	CO
Municipal waste	0.030	0.0040	1.071	0.0059	0.041
Waste oils	0.030	0.0040	0.513	0.030	0.070

There is a different approach regarding CRF 1.A.2.f *Non-metallic minerals* subsector and corresponding subsector under IPPU (CRF 2.A.1 *Cement production*). Until 2010 indirect GHG emissions under CRF 2.A.1 sector were calculated using EMEP/CORINAIR 2007 and EMEP/EEA 2009 methodology, but afterwards these emissions were automatically detected at plant site, and measurements are taken in the main chimney. However, as these values are measured directly in the chimney, there is no way to allocate emissions under Energy and IPPU sectors separately (there are both emissions from fuel combustion and technological processes). Regarding calculation of indirect GHGs, to avoid double counting, the following fuel types (used tyres, ecofuel, coal, natural gas consumed in "Cemex") are subtracted from Energy part (from CRF 1.A.2.f subsector) and their emissions can be considered as included elsewhere (CRF 2.A.1 sector under IPPU) in case of "Cemex". However, as "Cemex" is not the only company under CRF 1.A.2.f subsector, fuel consumption and emissions appear from other enterprises. As for GHGs, these emissions are taken from EU ETS reports (CO_2) reported by "Cemex" or calculated (CH_4, N_2O), therefore can be allocated under appropriate sectors.

Activity data

Mainly emissions from fuel combustion are calculated using fuel consumption data from the national Energy Balance, prepared by CSB. The data collection system for CRF 1.A.2 sector is the same as for CRF 1.A.1 sector. Data on fuel consumption in 1.A.2 sector are presented in Annex A.3.1.

Autoproducers data prepared by CSP are taken into account into the calculation of the emissions from CRF 1.A.2 sector according to 2006 IPCC Guidelines.

Only gasoline combustion is reported as off-roads in CRF 1.A.4 sector, except for 1A4c where approximate amounts of diesel are consumed in offroad installations.

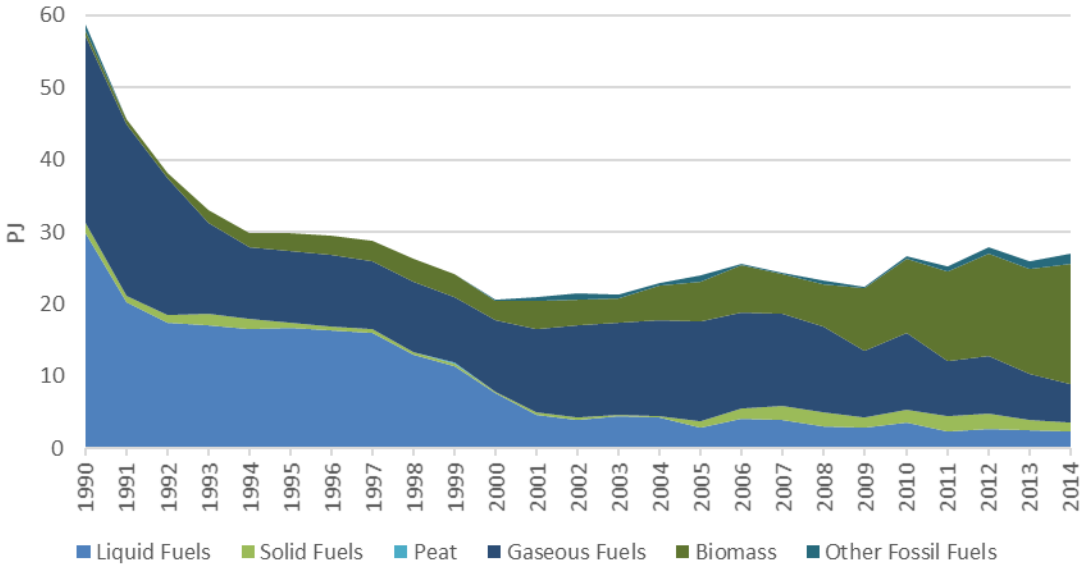

Figure 3.18 Fuel consumption in Manufacturing industries and construction (CRF 1.A.2) for 1990-2014 (PJ)

The most of fuel types with an exception of biomass and other fossil fuels have decreased in 1990-2014 (Figure 3.18). Liquid fuels have the biggest decrease in time period by 92%. It is explained with fuel switching processes when liquid fuels were replaced with other cheaper fuels. Also stronger legislation contributed fuel replacement to the type of fuels with lower level of emissions. Decrease of natural gas reflects the total decrease of industrial production if comparing with 1990.

The consumption of solid fuels (mainly coal) decreased in 1990-2004 with an exception of 1993-1994, mainly due to increased use of coal in Construction and Textiles and Leather sectors. Solid fuels consumption was growing rapidly by 7.5 times since 2004 until 2008 because of the growth in national economy, and decreased in 2009 by 32% due to global crisis. However, starting from 2009, the consumption of solid fuels grew by 58% until year 2012. The increase of solid fuel consumption was promoted by the increase of oil price overall the world when coal combustion was cheaper than combustion of residual fuel oil and diesel oil. The increase in Latvia is also explained with the development of mineral production sector – cement production – where coal is consumed. In 2012-2014 there can be seen a drop in solid fuel consumption – in Non-metallic minerals sector the consumption decreased by 34%, and in Iron and Steel sector by 100% because of bankruptcy of the largest steel producing company, which was mentioned in 3.2.5.2. Methodological issues.

After the crisis in the beginning of 1990s natural gas consumption steadily increased with some small exceptions due to fuel replacement processes and development of national economy.

Consumption of biomass fuel has increased very significantly – by 2.6 times in 1990–2014 with some fluctuations in 2000-2008. Lower costs of solid and liquid biomass, free and large availability of the fuel in-country as well as development of EU ETS were the main reasons for liquid and solid fuels' replacement with biomass and natural gas.

Consumption of used tires and municipal waste in Mineral production (information taken from „CEMEX", the only company which combusts used tires and municipal waste for energy purposes) reported as other fossil fuels had a 46-fold increase in 1999-2014, and continue to increase year by year. Comparing with 2010, the consumption of waste has increased by 2.1 times in 2014. The increase was influenced by intensified cement production that was caused by increased demand of construction materials and sharp development of construction sector. In other fossil fuels also used oils are reported, and the amounts of this fuel are fluctuating over years with a decreasing trend in recent years.

3.2.5.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty in activity data of fuel combustion in 1.A.2 sector is ±2% in 2014. CSB gives approximately 2% statistical sample error for statistical data. According to CSB, as data are obtained using information given by respondents, this number is a variation coefficient which characterizes selection of respondents. Total variation coefficient for energy balance is within 2-3%. In Latvia all fossil fuels (oil, natural gas and coal) are imported and import and export statistics are fairly accurate.

Uncertainty of activity data for solid biomass combustion was assigned as 5% because biomass activity data were collected by CSB with questionnaires sent by enterprises consumed biomass. Also, according to 2006 IPCC Guidelines, Volume 2, Chapter 1, pg. 1.19, biomass data are generally more uncertain than other data in national energy statistics, because a large fraction of the biomass may be part of the informal economy, and the trade in these type of fuels is frequently not registered in the national energy statistics and balances.

Uncertainty of other fuels consumption – municipal and industrial waste used in mineral production is assumed also low – 2% as the activity data is obtained from only one producer within EU ETS therefore the data is verified by accredited verifier and Regional Environmental Board.

CO_2 emission factor was estimated according physical characterization of used fuels in country basing on average NCV reported by fuel consumers and carbon content so uncertainty for liquid fuels was assigned as quite low about 10%. The same uncertainty level was assigned for peat. However, for combustion of solid fuels and other fossil fuels (waste oils) the uncertainty of CO_2 emission factor was assigned higher to 20% because CO_2 emission factor of anthracite, coal and coke was taken from 2006 IPCC Guidelines. CO_2 emission factor for natural gas was assumed rather low as 5% because plant specific fuel data is used to estimate emission factor.

CO_2 emission factors for industrial and municipal waste are assumed as 2% as were determined in accredited laboratory of cement production company.

CH_4 and N_2O emission factor used in estimation of emissions was taken according to 2006 IPCC Guidelines, Volume 2, Chapter 2 *Stationary combustion*, Table 2.12., which provides the range of default values for uncertainties. The uncertainty both for CH_4 and N_2O EFs was assigned as uncertainties used in previous submissions – 50%.

Time series of the estimated emissions are consistent and complete because the same methodology emission factors and data sources are used for sectors for all years in time series. Emissions from all sectors are estimated or reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.2.5.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the Energy sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

All documentation and information received for inventory purposes are archived in FTP folder. All findings are documented by using check-lists, available on Regulations of the Cabinet of Ministers No. 217 adopted on 27 March 2012 "The National Inventory System of Greenhouse Gas Emission Units".

Activity data verification

All sources of energy data are presented in the corresponding NIR chapter Methodological issues.

as well as disaggregated data at the finest level possible are presented in the corresponding Annex A.3.1. Data completeness has been explained in the previous subchapter.

Activity data have been checked at the data provider – Central Statistical Bureau, which has its own internal QA/QC procedures based on mathematic model and analysis to avoid logic mistakes. When activity data have been received, the sectoral expert responsible for the emission estimation and reporting are comparing all data changes with the previous inventory, and all changes are explained in the corresponding subchapter. All fluctuations or changes in NCVs are double checked and agreed with CSB.

All activity data used in Sectoral Approach are also compared with activity data used in Reference Approach estimations. All significant differences (±5%) are explained in the corresponding subchapter.

Emission factor verification

For country-specific CO_2 emission factors, the sources of the calorific values, carbon content and oxidation factors, as well as these values are provided in corresponding NIR chapter Methodological issues.

Country specific CO_2 values for year are compared with default ones available on 2006 IPCC Guidelines, Volume 2, Chapter 2 *Stationary combustion*, Table 2.2. Whether country specific CO_2 emission factor is or is not in the confidence interval can be seen in Table 3.27.

Table 3.27 Comparison of country specific and 2006 IPCC default CO_2 emission factor values (kt/PJ)

	Lower	CS	Upper	EU ETS
Gasoline	67.50	71.18	73.00	
Diesel oil	72.60	74.00	74.80	74.75
RFO	75.50	76.59	78.80	77.36
LPG	61.60	62.44	65.60	62.75
Jet fuel	69.70	71.51	74.40	
Other kerosene	70.80	71.50	73.70	
Other liquid	72.20	72.59	74.40	
Shale oil	67.80	76.35	79.20	74.75
Peat	100.00	103.87	108.00	105.99
Natural gas	54.30	54.26	58.30	55.44
Wood	95.00	107.78	132.00	
Sludge gas	46.20	50.87	66.00	
Landfill gas	46.20	50.87	66.00	
Other biogas	46.20	50.87	66.00	

Only natural gas country specific CO_2 emission factor is outside of confidence interval given by 2006 IPCC Guidelines. Main reasons are different carbon content in fuel, as well as different NCVs.

Emission verification:

To verify the CO_2 emissions, logical mistakes are checked by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogical changes in the activity data and emissions. The emissions for indirect GHGs in the database are cross-checked with emissions reported within CLRTAP for verification purposes.

CO_2 emissions are compared with emissions in Reference Approach estimations, and all significant differences (±5%) are explained in the corresponding subchapter.

3.2.5.5 Category-specific recalculations

Recalculations have been done in CRF 1.A.2.e, 1.A.2.f, 1.A.2.g sectors due to activity data corrections, therefore GHG emissions as well as indirect GHGs are recalculated. Regarding SO_2, EFs have been revised in every stationary combustion sector.

3.2.5.6 Category-specific planned improvements

It is planned to update CO_2 EFs for most widely used fuels in Latvia and estimate life cycle of lubricants and used oils.

3.2.6 Transport (CRF 1.A.3)

3.2.6.1 Category description

This section describes GHG emissions resulting from transport fuel combustion. In 2014, this source category was responsible for around 26.0% of total GHG emissions in Latvia, reaching 2952 kt (see Figure 3.19).

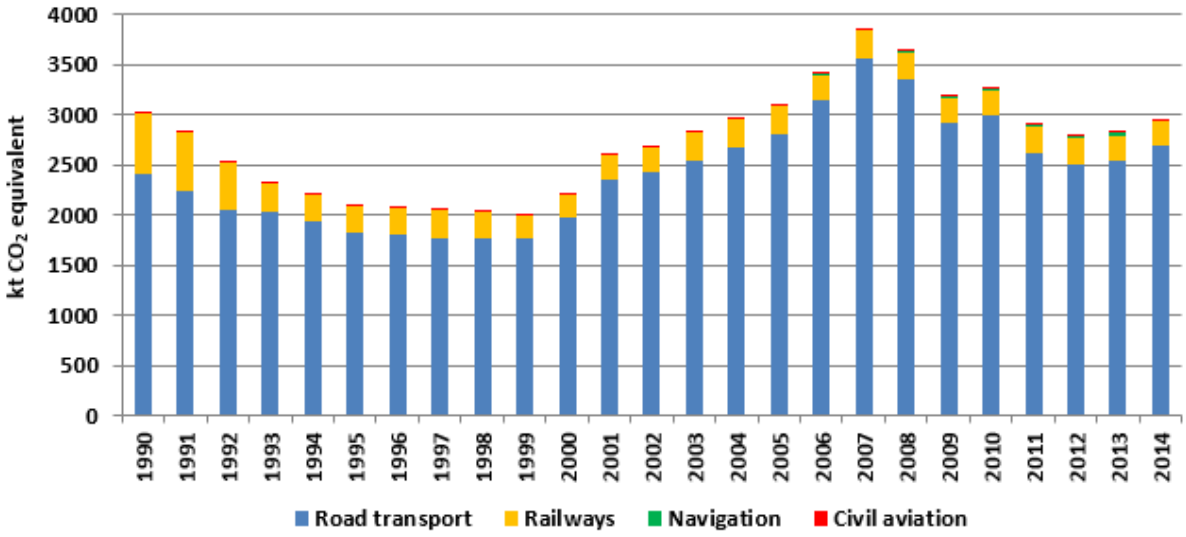

Figure 3.19 GHG emissions development in transport 1990 – 2014 (kt CO_2 eq.)

Emissions from Transport (CRF 1.A.3) include all domestic transport sectors: civil aviation, road transport, railways, domestic navigation and other mobile sources (which are not included in other sectors).

In 2014, total GHG emissions in the transport sector, compared to 1990 level, have decreased by 2.6%. The GHG emissions in 2014, compared to 2013, were by 4.3% higher.

The road transport constitutes a convincing majority of the total GHG emissions in the transport sector. In 2014, it gave around 91.3 % of total emissions but the next largest emission source is railway – 8.1 % (see Figure 3.20).

CO_2 emissions constitute nearly 97% of the total GHG emissions in the transport sector and they are key sources in road transport and railway as well (see Figure 3.21).

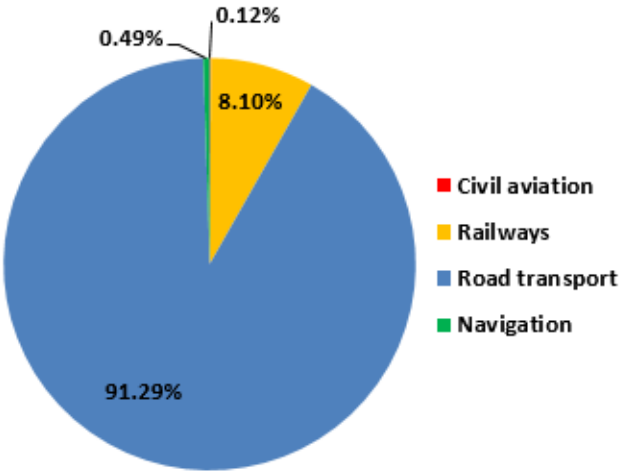

Figure 3.20 GHG emissions in transport by sub-sectors in 2014

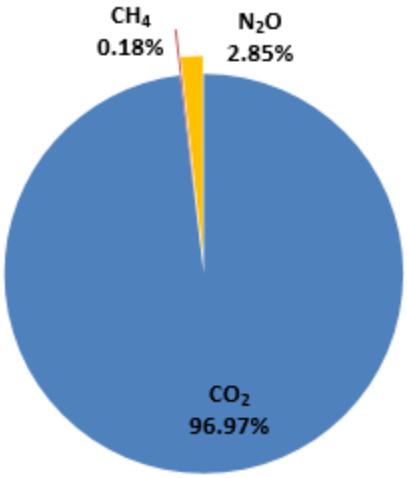

Figure 3.21 GHG emissions in transport sector by gases in 2014

One of the critical factors influencing CO_2 emission is the amount and type of the consumed fuel. In 2014, total fuel consumption in the transport sector, compared to 2013 level, has increased by 5.3 %. In different subsectors various changes have taken place in 2014. In domestic civil aviation the fuel consumption has not changed, whereas in the railway transport it has decreased by 3.0 %. In the road transport the fuel consumption has increased by around 5.9 %, but in domestic navigation it has decreased approximately 2 times.

In total, road transport consumes about 92%, railway – about 7.3% and domestic civil aviation and domestic navigation – the remaining share of fuel.

Diesel oil is the major fuel type in the transport sector and it constitutes 69.9 %, and is followed by gasoline – 21.2 %, but LPG constitutes 6.5% and biofuels (biodiesel and bioethanol) 2.3 % of the total fuel consumption in the transport sector (see Figure 3.22). The share of biofuels has increased from 2.0 % in 2013 up to 2.3% in 2014. Biofuel includes biodiesel and bioethanol and it mainly is used in road transport but small portion is

consumed in railway as well. LPG consumption has increased by 11.7% in 2014 compared to 2013.

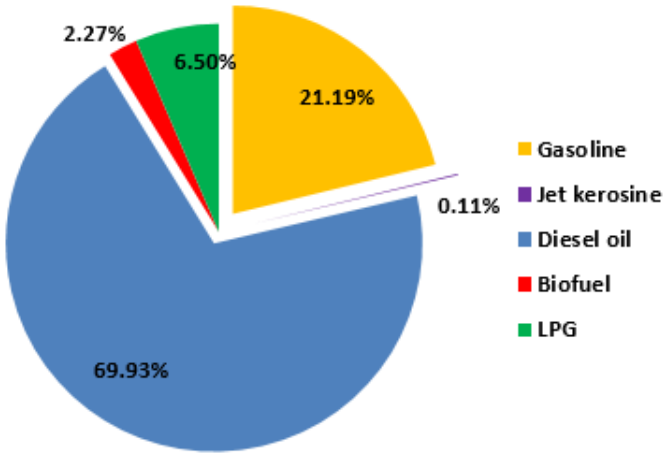

Figure 3.22 Fuel consumption in transport by fuel type (2014)

3.2.6.1.1 Civil aviation (CRF 1.A.3.a)

In Latvia, civil aviation, excluding international flights, is really narrow. Therefore the fuel consumption and thus also the volume of GHG emissions is comparably small, constituting mere 0.12% of GHG emissions from transport sector in year 2014 (see Figure 3.20; Figure 3.23). In aviation emissions are calculated for aviation gasoline and jet kerosene. The aviation gasoline is mainly used by small-sized propeller planes but jet kerosene is used by airplanes with turbofan and turbo props engines.

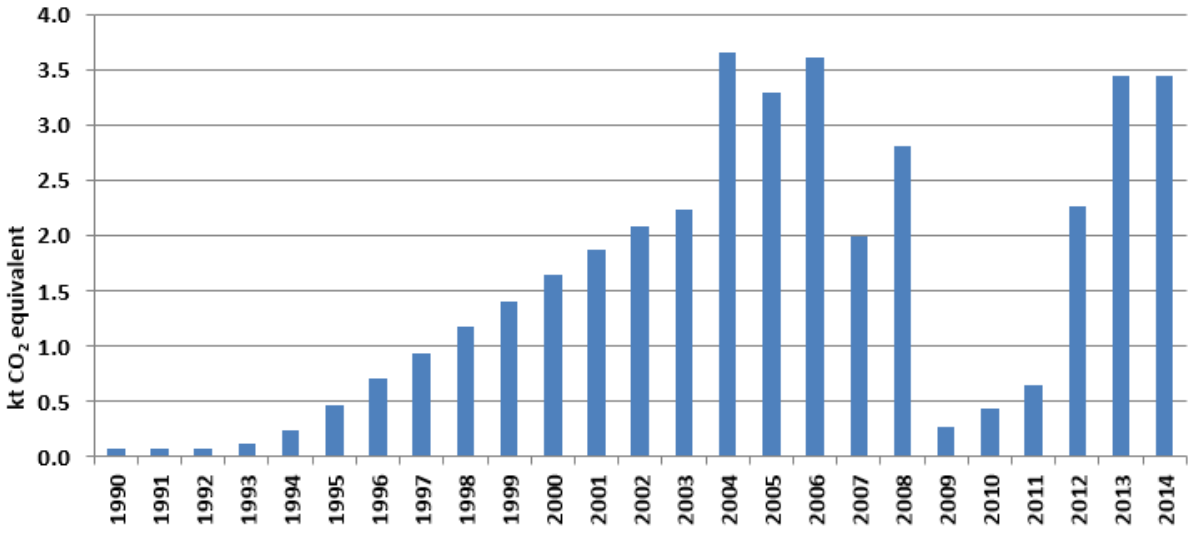

Figure 3.23 GHG emissions in civil aviation (kt CO_2 eq.)

In Latvia, there are four airports for commercial aviation, of which the largest is the Riga International Airport. Considering that local commercial flights are very dependent on the strategy of local state owned airline company; the number of flights, fuel consumption and emission amount are quite unsteady over the years. As it can be seen, after the state owned (99.8% of shares) local airline company had aborted domestic commercial flights in year

2009, fuel consumption had decreased dramatically in 2009. Today the main activities in civil aviation relates with private flights. Economic recovery starting in Latvia in 2011 has fostered activity and fuel consumption in civil aviation. The results from the carried out additional analyses indicate no evidence of any certain trend in gasoline and jet fuel consumption.

Methods

When calculating emissions from civil aviation, two approaches have been applied. 2006 IPCC Guidelines Tier 1 method has been applied when estimating emissions from aviation gasoline for all gases. When calculating emissions from jet kerosene Latvia uses Tier 1 to estimate emissions of CO_2 and SO_2, and Tier 2 to estimate CH_4, N_2O and all other gases. Using Tier 2 approach, emissions for LTO (landing/take off) and cruise are calculated individually. Separate emission factors are provided for LTO and Cruise activities. Prior to the emission calculation, representative aircraft type was chosen, for which the fuel consumption and emission data exist in the EMEP database (EMEP/EEA 2013).

1. Total Emissions = LTO Emissions + Cruise Emissions

*2. LTO Emissions = Number of LTOs * Emission Factor of LTOs*

*3. LTO Fuel Consumption = Number of LTOs * Fuel Consumption per LTO*

*4. Cruise Emissions = (Total Fuel Consumption – LTO Fuel Consumption) * EF Cruise*

The summary of the latest key category assessment, methods and EF used is presented in Table 3.28.

Table 3.28 Summary of source category description, CRF 1.A.3.a

CRF	Gas	Method	EF	All sources estimated
1.A.3.a	CO_2	T1	D	Yes
	CH_4	T1,T2	D	Yes
	N_2O	T1, T2	D	Yes

T1 Tier 1; T2 Tier 2; D Default.

Activity data

The data about fuel consumption (see Table 3.29) in aviation is derived from the CSB. CSB has started to separate fuel consumption for domestic flights from total fuel consumption data in aviation as of year 2006. For the time period 1990 – 2005 the data for fuel consumption is used from the study ("Evaluation of fuel consumption for domestic aviation and navigation", FEI, 2004). For 2004 onwards, the air flight statistics is provided by the Riga and Liepaja airports.

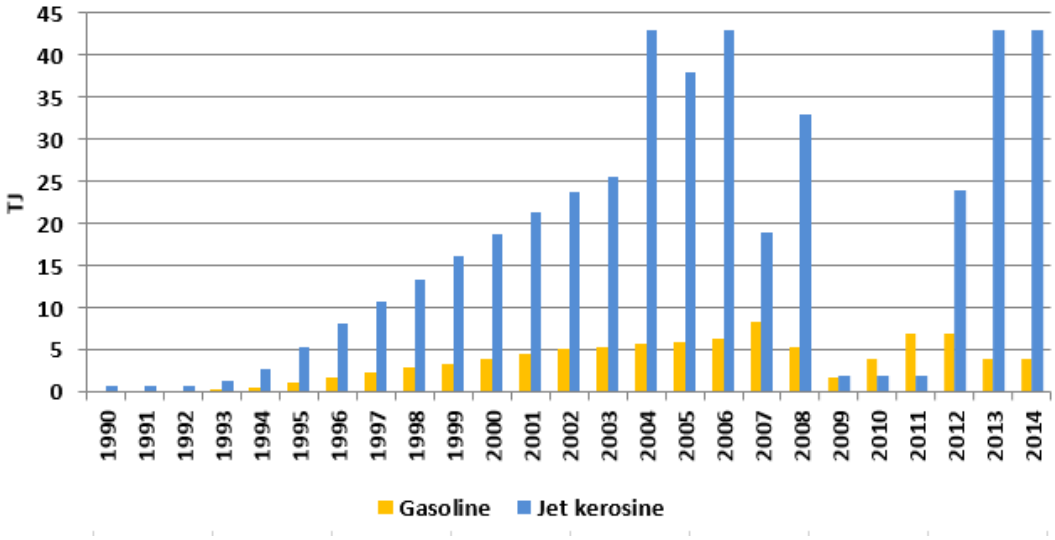

Figure 3.24 Fuel consumption in domestic civil aviation (TJ)

The variation in EFs is caused due to the application of 2 methods for emissions calculation for jet kerosene consumption in civil aviation: 1990-2003 with Tier 1 method; 2004-2014 with Tier 2 method. A reason for implementation of 2 methods is availability of necessary activity data (flight numbers) in time periods. To minimize a variation and to improve time series consistency, it is planned to make recalculation of emissions for time period 1990 – 2003 in the next inventory submission.

Table 3.29 Fuel consumption in domestic civil aviation (TJ)

	Jet kerosene	Gasoline
1990	0.8	0.2
1995	5.4	1.1
2000	18.8	4.0
2001	21.4	4.6
2002	23.7	5.1
2003	25.5	5.4
2004	43.0	5.7
2005	38.0	6.0
2006	43.0	6.4
2007	19.0	8.4
2008	33.0	5.4
2009	2.0	1.7
2010	2.0	4.0
2011	2.0	7.0
2012	24.0	7.0
2013	43.0	4.0
2014	43.0	4.0

Emission factors

Default EFs of LTO and cruise (jet kerosene) for civil aviation is used (2006 IPCC Guidelines and EMEP/EEA 2013).

Table 3.30 Emission factors used in the calculation of emissions from civil aviation (kt/PJ)

	CO_2	CH_4	N_2O	NOx	CO	NMVOC	SO_2
Aviation gasoline	70.0	0.0005	0.002	0.25	0.1	0.05	0.023

3.2.6.1.2 Road transport (CRF 1.A.3.b)

The road transport constituted 91.3 % of GHG emissions in the transport sector in 2014. After the rapid growth in the period 2000 – 2007 (see Figure 3.25), emissions in 2009 have sharply decreased. The main reason was a sharp decreasing of fuel consumption in the road transport in 2009. It decreased by 12.8 %, compared to 2008 level. The major reason for this tendency was recession of the national economy and decrease of transport activities – decrease of passenger km by passenger cars and ton km by freight transport. The road transport is widely used in the local transportation and also for providing cross-border transportation. The freight road transport approximately constitutes 41% (2014) of the total freight in the country (traffic of goods in ton-km). The share has decreased by around 1 % point, compared with year 2013. In the freight road transport the inland freight constitutes approximately 90% of gross – timber products, food products, household goods and building materials are dominant. Fuel consumption in road transport has increased by around 5.9 % in year 2014 compare with 2013. In different fuels various changes have taken place in 2014 compare with 2013. Gasoline consumption has decreased by 2%, whereas biofuel consumption has increased by 14 %, diesel fuel consumption has increased by 7.9% and LPG consumption by 11.7 % (see Figure 3.29).

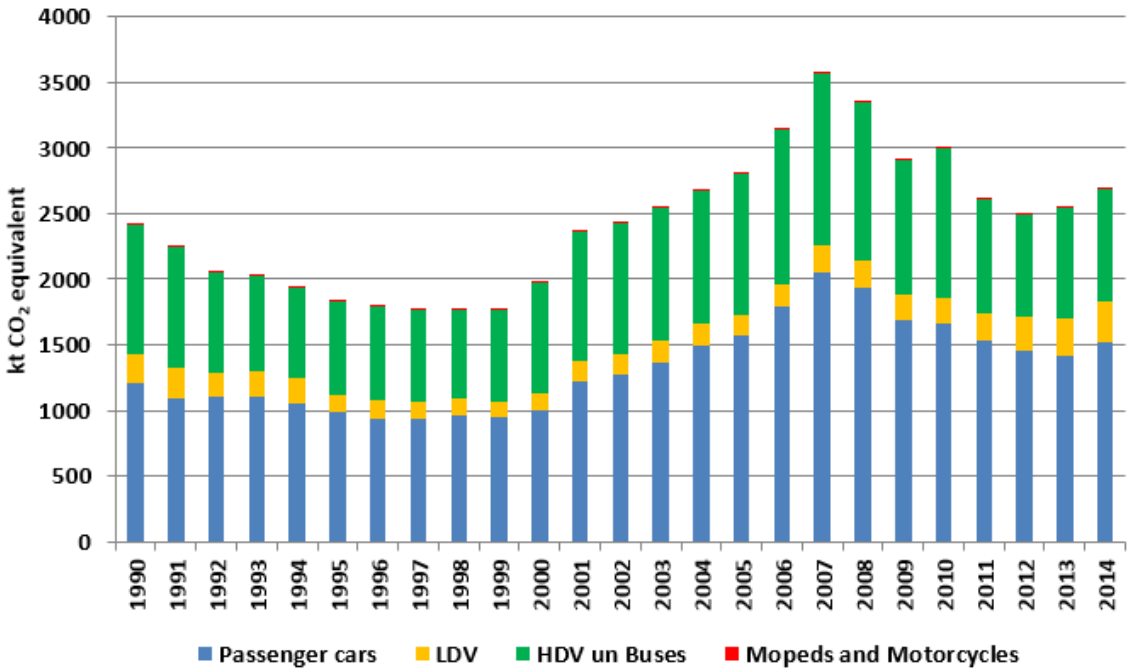

Figure 3.25 GHG emissions in road transport (kt CO_2 eq.)

Road transport includes five vehicle categories: Passenger cars, Buses, Heavy duty-vehicles (HDV), Light duty-vehicles (LDV) and Mopeds & Motorcycles. In time period 1990 – 2014, essential changes have taken place in the structure of GHG emissions created by the road

transport (see Table 3.31). Gasoline has been the most common fuel used for road transports up to year 2000, but in 2014 the amount of diesel used for road traffic is 2.9 times more as gasoline and the emissions of CO_2 from diesel surpassed the emissions of CO_2 from gasoline as from 2001.

In 2014, emissions from gasoline consumption created by passenger cars were less than that of 1990 level, while emissions created by diesel oil consumption in passenger cars have increased several times. The emissions of Light-duty vehicles (LDV) and heavy-duty vehicles (HDV) gasoline consumption have decreased, but the emissions of diesel oil fuel consumption have essentially increased at this time span.

Table 3.31 GHG emissions in road transport by vehicle types (kt CO_2 eq.)

	Passenger Cars		LDV		HDV	
	Gasoline	**Diesel**	**Gasoline**	**Diesel**	**Gasoline**	**Diesel**
1990	1155.05	43.06	164.22	54.69	432.27	525.09
1995	945.22	35.70	93.49	38.76	266.36	440.06
2000	863.56	119.35	48.07	77.53	144.82	659.84
2001	952.95	252.82	43.60	101.49	114.65	835.30
2002	957.50	285.19	37.08	116.94	94.85	879.41
2003	973.92	359.34	32.20	121.74	83.02	907.51
2004	1001.36	448.41	28.49	130.26	65.61	929.81
2005	992.50	520.69	24.24	129.76	54.83	1006.67
2006	1110.88	621.07	23.46	147.46	49.10	1116.17
2007	1225.32	767.45	22.38	179.56	43.15	1254.12
2008	1118.42	767.09	19.73	180.02	34.89	1161.83
2009	936.98	705.90	16.39	169.39	20.16	1002.51
2010	851.79	751.82	14.62	183.59	16.72	1113.99
2011	788.71	670.86	15.20	190.22	15.91	852.60
2012	665.92	681.98	17.02	235.77	13.22	760.11
2013	602.56	678.73	15.64	254.48	12.41	827.12
2014	590.45	774.49	15.12	283.45	11.35	843.14
Share of Energy total, 2014	8.5%	11.1%	0.2%	4.1%	0.2%	12.1%
2014 versus 2013	-2.0%	+14.1%	-3.3%	+11.4%	-8.5%	+1.9%
2014 versus 1990	-48.9%	+1698.6%	-90.8%	+418.3%	-97.4%	+60.6%

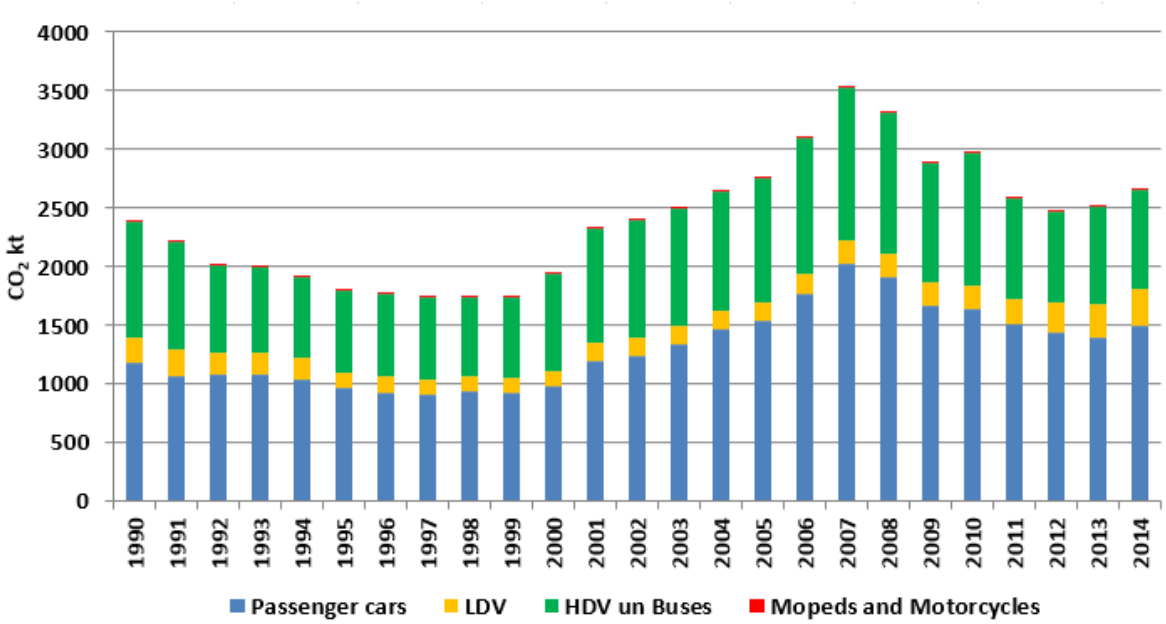

Figure 3.26 CO_2 emissions in road transport by vehicle types

CO_2 emissions are directly fuel-use dependent and, in this way, the development in the emissions reflects a trend in the fuel consumption. As shown in Figure 3.26, the most important emissions source for the road transport is passenger cars and HDV vehicles followed by LDV, buses and motorcycles. Share of CO_2 emissions from passenger cars was 57%, HDV and buses 32% and LDV 11% in year 2014. In 2014, CO_2 emissions in road transport, compared to 2013 level have increased by 5.7 %.

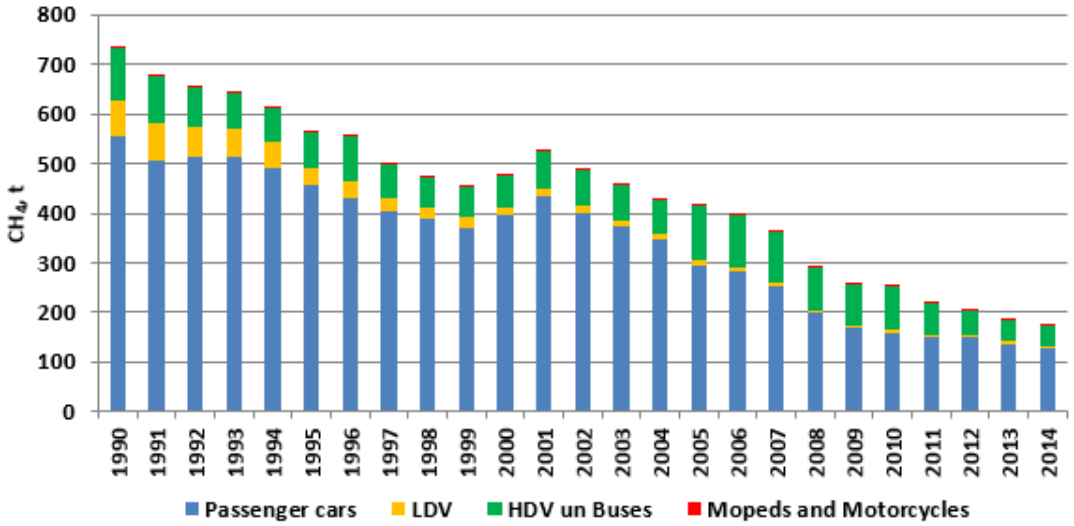

Figure 3.27 CH_4 emissions in road transport by vehicle types

CH_4 emissions present consistent decrease trend within the whole period (see Figure 3.27). In 2014, CH_4 emissions in road transport, compared to 2013 level have decreased by 4.8 %. The majority of CH_4 emissions from the road transport come from gasoline passenger cars (71.8%). The substantial emission drop from 2001 onwards is explained by the sharp

penetration of EURO3, EURO4 and EURO5 passenger cars into the Latvia fleet and additionally in years 2009 - 2014 with decreasing of gasoline consumption by passenger cars.

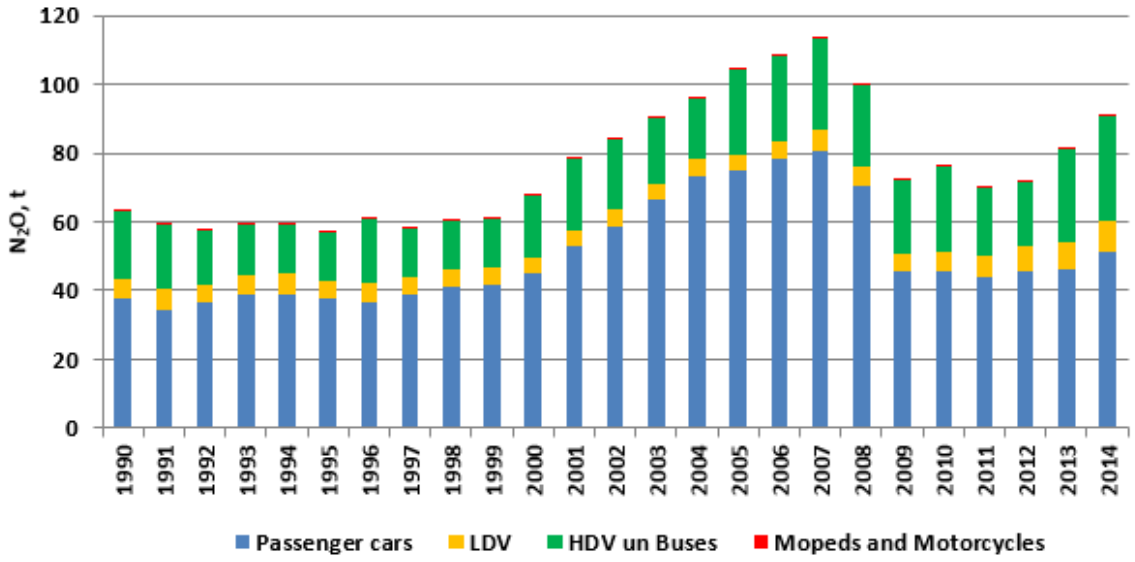

Figure 3.28 N_2O emissions in road transport by vehicle types

In 2014, N_2O emissions in road transport, compared to 2013 level have increased by 11.2 %. Taking into account that N_2O emission rates are largely dependent from implemented combustion and emission control technologies, different factor interaction characterises the trend of N_2O changes.

To analyze the trend of N_2O emission at first the significance of different emission sources should be clearly identified. The passenger cars (Figure 3.28) contribute 56.5%, LDV 9.9% and HDV and busses 33.4% of total N_2O emission in Latvia's road transport. Thus the N_2O emission trend is mainly determined by the change in the technologies and fuel used by passenger cars.

Regarding total N_2O emission created by the fleet of Latvia passenger cars, gasoline fuelled passenger cars contribute slightly above 35%, the rest is emitted by diesel fuelled passenger cars. Important, in the period after year 2005 the average N_2O emission factor (t/TJ) for gasoline fuelled passenger cars has tendency to decrease due to change in the relative share of EURO3 and EURO4 cars and EURO5 cars. The N_2O emission factor (g/km) of gasoline fuelled passenger cars of the EURO1 and EURO2 classes is more than twice higher compared to the factor of gasoline fuelled passenger cars of the EURO3 and EURO4 classes. The mileage shares in 2014, calculated by summing the shares of EURO3 and EURO4 and EURO5 gasoline passenger cars, has increased almost twice – from 29.5% to 58.2% of the total gasoline passenger cars mileage, compared to year 2005.

At the same time, one can see the opposite trend in the group of diesel passenger cars. The N_2O emission factor (g/km) of EURO3 and EURO4 and EURO5 diesel passenger cars is per about 60% higher than the emission factor for EURO1 and EURO2 diesel passenger cars. Thus, due to the significant rise of the mileage share of EURO3, EURO4 and EURO5 cars – from 24% (year 2005) up to 69.8% (year 2014) of the total diesel passenger cars mileage, the average N_2O emission factor (t/TJ) for diesel passenger cars has also slightly increased.

Methods

For road transport, the detailed methodology is used to make annual estimates of the Latvian emissions, as described in the 2006 IPCC Guidelines and EMEP/EEA 2013. The actual calculation is made with a COPERT IV model[19]. COPERT IV provides factors for fuel consumption and for all exhaust emission components which are included in the national inventory. For several reasons, COPERT IV is regarded as the most appropriate source of road traffic fuel consumption and emission factors. First of all, very few Latvia's emission measurements exist, so data are too scarce to support emission calculations on a national level. Secondly, the COPERT model is regularly updated with new experimental findings from European research programmes and, apart from updated fuel-use and emission factors, the use of COPERT IV by many European countries ensures a large degree of cross-national consistency in reported emission results.

In COPERT IV, fuel consumption and emission simulation can be made for operationally hot engines, taking into account gradually tighten emission standards and emission degradation due to catalyst wear. Furthermore, the emission effects of cold-start and evaporation are simulated. Estimation of evaporative emissions of hydrocarbons and the inclusion of cold start emission effects are dealt with in the Latvian inventory by using LEGMA meteorological input data for ambient temperature variations during months; the distribution of evaporate emissions in the driving modes are used default by COPERT IV model.

Corresponding to the COPERT IV fleet classification, all vehicles in the Latvia's fleet are grouped into vehicle classes, subclasses and layers (see Annex A.3.5). The layer classification is a further division of vehicle sub-classes into groups of vehicles with the same average fuel consumption and emission behaviour, according to EU emission legislation levels.

Trip-speed dependent basis factors for fuel consumption and emissions are implemented. The fuel consumption and emission factors used in the Latvia inventory are taken from the COPERT IV model. The summary of the methods and EF used is presented in Table 3.32.

Table 3.32 Summary of source category description, CRF 1.A.3.b

CRF	Gas	Method	EF	All sources estimated
1.A.3.b	CO_2	T2	CS	Yes
	CH_4	T2	D (COPERT model)	Yes
	N_2O	T2	D (COPERT model)	Yes

T2 Tier 2; CS Country Specific; D Default.

To calculate CO_2 emissions from lubrication oil using in car's engines in road transport it is calculated amount of oil, which the oil film developed on the inner cylinder walls. This oil film further is exposed to combustion and is burned along with the fuel. A calculation of lubricant oil consumption for engine operation has been performed using a typical oil consumption factors for different vehicle types, fuel used and vehicle age (see Table 3-28 EMEP/EEA 2013). Based on this calculated lubricant oil consumption and using default EF (2006 IPCC Guidelines) CO_2 emissions for lubricant oil burning for engine operation has been calculated.

[19] www.emisia.com

For estimating CO_2 emissions from use of urea-based additives in catalytic converters (non-combustive emissions), it is used equation from 2006 IPCC Guidelines:

$$Emission = Activity \times \frac{12}{60} \times Purity \times \frac{44}{12}$$

where:
Emissions - CO_2 Emissions from urea-based additive in catalytic converters (kt CO_2)
Activity - amount of urea-based additive consumed for use in catalytic converters (kt)
Purity - the mass fraction (= percentage divided by 100) of urea in the urea-based additive
12/60 - conversion from urea to carbon
44/12 - conversion from carbon to CO_2

In calculations, it is assumed that 75% of the HDV (starting with Euro IV class and later) the urea-based additives are used in catalytic converters. The activity level is 3 percent of diesel consumption by the HDV. Thirty-two and half percent is taken as default purity. Estimated CO_2 emissions are reported in the IPPU sector (CRF 2).

Activity data

As a basis for model input information CSB and LR Road Traffic Safety Directorate (RTSD) data is used. CSB data have been used considering the fuel consumption, RTSD collected and published data have been used considering stock of road transport in Latvia. Total mileage data for passenger cars, light duty trucks, heavy duty trucks and buses produced by the RTSD is used for the years 1996-2014. The summary of the data sources used in emission calculation for road transport are presented in Table 3.33.

Table 3.33 Activity data and sources used for emission calculation in road transport

Activity data	Source of activity data	Remarks
Fuel consumption	Calculated consumption by COPERT IV model	Calibrated with national statistics. Deviation less than 0,15%
Number of cars	Road Traffic Safety Directorate	For calculation it is used number of cars with permission to participate in traffic
Number of cars by fuel and vehicle type	Road Traffic Safety Directorate and expert calculation	Based on available data cars are grouped by fuel type, engine power, age and vehicle categories according to emission control system
Distance travelled by cars by fuel and vehicle type	Road Traffic Safety Directorate expert calculation	Based on an average data by cars classes it is modelled by fuel type, engine power, age and vehicle categories
Emission factors	National specific for CO_2 emissions, COPERT emission factors for CH_4 and N_2O	CO_2 emission factors are based on carbon content in fuel. 1990 – 1999 EF for unleaded gasoline is 68.6; 2000 - onwards EF gasoline is 71.18 1990 – onwards EF diesel oil 74.0

General information about activity data is presented in Figure 3.30- Figure 3.36 (number of cars and their split by sub-classes and layers). Before emission calculation COPERT IV model was calibrated to be consistent with actual fuel consumption (energy statistics see Table 3.34). Deviation between fuel consumption in COPERT model and statistics is less than 0.1%. Thus we can say that all emission calculation is based on fuel consumption amount.

Table 3.34 Fuel consumption in road transport (TJ)

	Gasoline	Diesel oil	LPG	Natural gas	Biofuel (biodiesel and bioethanol)
1990	24200	8328	592	335	-
1995	17996	6883	501	33	-
2000	14520	11472	865	68	-
2001	15268	15934	865	101	-
2002	14960	17166	865	68	-
2003	14950	18611	956	68	-
2004	15038	20225	1047	68	-
2005	14730	22180	1093	68	107
2006	16313	25235	1184	68	100
2007	17852	29488	1093	67	71
2008	16269	28256	956	33	82
2009	13586	25154	865	4	173
2010	12308	27449	989	1	1102
2011	11432	22945	1184	-	844
2012	9697	22465	1858	-	742
2013	8794	23539	2368	-	737
2014	8617	25409	2646	-	840

As seen in Figure 3.29 the fuel consumption has essentially changed in the time period 1990 – 2014. The gasoline consumption from the highest consumption in 1990 has decreased till 1999, reaching the lowest consumption and after six year stabilization the increase was seen in 2006 and 2007. Consumption of gasoline had decreased in 2014 by 0.2% compared to 2013. Whereas diesel fuel consumption starting from 1997 has increased gradually till 2007. While it decreased in 2008 and 2009 mainly due to economic recession. Diesel fuel consumption has increased in 2014 by 8.3% compared to 2013. Substantial LPG consumption increasing in road transport was observed starting from 2011.

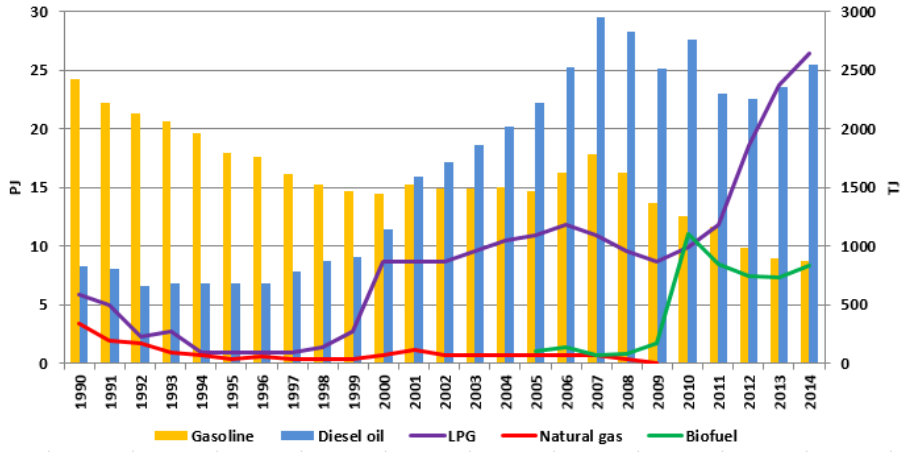

Figure 3.29 Development of Fuel consumption in road transport (TJ)[20]

[20] *LPG, natural gas and biofuel on secondary axes*

The vehicle numbers per passenger cars sub-class and layers are shown in Figure 3.30.

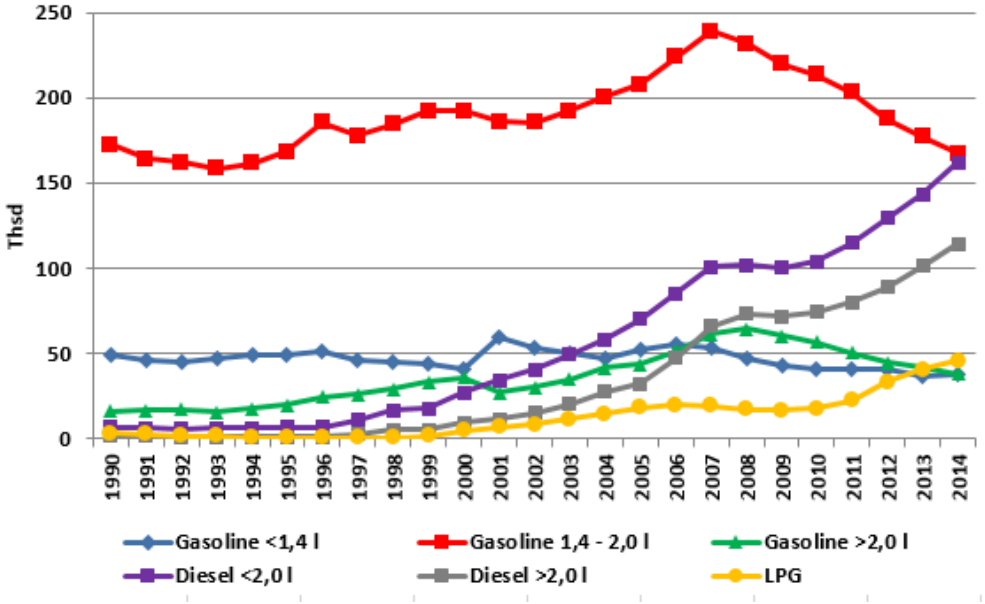

Figure 3.30 Distribution of passenger cars fleet by sub-classes (Thsd)

Analyzing the development of the passenger car fleet in the time period 1990 – 2014 (Figure 3.31, Figure 3.32), following features can be noted:

- Cars with a gasoline engine of a capacity > 2.0l constitute the major part;
- Cars with a gasoline engine of a capacity < 1.4l during the whole period have small changes and it`s constitute approximately 7% in year 2014 from total passenger cars;
- Cars with a gasoline engine of a capacity >2.0l starting from year 2010 have a small increasing in their share of total passenger cars;
- As of 2000, the number of cars with diesel engines, both, < 2.0l and > 2.0l, grow rapidly and its share is 48.9% from the total number of passenger cars in 2014;
- As of 2005, in the car fleet with a gasoline engine, the number of EURO 3 and EURO 4 cars grows rapidly. In 2014 a share of EURO3 and EURO4 and EURO5 and EURO6 cars constitutes 26.4%;
- As of 2005, in the car fleet with a diesel engine, the number of EURO 4 and EURO 5 cars grows rapidly. In 2014 a share of EURO4, EURO5 and EURO6 cars constitute 27.4%.

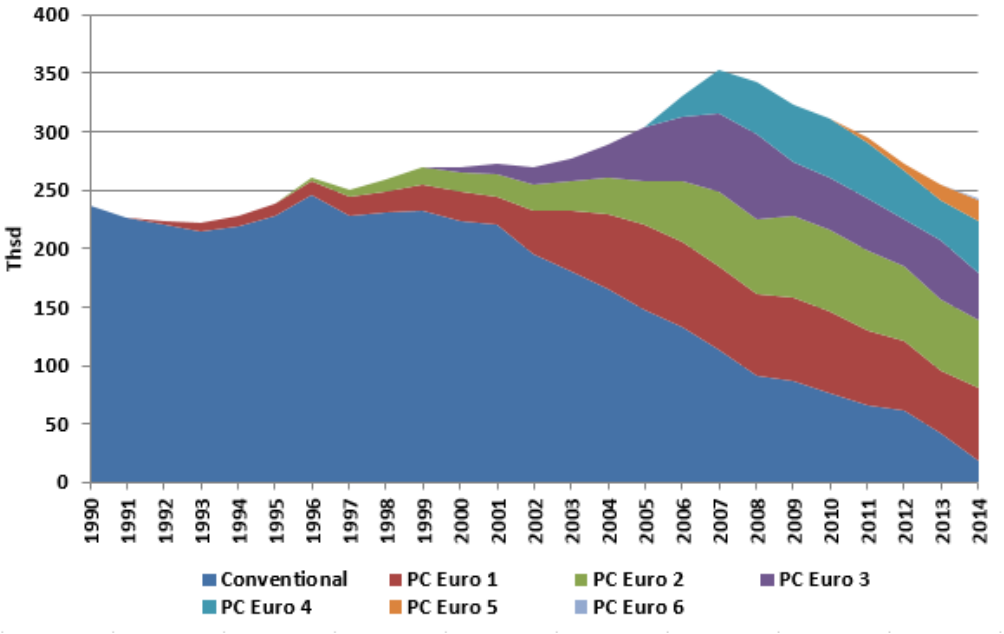

Figure 3.31 Distribution of gasoline passenger cars fleet by layers (Thsd)

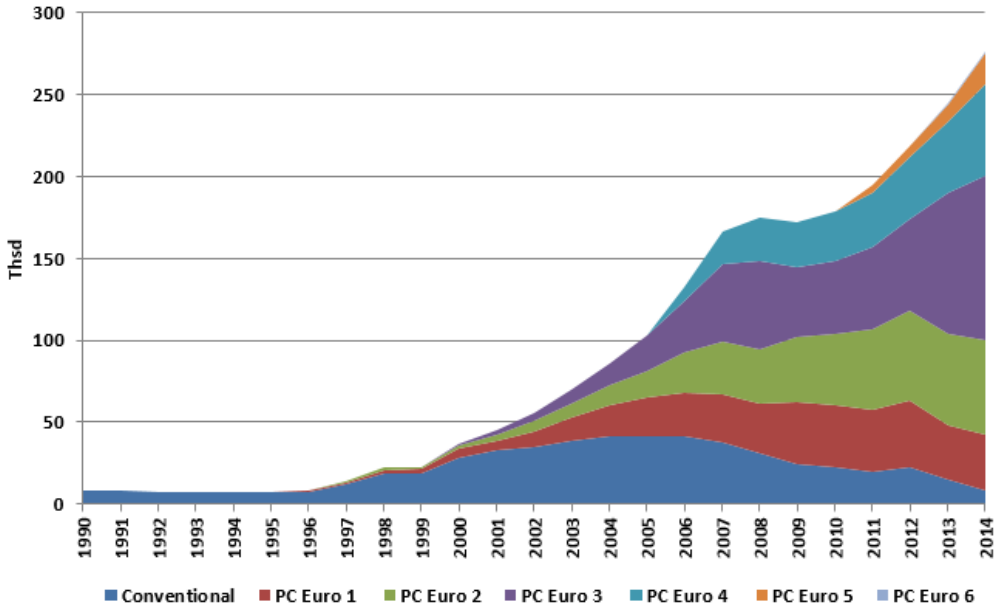

Figure 3.32 Distribution of diesel oil passenger cars fleet by layers (Thsd)

Analyzing the development of LDV fleet (Figure 3.33, Figure 3.34) in the time period 1990-2014, major features can be noted as follows:

- As of 1996, the number of cars with a gasoline engines have decreased;
- As of 2000, the number of cars with a diesel engine rapidly increases. In 2014 the share of diesel cars is 92.7%;
- As of 2005, the number of EURO4 and EURO5 cars have increased. In 2014 the share of EURO4, EURO5 and EURO6 cars constitute 45.5%;

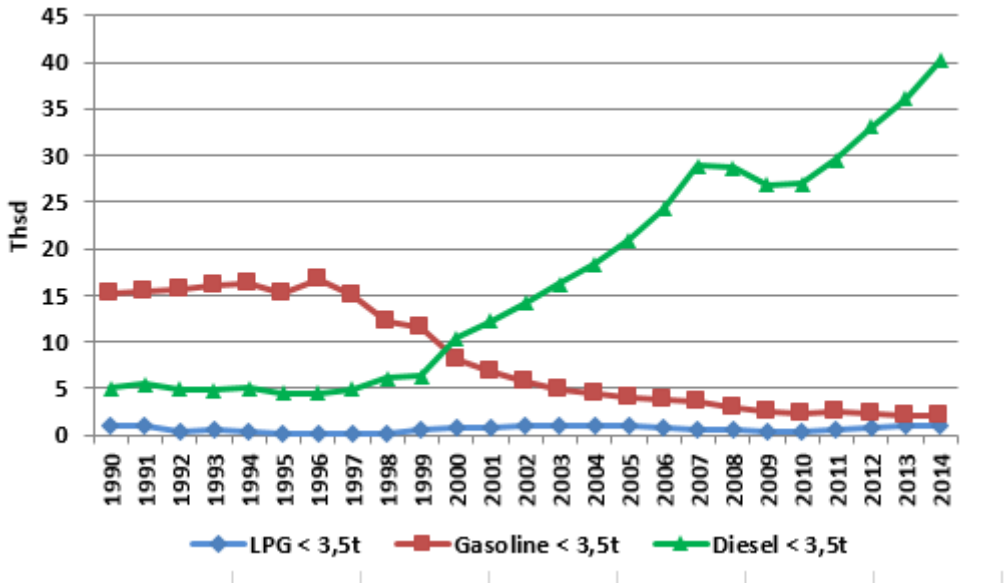

Figure 3.33 Distribution of light duty vehicles fleet by sub-classes (Thsd)

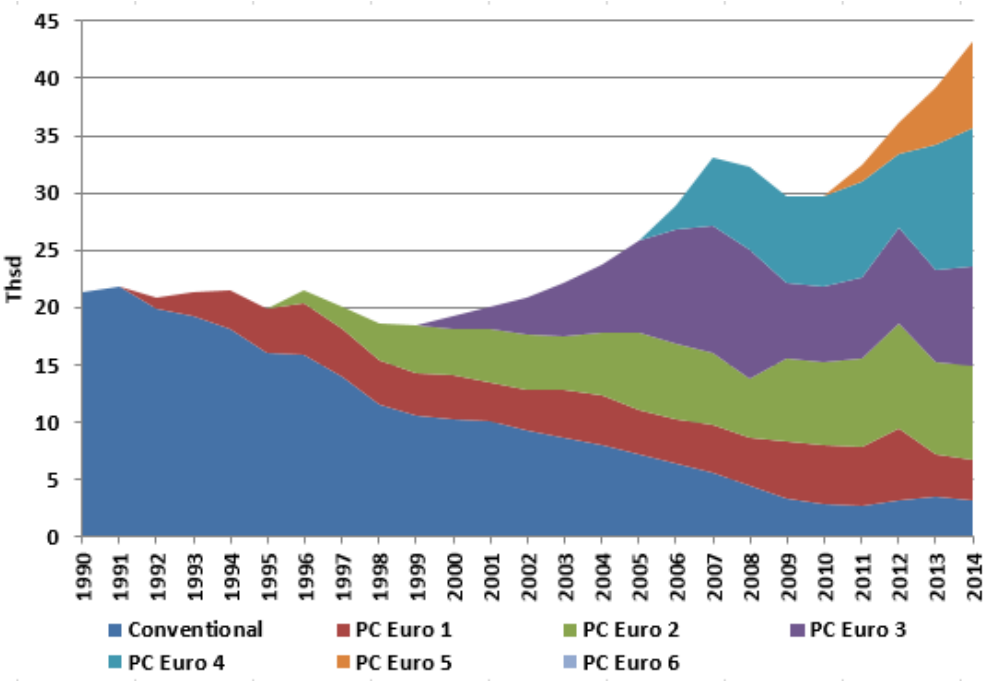

Figure 3.34 Distribution of light duty vehicles fleet by layers (Thsd)

The vehicle numbers per HDV sub-classes and layers are presented in Figure 3.35 and Figure 3.36. Analyzing the development of HDV fleet in the following time period, major features can be noted as follows:

- Since 2000, the number of cars with a gasoline engines have rapidly decreased. The share of gasoline cars has decreased from 33% to 4.1 % corresponding years 2000 and 2014;
- Since 2000, the number HDV cars with tonnage 14-34 t and a diesel engine starts to increase;

- As of 2000, average age reduction of cars takes place gradually. In 2014 the share of EURO IV, EURO V and EURO VI cars constituted 41.2%.

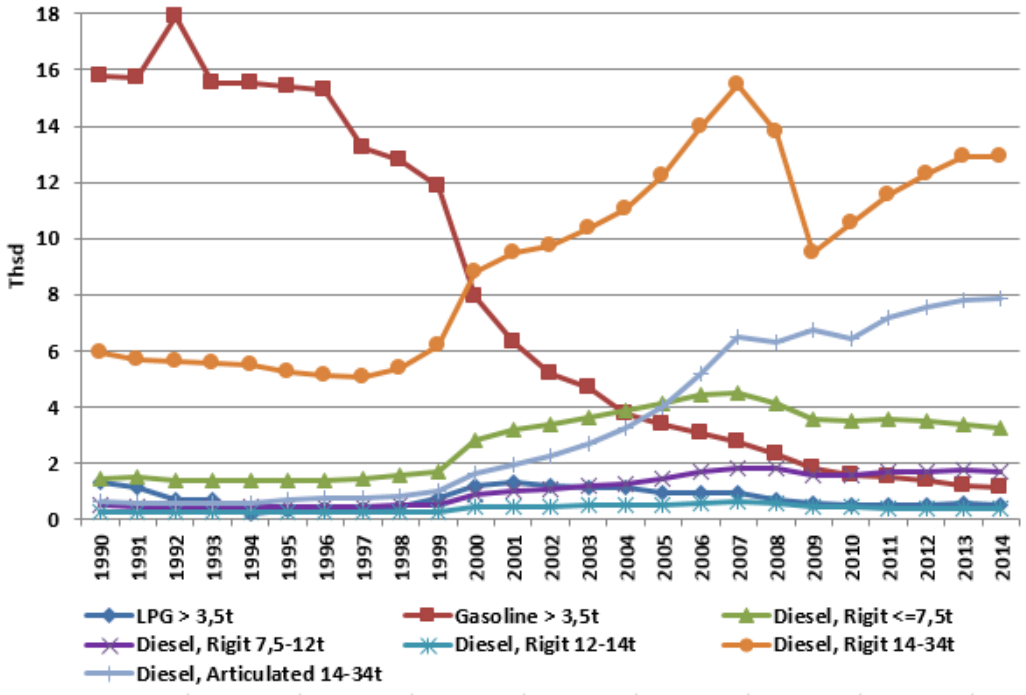

Figure 3.35 Distribution of heavy duty vehicles fleet by sub-classes (Thsd)

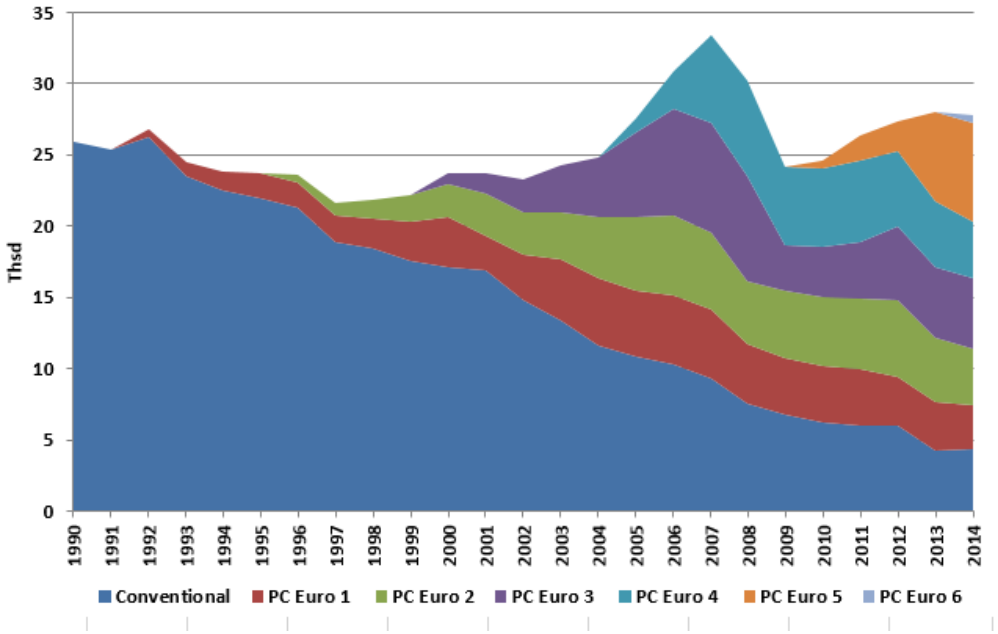

Figure 3.36 Distribution of heavy duty vehicles fleet by layers (Thsd)

Emission factors

CO_2 emissions in COPERT IV model were calculated using country-specific CO_2 emission factor that are calculated based on the information available on the C and H content in fuel.

Country specific EF for CO_2 emission calculation (gasoline, diesel oil) in road transport is used:

- 1990 – 2014 EF diesel oil 74.0 kg/GJ ("Guidance Manual for CO_2 emission estimations" (2004) see Annex A.3.2 of NIR);
- 1990 – 2014 EF for unleaded gasoline is 71.18 kg/GJ.

Country specific CO_2 EF for gasoline has been calculated within a research "Research on carbon content in transport fuels" in 2012. The research on C content in fuels carried out in 2012 quantified C and H content in gasoline. For gasoline the C content is 86.3%, further it is calculated NCV for gasoline (43.97 MJ/kg) and estimated CO_2 emission factor in accordance with 2006 IPCC Guidelines. Based on the results of this research, CO_2 EF of gasoline has been calculated - 71.18 kg/GJ. Although quantification of C and H content in gasoline has been performed for fuel with a requirement for gasoline quality which is in force since January 1, 2009, the updated CO_2 EF is implemented for emissions calculation 1990-2008 as well to ensure consistent time series. Rest of emission factors comes from the COPERT IV model.

3.2.6.1.3 Railways (CRF 1.A.3.c)

In 2014, the fuel consumption in railway constituted 8.05% of GHG emissions from the total GHG emissions in transport. Freight transport has a dominant role in railway. The railway transport accomplishes around 59% (2014) of the total freight transport in Latvia (traffic of goods in ton-km) and the transit transport traffic is dominant. In 2009 and 2010, transported freight along the railway and therefore the diesel consumption has a slightly decreased, compared to 2008 level. Due to dependence on transit transport of goods from Russia fuel consumption has decreased by approximately 3.0% in 2014 compared to 2013. It results in decreased GHG emissions by 4.2% in 2014 compared to 2013 level. Emission calculation in railway transport includes railway transport operated by diesel locomotives.

Railway related fuel consumption is key sources for CO_2 emissions. In 2014, total GHG emissions in railway, compared to 1990 level have decreased by 59.8% (see Figure 3.37).

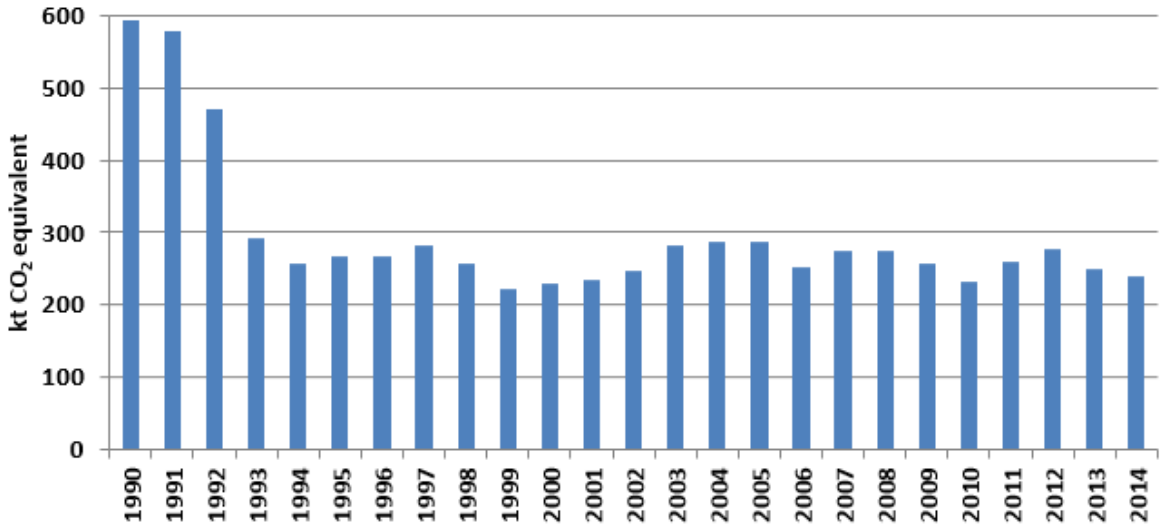

Figure 3.37 Development of GHG emissions in railway (kt CO_2 eq.)

Methodological issues

Methods

When calculating emissions from railway, 2006 IPCC Guidelines Tier 1 and Tier 2 methods have been applied. The summary of the latest key category assessment, methods and EF used is presented in Table 3.35.

Table 3.35 Summary of source category description, CRF 1.A.3.c

CRF	Gas	Method	EF	All sources estimated
1.A.3.c	CO_2	T2	CS	Yes
	CH_4	T1	D	Yes
	N_2O	T1	D	Yes

T1 Tier 1; T2 Tier 2; CS Country Specific; D Default.

Activity data

The data about diesel oil consumption in railway are derived from the CSB. Development of diesel oil consumption is presented in Figure 3.38 and Table 3.36. As we see, starting from 2010 a small portion of biodiesel is used in railway.

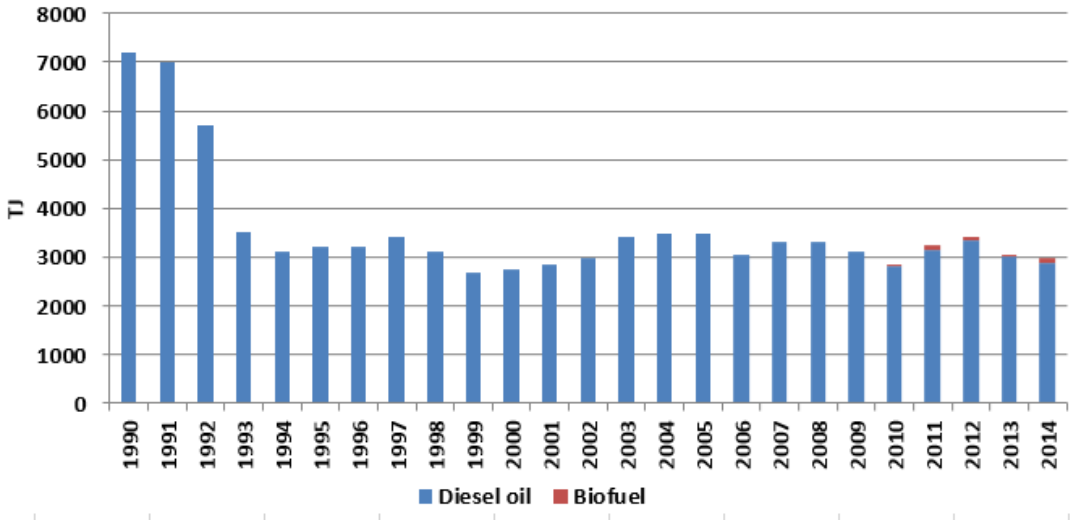

Figure 3.38 Development of fuel consumption in railway (TJ)

Table 3.36 Fuel consumption in railway (TJ)

	Diesel oil	Biodiesel
1990	7181	-
1995	3229	-
2000	2762	-
2001	2847	-
2002	2974	-
2003	3399	-
2004	3484	-
2005	3484	-
2006	3059	-
2007	3314	-
2008	3314	-
2009	3102	-

	Diesel oil	Biodiesel
2010	2804	35
2011	3144	91
2012	3357	63
2013	3017	48
2014	2889	83

Emission factors

Country specific EF for CO_2 emissions is used ("Guidance Manual for CO_2 emission estimations" (2004) see Annex A.3.2 of NIR). Rest of emission factors comes from 2006 IPCC Guidelines and EMEP/EEA 2013 (see Table 3.37).

Table 3.37 Emission factors used in the calculation of emissions from railway

	CO_2	CH_4	N_2O	NOx	CO	NMVOC	SO_2
	kt/PJ	**kt/PJ**	**kt/PJ**	**kt/PJ**	**kt/PJ**	**kt/PJ**	**kt/PJ**
Diesel oil	74	0.00415	0.0286	1.2332	0.251823	0.10943	0,02353 (2003-2004) 0,09414 (1990-2007) 0.04707 (2008-2014)

3.2.6.1.4 Domestic Navigation (CRF 1.A.3.d)

In 2014, fuel consumption in navigation was responsible for around 0.5% of GHG emissions from total GHG emissions in transport.

Although Latvia has several ports, domestic navigation that providing transport of freight or passengers among local ports is not developed. Major activities in ports deal with international freight transport. In domestic navigation, the emissions are calculated for miscellaneous vessels (tugs, barges, towboats, and icebreakers), recreational crafts and personal boats (see Figure 3.39).

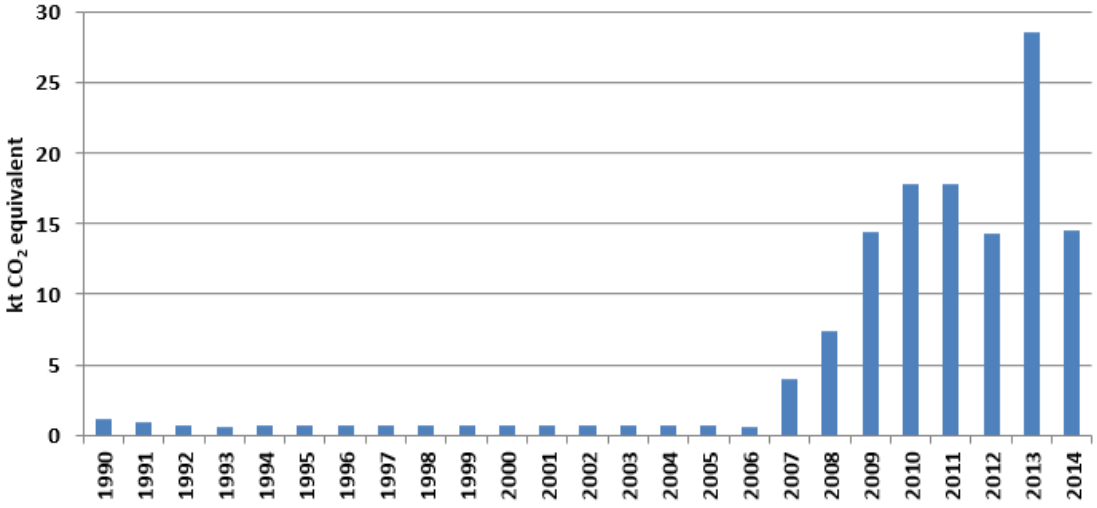

Figure 3.39 GHG emission development in domestic navigation (kt CO_2 eq.)

Fuel consumption and CO_2 emissions trend in domestic navigation mainly depends from international (import, export) cargo activities in ports (cargo turnover and number of vessels

served in ports). During the period 2006-2014 international cargo turnover in ports has increased by approximately 24.5% and number of served vessels by approximately 10%. This increasing trend of activity partly explains fuel consumption increasing. On the other hand, fuel consumption is affected by the number of vessels serviced in ports. As shown in Figure 3.40 in spite of the rapid increase in the volume of cargo at the port of Riga, the number of serviced ships has remained almost unchanged. The main reason for this trend is the increase in the gross tonnage of vessels. The most significant increase was registered in the average tanker gross tonnage, but also in other cargo carrier groups (container, dry bulk carriers).

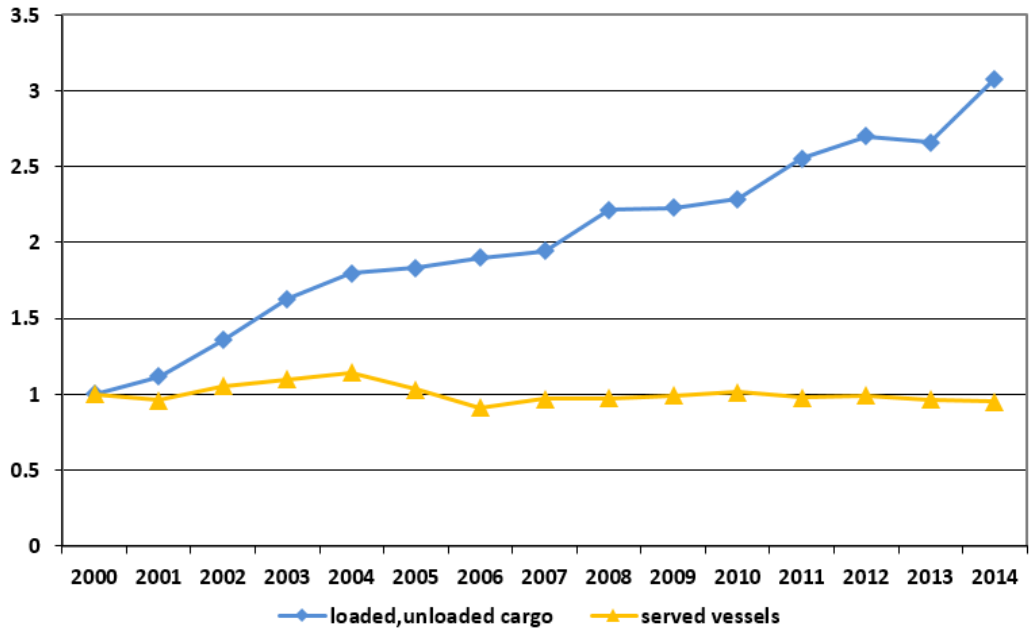

Figure 3.40 Loaded, unloaded cargo and served vessels at Riga port (2000 = 1)

Other additional factor which makes impact to fuel consumption in domestic navigation is weather conditions. This we can definitely see for 2010 and 2011 when air temperature was low and sea was covered by ice. An ice breaker operated many months to ensure operation of ports in 2010 and 2011. This has made an impact on fuel consumption in 2010 and 2011.

Before GHG emission calculation is performed CSB is asked to check and further confirm fuel consumption in sector if fluctuation is more than 20% points compare to the previous year.

Methodological issues

Methods

When calculating emissions from navigation, Tier 1 and Tier 2 methods from 2006 IPCC Guidelines have been applied. Country specific CO_2 EF is used for emission calculation from diesel fuel consumption. The summary of the latest key category assessment, methods and EF used is presented in Table 3.38.

Table 3.38 Summary of source category description, CRF 1.A.3.d

CRF	Gas	Method	EF	All sources estimated
1.A.3.d	CO_2	T1,T2	CS; D	Yes
	CH_4	T1	D	Yes
	N_2O	T1	D	Yes

T1 Tier 1; T2 Tier 2; CS Country Specific; D Default.

Activity data

The data about diesel oil consumption and gasoline consumption in domestic navigation are derived from the CSB. CSB have started to collect data about diesel oil consumption and gasoline consumption in domestic navigation from 2006. For the time period 1990 – 2005 the data for fuel consumption is used from the study "Evaluation of fuel consumption for domestic aviation and navigation" (FEI, 2004). Development of fuel consumption in domestic navigation is presented in Figure 3.41 and Table 3.39. Diesel oil consumption has decreased approximately 2 times in 2014 compared to 2013.

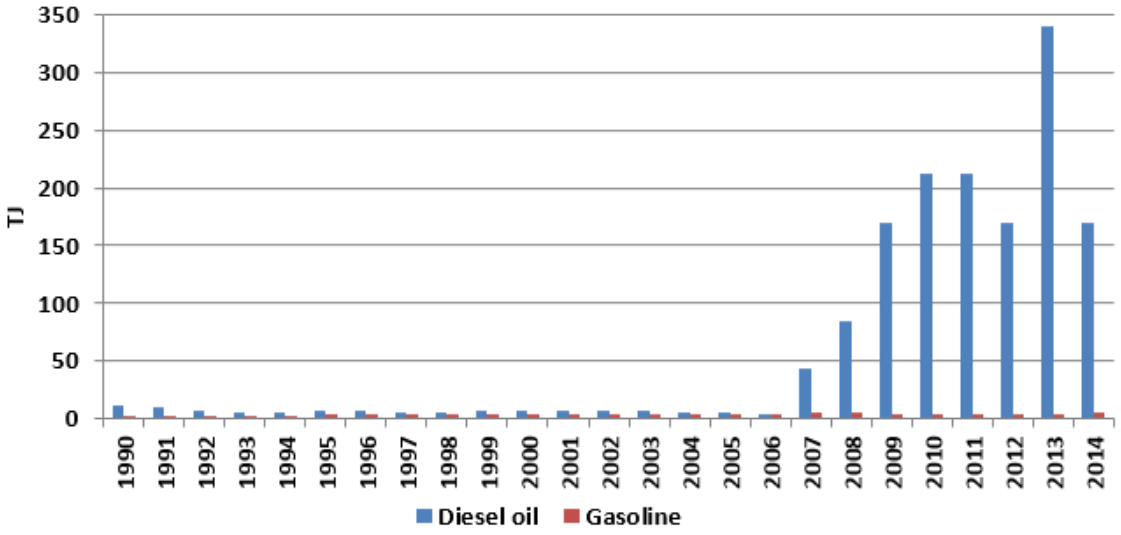

Figure 3.41 Development of gasoline and diesel oil fuel consumption in domestic navigation

Variation in local navigation's fuel consumption in 2012-2014 indicates that this consumption is highly dependent on the harbour services' activities. In 2013 there was done harbour deepening of large scale resulting also in significant increase in fuel consumption. After the realization of noted project, the fuel consumption in 2014 come back to roughly 2012 level.

Table 3.39 Fuel consumption in domestic navigation (TJ)

	Diesel oil	Gasoline
1990	11	2
1995	6	3
2000	6	3
2001	6	3
2002	6	4
2003	6	4
2004	6	4

	Diesel oil	Gasoline
2005	5	4
2006	4	4
2007	43	5
2008	85	5
2009	170	4
2010	212	3
2011	212	3
2012	170	3
2013	340	4
2014	170	5

Emission factors

Default EFs for navigation is used (2006 IPCC Guidelines and EMEP/EEA 2013,Table 3.40).

Table 3.40 Emission factors used in the calculation of emissions from navigation

	CO_2, t/TJ	CH_4, t/TJ	N_2O, t/TJ
Gasoline	69.3	0.0473	0.000296
Diesel oil	74.0	0.004	0.003

3.2.6.2 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6. Activity data about fuel consumption in transport sector is mainly available from 1990 and they are provided by CSB. Considering that CSB gives approximately 2% statistical sample error for statistical data uncertainty in activity data of fuel consumption in transport is ±2% in 2014. Before GHG emission calculation is performed CSB is asked to check and further confirm fuel consumption in sector if fluctuation is more than 20% points compare to the previous year. Uncertainty range for calculated or modelled activity data (lubricant oil using in cars' engines, gasoline consumption in domestic navigation) is 10 – 20%.

CO_2 emission factor was estimated according physical characterization of used fuels in country based on average NCV reported by fuel consumers and carbon content so uncertainty was assigned as quite low about 2% (diesel oil and gasoline in road transport). For rest of fuels in transport sector default CO_2 emission factors from 2006 IPCC Guidelines were used and uncertainty was assigned 5%. Default CH_4 and N_2O emission factors used in estimation of emissions was taken from 2006 IPCC Guidelines, so uncertainty was assigned 50 %.

In order to maintain consistency with the time-series the estimation procedures have been developed as described above (chapter 1.6.). However, due to the fact that some of the estimations are not based on activity data but on other factors as LTO cycles in civil aviation sector, a certain degree of uncertainty exists. In road transport one important basic parameter for the COPERT IV model is vehicle-km, which is calculated through another model. This second model is based on the mileage driven by the vehicle noted at time of TA (annual inspection/testing of the vehicle) at Road Traffic Safety Directorate. If it is in place sharp changing of some external factors impacted fuel consumption, for example economy

recession, fuel price or energy tax, it will not be shown as clearly in the development of vehicle mileage as in statistics on fuel consumption.

To ensure time series consistency any recalculation related with model version updating is realized for all time period. Linear interpolation has been implemented only for cases when activity data fluctuation does not take place.

3.2.6.3 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the transport sector in order to achieve these quality objectives. Meetings dedicated for quality ensure and improvement are held annually among inventory and external experts.

All Tier 1 general inventory level QC procedures listed in chapter 1.2. applicable to this sector are used. These measures are implemented every year during the transport sector inventory. In addition, the consumption of every type of fuel in the last year is checked and compared with previous years. If large variations are discovered for certain fuels, responsible CSB staff is contacted for an explanation.

Estimated emissions verification:

- All estimations of the emissions done for a transport sector are checked on the logical mistakes by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogic changes in the activity data and emissions.
- Emissions are checked using time series consistency check for the EF estimated in CRF Reporter. EFs are calculated per fuel, substance and CRF-code and checked against the emission factors to make sure that no calculation errors have occurred when emissions were computed. The calculated air transport emissions have been compared and verified with Eurocontrol's emission data for 2008-2014. The calculated activity data for fuel consumption of LTO and cruise mode and emissions were comparable and very close to those estimated by Eurocontrol.
- For road transport a checking is done on less aggregated level than in CRF. Non CO_2 EF changes that are higher than 10% in time series are double-checked and reasonable explanation for EF changes has to be found.

All findings are documented by using check-lists, available on Regulations of the Cabinet of Ministers No. 217 adopted on 27 March 2012 "The National Inventory System of Greenhouse Gas Emission Units". Each expert has to check and fill in QC form for each category taking into account criteria given in QA/QC plan approved in above mentioned national legislation. Potential errors and inconsistencies are documented in the special form and corrections are made if necessary. The QC measures have been implemented concerning used activity data, implemented Guidelines, methods and EF. Form then is sent to National Inventory Compiler and it is archived in FTP folder.

Additional QA/QC checks for Tier2 methodology

For emission calculation in road transport additional QA/QC check approach has implemented. QC activities are realized with emission data and activity data QC.

It is assessed that implemented default EF from COPERT IV model are applicable to national circumstances because model comprises all necessary technologies. Country specific EFs for CO_2 are calculated based on 2006 IPCC Guidelines methodology. Activity data (fuel consumption, total number of vehicles) provider CSB has the internal QA/QC procedures based on mathematical model and analysis to avoid logic mistakes. To ensure QA procedure expert from Road traffic and safety Directorate is asked to make peer review about the main assumption implemented in emission calculation.

3.2.6.4 Category-specific recalculations

The following recalculations and improvements of the emission inventories have been made in the transport sector since the emission reporting in 2014 (Table 3.41).

Table 3.41 Recalculations for Sub-category CRF 1.A.3 Transport

Sub-category	Recalculation	Improvements
Road transport (CRF 1.A.3.b)	CO_2 ; CH_4; N_2O emissions for 2009 – 2011 have been recalculated	Recalculations have been done due to corrected fuel consumption taking into account CSB corrections. Recalculation affected direct and non direct emissions. CO_2 emissions increased by around 1% for years 2010 and 2011
Civil aviation (CRF 1.A.3.a)	CO_2 ; CH_4; N_2O emissions for 2006 and 2007 have been recalculated	Recalculations have been done due to corrected jet fuel consumption. Recalculation affected direct and non direct emissions.
Road transport (CRF A.3.b)	CO_2 ; CH_4; N_2O emissions for 2012 and 2013 have been recalculated	Recalculations have been done due to improvement of activity data and corrected gasoline consumption. Improvements comprise more precise split of passenger cars, LDV and HDV by subgroups (depending on engine volume) and layers (EURO classes) and mileage. Recalculation affected direct and non direct emissions. CO_2 emissions increased by around 1%

3.2.6.5 Category-specific planned improvements

No improvements are planned for the sector.

3.2.7 Other Sectors (CRF 1.A.4)

3.2.7.1 Category description

CRF 1.A.4 Other sectors include emissions from the small combustion of fuels in Commercial/Institutional, Residential sectors and Agriculture/Forestry/Fisheries. In addition, emissions from mobile machinery used in Commercial, Residential and Agriculture and Forestry sectors are included here as off-road. Also emissions from autoproducers are

included in relevant sectors of CRF 1.A.4 – according to 2006 IPCC Guidelines these emissions have to be reported in sectors producing them.

In Submission 2016, the CRF subsector 1.A.4. Other sectors were split into subsectors which are in line with 2006 IPCC Guidelines/CRF Reporter structure:

- 1.A.4.a Commercial/Institutional:
  - 1.A.4.a.i Stationary combustion;
  - 1.A.4.a.ii Off-road vehicles and other machinery;
- 1.A.4.b Residential:
  - 1.A.4.b.i Stationary combustion;
  - 1.A.4.b.ii Off-road vehicles and other machinery;
- 1.A.4.c Agriculture/Forestry/Fishing:
  - 1.A.4.c.i Stationary combustion;
  - 1.A.4.c.ii Off-road vehicles and other machinery;
  - 1.A.4.c.iii Fishing.

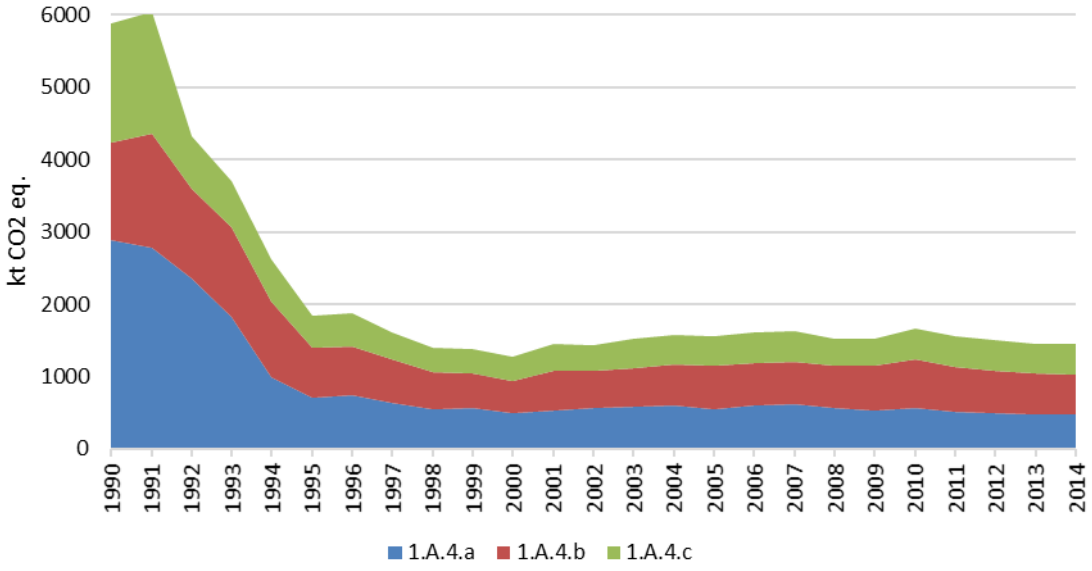

Figure 3.42 GHG emissions in CRF 1.A.4. Other sectors by subsectors (kt CO_2 eq.)

In Figure 3.42, there can be seen the distribution of GHG emissions in CRF 1.A.4 sector. The largest part of emissions contributes to CRF 1.A.4.b Residential (38.4% in 2014). Other subsectors' shares are quite similar – in 1.A.4.a Commercial/Institutional there are 32.96% from 1.A.4 emissions produced, while in 1.A.4.c Agriculture/Forestry/Fisheries, where also offroad emissions from Fisheries have been included, the share of 1.A.4 emissions is 28.7%

Table 3.42 Emissions from Other Sectors (CRF 1.A.4) in 1990–2014 (kt)

	CO_2	CH_4	N_2O	Aggregate GHGs (CO_2, CH_4, N_2O)	NO_x	CO	NMVOC	SO_2
	kt			kt CO_2 eq.	kt			
1990	5595.15	8.83	0.248	5889.98	22.58	162.89	17.02	34.65
1991	5707.27	9.85	0.319	6048.67	25.66	158.78	16.51	32.73
1992	4036.48	8.66	0.241	4324.62	19.55	140.82	15.22	26.62
1993	3403.89	9.19	0.214	3697.43	17.65	148.04	15.80	22.14
1994	2347.99	9.05	0.178	2627.11	13.73	145.39	15.65	17.44

	CO_2	CH_4	N_2O	Aggregate GHGs (CO_2, CH_4, N_2O)	NO_x	CO	NMVOC	SO_2
	kt			kt CO_2 eq.	kt			
1995	1564.12	9.27	0.166	1845.53	11.07	140.85	16.36	9.95
1996	1585.29	9.45	0.174	1873.52	11.25	148.52	17.05	10.73
1997	1343.94	8.95	0.171	1618.67	9.27	139.51	16.14	8.29
1998	1153.96	8.09	0.156	1402.59	7.84	133.00	15.25	6.31
1999	1136.28	8.01	0.150	1381.05	8.75	128.64	15.05	5.11
2000	1050.76	7.41	0.144	1278.84	8.31	125.24	14.46	3.93
2001	1209.82	8.19	0.153	1460.07	9.19	137.79	15.64	4.49
2002	1182.77	7.90	0.152	1425.49	8.53	133.00	15.32	3.81
2003	1268.75	8.11	0.160	1519.40	9.72	140.02	16.14	3.76
2004	1318.31	8.35	0.172	1578.26	9.76	141.20	16.50	3.65
2005	1292.72	8.24	0.177	1551.44	9.34	143.32	16.59	3.67
2006	1354.01	7.91	0.188	1607.75	9.31	139.15	16.17	3.42
2007	1370.96	7.96	0.197	1628.45	8.91	136.13	16.04	3.06
2008	1292.32	7.07	0.175	1521.25	8.06	132.07	14.95	2.45
2009	1279.73	7.68	0.185	1526.81	8.23	145.13	16.34	2.57
2010	1458.28	6.32	0.180	1670.09	8.17	111.95	12.85	2.28
2011	1355.77	6.20	0.181	1564.65	8.13	117.35	13.22	2.24
2012	1278.47	6.73	0.178	1499.67	7.94	117.79	13.63	2.17
2013	1247.42	6.13	0.174	1452.50	7.73	105.10	12.36	2.02
2014	1250.10	5.89	0.173	1448.92	7.76	98.03	11.47	1.95
Share of Energy total, 2014	19.1%	47.3%	46.9%	20.8%	26.1%	77.3%	53.1%	49.1%
2014 vs 2013	0.2%	-3.9%	-0.5%	-0.2%	0.4%	-6.7%	-7.2%	-3.3%
2014 vs 1990	-77.7%	-33.3%	-30.3%	-75.4%	-65.6%	-39.8%	-32.6%	-94.4%

GHG emissions in CRF 1.A.4 sector decreased by 78.3% in 1990-2000 due to reorganizations in the country after the collapse of Soviet Union, as mentioned in previous chapters (Table 3.42). Since 2000, GHG emissions started to grow due to thrive in national economy, and increased by 27.3% in until 2007. During economic crisis in 2008-2009 the emissions decreased by 6.2% from 2007, and increased in the following two years because of recovery in economy. However, in the recent years – 2012 and 2013 the GHG emissions decreased by 4.2% and 7.2% comparing with 2011 level – in 2012 a lot more biomass was used, and the use of solid fuels decreased significantly, whereas in 2013 gaseous fuels were used less than in 2012, and also the consumption of biomass reduced. In 2014 the GHG emissions are almost in the same level as in 2013. There can also be seen a trend that if the average temperature comparing with previous year has increased, CO_2 emissions are less and vice versa.

CH_4 and N_2O emissions shows the biomass consumption trend – in 2012 the increase in emissions was 8.5% and decrease 1.6%, respectively, comparing with 2011, and in 2013 there can be seen a decrease in CH_4 and N_2O emissions by 8.9% and 2.1%, comparing with 2012. A decrease in emissions can be seen also in 2014, comparing with 2013 – CH_4 emissions have decreased by 3.9%, and N_2O emissions have a decrease by 0.5%.

Indirect GHG emissions from CRF 1.A.4 Other sectors were estimated as well. SO_2 had the biggest decrease by 94.4% in 1990–2014. It can be explained with fuel switching from coal, peat and heavy fuel oils to natural gas and biomass from what sulphur dioxide emissions are

not emitted. Also a strict national legislation was approved to improve the quality of used liquid fuels in country. NOx emissions have also decreased by 65.6% in 1990-2014, NMVOC emissions – by 32.6%, and CO emissions – by 39.8%. The decrease can also be explained with fuel switch from solid to natural gas and biomass, which have lower emission factors.

3.2.7.2 Methodological issues

Methods

2006 IPCC Guidelines' Tier 2 method was used to estimate CO_2 emissions from fuel combustion as country specific parameters were used to estimate CO_2 emission factor. However, for some fuels there are no country-specific emission factors, therefore 2006 IPCC Guidelines Tier 1 method using default emission factors was used. 2006 IPCC Guidelines' Tier 1 method was used to calculate CH_4 and N_2O emissions from the CRF 1.A.4 sector.

Calculation of all emissions from fuel combustion is done with Excel databases developed by the experts from LEGMC.

The general method for emission data preparation was used:

$$Em = EF \times B_q$$

where:
Em – total emissions (kt)
EF – estimated or default emission factor (t/TJ)
B_q – amount of fuel in thermal units (TJ)

Emission factors and other parameters

The main sources for emission factors are:

- National studies for country specific parameters and emission factors;
- Data from only natural gas supplier company of natural gas physical characteristics;
- IPCC 2006 Guidelines;
- EMEP/EEA 2013.

Country specific emission factors were used to calculate carbon dioxide (CO_2) and sulphur dioxide (SO_2) emissions.

CO_2 emission factors

CO_2 emission factors for CRF 1.A.4 Other sectors are estimated with the same equations and using same methods as for CRF 1.A.1 Energy industries sector, including calculation methods and assumptions for landfill gas and other biogas as in CRF 1.A.1 sector.

For some fuels default CO_2 emission factors from 2006 IPCC Guidelines, Volume 2, Chapter 2 *Stationary combustion*, Table 2.4, were taken due to unavailability of country specific data:

- other liquid fuels – 73.3 kt/PJ;
- coal – 94.6 kt/PJ;
- biodiesel – 70.8 kt/PJ;
- straws – 100 kt/PJ;
- charcoal – 112 kt/PJ;
- waste oils – 73.3 kt/PJ.

For CRF 1.A.4.c.iii Fishing default CO_2 emission factors were taken from 2006 IPCC Guidelines, Volume 2, Chapter 3 *Mobile combustion*, Table 3.5.2:

- diesel oil – 74.1 kt/PJ;
- residual fuel oil – 77.4 kt/PJ.

SO_2 emissions factors

SO_x emission factors for CRF 1.A.4 Other sectors are estimated with the same equations and using same method as for CRF 1.A.1 and CRF 1.A.2 sectors.

Other emission factors

The default CH_4 and N_2O emission factors are taken from 2006 IPCC Guidelines, Volume 2, Chapter 2 *Stationary combustion*, Table 2.3 (CRF 1.A.4.a, 1.A.4.c). For estimating CH_4 emissions from wood in CRF 1.A.4.b.i sector, Tier 2 approach with country specific EFs was used. These factors were obtained in a research "*Estimation of* CH_4 *and* N_2O *emission factors for solid biomass, taking into account fuel and installation types*". N_2O emission factors for wood products are taken from 2006 IPCC Guidelines, Chapter 2 *Stationary combustion*, Table 2.3. It has to be noted that for wood and charcoal the lowest N_2O EFs were taken from the given range.

NO_x, CO and NMVOC emission factors used in estimation of emission were taken from EMEP/EEA 2013, Chapter 1.A.4 Small combustion, Tables 3-12 to 3-25 (CRF 1.A.4.b.i), Tables 3-7 to 3-10 (CRF 1.A.4.a.i, 1.A.4.c.i).

List of other emission factors can be seen in Table 3.43 and Table 3.44.

Table 3.43 CH_4, N_2O, NO_x, NMVOC, CO emission factors in CRF 1.A.4.a and 1.A.4.c (kt/PJ)

	CH_4		N_2O	NO_x	NMVOC	CO
	1.A.4.a	1.A.4.c				
Diesel oil	0.010	0.010	0.0006	0.513	0.03	0.066
RFO	0.010	0.010	0.0006	0.513	0.03	0.066
LPG	0.005	0.005	0.0001	0.074	0.023	0.029
Jet fuel	0.010	0.010	0.0006	0.513	0.03	0.066
Other kerosene	0.010	0.010	0.0006	0.513	0.03	0.066
Other liquid	0.010	0.010	0.0006	0.513	0.03	0.066
Waste oils	0.300	0.300	0.0040	0.513	0.03	0.066
Shale oil	0.010	0.010	0.0006	0.513	0.03	0.066
Coal	0.010	0.300	0.0015	0.173	0.089	0.931
Peat briquettes	0.010	0.300	0.0015	0.173	0.089	0.931
Peat	0.010	0.300	0.0015	0.173	0.089	0.931
Natural gas	0.005	0.005	0.0001	0.074	0.023	0.029
Wood	0.300	0.300	0.0040	0.091	0.300	0.570
CH_4 from landfill gas	0.005	0.005	0.0001	0.074	0.023	0.029
Other biogas	0.005	0.005	0.0001	0.074	0.023	0.029
Straws	0.300	0.300	0.0040	0.091	0.300	0.570
Biodiesel	0.010	0.010	0.0006	0.513	0.03	0.07
Charcoal	0.200	0.300	0.0040	NO	NO	NO

Table 3.44 CH_4, N_2O, NO_x, NMVOC, CO emission factors in CRF 1.A.4.b (kt/PJ)

		CH_4	N_2O	NO_x	NMVOC	CO
		kt/PJ				
Diesel oil		0.01	0.0006	0.069	0.00017	0.0037
RFO		0.01	0.0006	0.069	0.00017	0.0037
LPG		0.005	0.0001	0.042	0.0018	0.022
Other kerosene		0.01	0.0006	0.069	0.00017	0.0037
Coal		0.3	0.0015	0.158	0.174	4.787
Peat briquettes		0.3	0.0015	0.158	0.174	4.787
Peat		0.3	0.0014	0.158	0.174	4.787
Natural gas		0.005	0.0001	0.042	0.0018	0.022
Wood	Central heating boilers	0.361	0.0015	0.080	0.350	4.000
	Hot water boilers	0.009	0.0015	0.080	0.350	4.000
	Combination boilers - central heating and hot water boilers	0.131	0.0015	0.080	0.350	4.000
	Room furnaces	0.099	0.0015	0.080	0.350	4.000
	Economic furnaces	0.097	0.0015	0.095	0.250	2.000
	Kitchen stoves	0.083	0.0015	0.050	0.600	4.000
	Pellet stoves	IE	IE	0.080	0.010	0.300
Straws		0.3	0.004	0.050	0.600	4.000
Charcoal		0.2	0.0003	0.050	0.600	4.000

Gasoline emission factors are used for CH_4 and N_2O emission estimation from off-roads (2006 IPCC Guidelines, Volume 2, Chapter 3 *Mobile combustion*, Table 3.3.1.). As there is no information about distribution between 2-stroke and 4-stroke engines, it was assumed that 25% of consumed gasoline is combusted in 2-stroke engines, while 75% - in 4-stroke engines. Such assumption has been made, based on Danish data which are presented in EMEP/EEA 2013 for air pollutants' calculations. The emission factors for indirect GHGs were taken from Chapter 1.A.4. Non-road mobile sources and machinery. NO_x, CO and NMVOC emission factors used in estimation of emission were taken from EMEP/EEA 2013, Chapter 1.A.4 Non-road mobile sources and machinery, Table 3-1.

Also diesel oil and residual fuel oil consumed in Fisheries sector was assumed as consumed by fishing ships and the emission factors were taken from 2006 IPCC Guidelines, Volume 2, Chapter 3 *Mobile combustion*, Table 3.5.2. Emission factors for indirect GHGs are taken from EMEP/EEA 2013, Chapter 1.A.3.d., Table 3-1.

Emission factors for gasoline consumed in Offroads and diesel oil and residual fuel oil consumed in Fisheries are presented in Table 3.45.

Table 3.45 CH_4, N_2O, NO_x, NMVOC, CO emission factors for gasoline, diesel and RFO (kg/Mg[21])

		Gasoline		Diesel	Offroad Diesel		RFO
		2-stroke	4-stroke		Agriculture	Forestry	
CH_4	1.A.4.a.ii	0.18	0.12	NO	NO	NO	NO
	1.A.4.b.ii	0.18	0.12		NO	NO	
	1.A.4.c.ii	0.17	0.08		0.00415	0.00415	
	1.A.4.c.iii	NO	NO	0.007	NO	NO	
N_2O	1.A.4.a.ii	0.0004	0.002	NO	NO	NO	NO
	1.A.4.b.ii				NO	NO	
	1.A.4.c.ii				0.286	0.286	

[21] *For CH_4 and N_2O – kt/PJ*

		Gasoline		Diesel	Offroad Diesel		RFO
		2-stroke	4-stroke		Agriculture	Forestry	
	1.A.4.c.iii	NO	NO	0.002	NO	NO	
NO_x	1.A.4.a.ii	2.765	7.117	NO	NO	NO	NO
	1.A.4.b.ii				NO	NO	
	1.A.4.c.ii				35.043	29.093	
	1.A.4.c.iii	NO	NO	78.5	NO	NO	79.3
NMVOC	1.A.4.a.ii	242.197	17.602	NO	NO	NO	NO
	1.A.4.b.ii				NO	NO	
	1.A.4.c.ii				3.366	2.02	
	1.A.4.c.iii	NO	NO	2.8	NO	NO	2.7
CO	1.A.4.a.ii	620.739	770.368	NO	NO	NO	NO
	1.A.4.b.ii				NO	NO	
	1.A.4.c.ii				10.939	7.834	
	1.A.4.c.iii	NO	NO	7.4	NO	NO	7.4

Activity data

Mainly emissions from fuel combustion are calculated using fuel consumption data from the national Energy Balance, prepared by CSB. The data collection system for CRF 1.A.4 sector is the same as for CRF 1.A.1 and CRF 1.A.2 sectors. Data on fuel consumption in 1.A.4 sector are presented in Annex A.3.1.

Autoproducers data prepared by CSP are taken into account into the calculation of the emissions from CRF 1.A.4 sector according to 2006 IPCC Guidelines.

Only gasoline combustion is reported as off-roads in CRF 1.A.4 sector. It is sure that diesel oil is also consumed as off-roads but for now it is not possible for CSB and LEGMC to divide the consumption between fuel combusted stationary and filled in technological vehicles. Due to that all diesel oil reported in the sector is estimated as combusted stationary.

In CRF 1.A.4.c.iii Fishing it is assumed, that diesel oil and residual fuel oil is consumed by fishing vessels.

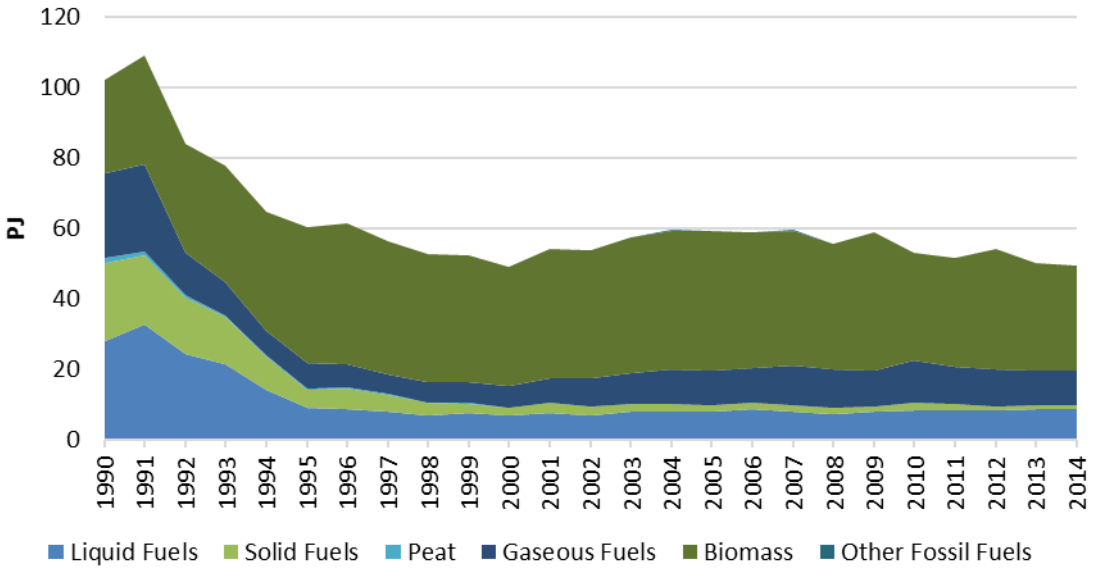

Figure 3.43 Fuel consumption in Other sectors (CRF 1.A.4) for 1990-2014 (PJ)

The biggest decrease in 1990-2014 was for solid fuel consumption – 95.7% and liquid fuels consumption – 68.5% (Figure 3.43). It is explained with fuel switching processes when solid and liquid fuels were replaced with cheaper fuels. Also stronger legislation contributed fuel switching to the type of fuels with a lower level of emissions.

Since 1990 biomass dominates as a fuel in CRF 1.A.4 sector. The biggest part of solid biomass consumption goes to Residential sector where biomass is the main fuel in small capacity burning installations. Consumption of biomass fuel has increased by 13% in 1990–2014 in Other sectors. However, it can be seen that the amounts of biomass have been fluctuating over recent years which can mainly be explained with temperature fluctuations during winter.

Since 1997 gaseous fuel consumption was constantly increasing until 2007, because it had lower costs to and liquid and solid fuels were replaced with natural gas as a fuel. The increase in fuel consumption in CRF 1.A.4 Other sectors is strongly linked to decrease in fuel consumption in CRF 1.A.1 Energy industries when central heating supply consumers switched to individual heating supply. In the recent years a decreased consumption in natural gas is observed, which was influenced by increasing costs of natural gas.

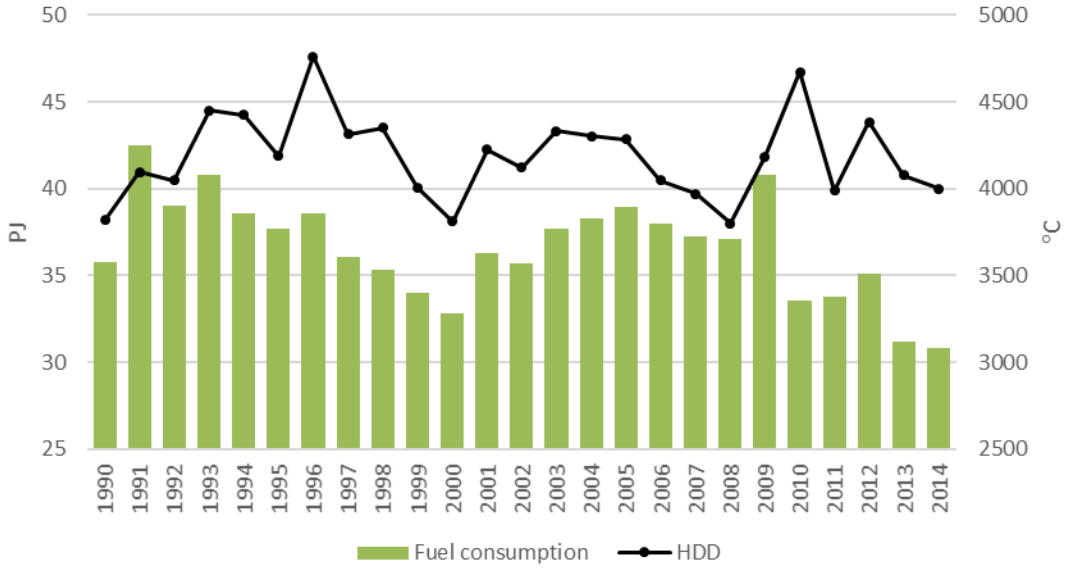

Figure 3.44 Fuel consumption in Residential sector (CRF 1.A.4.b) for stationary combustion and heating degree days in Latvia

As it can be seen in Figure 3.44, fuel consumption in 1.A.4.b sector is related with changes in temperature – in years where heating degree days are more, the amounts of consumed fuel are also larger, especially it can be seen in 1994-2003 and in the most recent years. In 2008 there was considerably low number of HDDs, and also the fuel consumed was less than in 2007. However, in 2009-2010 the correlation between HDDs and consumption is less visible because of impact of global crisis, which clearly affected the Residential sector. In 2011-2013 there can be seen a correlation in HDDs and fuel consumption – in 2012 the number of HDDs was by 9.9% higher than in 2011, and the amounts of fuel consumed were by 5% more. In 2013 the number of HDDs was by 7% less, and also fuel consumed was by 7% less than in 2012. In 2014 the number of HDDs was 2% less while the consumption of fuels was 1.2% less.

3.2.7.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty in activity data of fuel combustion in 1.A.4 sector is ±2% in 2014. CSB gives approximately 2% statistical sample error for statistical data. According to CSB, as data are obtained using information given by respondents, this number is a variation coefficient which characterizes selection of respondents. Total variation coefficient for energy balance is within 2-3%. In Latvia all fossil fuels (oil, natural gas and coal) are imported and import and export statistics are fairly accurate.

Uncertainty of activity data for solid biomass combustion was assigned as 5% because biomass activity data were collected by CSB with questionnaires sent by enterprises consumed biomass. As fuel consumption in CRF 1.A.4.b Residential sector is obtained only every 5 years using questionnaire and data are extrapolated until the next survey, therefore the uncertainty of all fuel consumption in residential sector is assumed 15%. According to 2006 IPCC Guidelines, Volume 2, Chapter 1, pg. 1.19, biomass data are generally more uncertain than other data in national energy statistics, because a large fraction of the biomass may be part of the informal economy, and the trade in these type of fuels is frequently not registered in the national energy statistics and balances. Uncertainty of landfill gas stationary combusted in enterprises covered by 1.A.4 Other sectors was assumed rather low – 2% because the combusted fuel amount is obtained directly from landfill plant that has precise measurement equipment for accounting of combusted fuel. Still the methane percentage amount in combusted landfill gas is given approximately, therefore final uncertainty of biomass fuels is assumed as 5%.

CO_2 emission factor was estimated according physical characterization of used fuels in country basing on average NCV reported by fuel consumers and carbon content, hence the uncertainty for liquid fuels was assigned as quite low – about 10%. The same level of uncertainty was assigned for solid fuels. CO_2 emission factor for natural gas was assumed rather low – as 5% because annual plant specific fuel data is used to estimate emission factor.

CH_4 and N_2O emission factor used in estimation of emissions was taken according to 2006 IPCC Guidelines, Volume 2, Chapter 2 *Stationary combustion*, Table 2.12., which provides the range of default values for uncertainties. The uncertainty both for CH_4 and N_2O EFs was assigned as uncertainties used in previous submissions – 50%.

Time series of the estimated emissions are consistent and complete because the same methodology, emission factors and data sources are used for sectors for all years in time series. Emissions from all sectors are estimated or reported as not occurring / not applicable, therefore there are no "not estimated" sectors.

3.2.7.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed

according to the QA/QC plan in the Energy sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

All documentation and information received for inventory purposes are archived in FTP folder. All findings are documented by using check-lists, available on Regulations of the Cabinet of Ministers No. 217 adopted on 27 March 2012 "The National Inventory System of Greenhouse Gas Emission Units".

Activity data verification

All sources of energy data are presented in the corresponding NIR chapter (0 GHG emissions in CRF 1.A.4 sector decreased by 78.3% in 1990-2000 due to reorganizations in the country after the collapse of Soviet Union, as mentioned in previous chapters (Table 3.42). Since 2000, GHG emissions started to grow due to thrive in national economy, and increased by 27.3% in until 2007. During economic crisis in 2008-2009 the emissions decreased by 6.2% from 2007, and increased in the following two years because of recovery in economy. However, in the recent years – 2012 and 2013 the GHG emissions decreased by 4.2% and 7.2% comparing with 2011 level – in 2012 a lot more biomass was used, and the use of solid fuels decreased significantly, whereas in 2013 gaseous fuels were used less than in 2012, and also the consumption of biomass reduced. In 2014 the GHG emissions are almost in the same level as in 2013. There can also be seen a trend that if the average temperature comparing with previous year has increased, CO_2 emissions are less and vice versa.

CH_4 and N_2O emissions shows the biomass consumption trend – in 2012 the increase in emissions was 8.5% and decrease 1.6%, respectively, comparing with 2011, and in 2013 there can be seen a decrease in CH_4 and N_2O emissions by 8.9% and 2.1%, comparing with 2012. A decrease in emissions can be seen also in 2014, comparing with 2013 – CH_4 emissions have decreased by 3.9%, and N_2O emissions have a decrease by 0.5%.

Indirect GHG emissions from CRF 1.A.4 Other sectors were estimated as well. SO_2 had the biggest decrease by 94.4% in 1990–2014. It can be explained with fuel switching from coal, peat and heavy fuel oils to natural gas and biomass from what sulphur dioxide emissions are not emitted. Also a strict national legislation was approved to improve the quality of used liquid fuels in country. NOx emissions have also decreased by 65.6% in 1990-2014, NMVOC emissions – by 32.6%, and CO emissions – by 39.8%. The decrease can also be explained with fuel switch from solid to natural gas and biomass, which have lower emission factors.

Methodological issues) as well as disaggregated data at the finest level possible are presented in the corresponding Annex A.3.1. Data completeness has been explained in the previous subchapter.

Activity data have been checked at the data provider – Central Statistical Bureau, which has its own internal QA/QC procedures based on mathematic model and analysis to avoid logic mistakes. When activity data have been received, the sectoral expert responsible for the emission estimation and reporting are comparing all data changes with the previous inventory, and all changes are explained in the corresponding subchapter. All fluctuations or changes in NCVs are double checked and agreed with CSB.

All activity data used in Sectoral Approach are also compared with activity data used in Reference Approach estimations. All significant differences (±5%) are explained in the corresponding subchapter.

Emission factor verification

For country-specific CO_2 emission factors, the sources of the calorific values, carbon content and oxidation factors, as well as these values are provided in 0 GHG emissions in CRF 1.A.4 sector decreased by 78.3% in 1990-2000 due to reorganizations in the country after the collapse of Soviet Union, as mentioned in previous chapters (Table 3.42). Since 2000, GHG emissions started to grow due to thrive in national economy, and increased by 27.3% in until 2007. During economic crisis in 2008-2009 the emissions decreased by 6.2% from 2007, and increased in the following two years because of recovery in economy. However, in the recent years – 2012 and 2013 the GHG emissions decreased by 4.2% and 7.2% comparing with 2011 level – in 2012 a lot more biomass was used, and the use of solid fuels decreased significantly, whereas in 2013 gaseous fuels were used less than in 2012, and also the consumption of biomass reduced. In 2014 the GHG emissions are almost in the same level as in 2013. There can also be seen a trend that if the average temperature comparing with previous year has increased, CO_2 emissions are less and vice versa.

CH_4 and N_2O emissions shows the biomass consumption trend – in 2012 the increase in emissions was 8.5% and decrease 1.6%, respectively, comparing with 2011, and in 2013 there can be seen a decrease in CH_4 and N_2O emissions by 8.9% and 2.1%, comparing with 2012. A decrease in emissions can be seen also in 2014, comparing with 2013 – CH_4 emissions have decreased by 3.9%, and N_2O emissions have a decrease by 0.5%.

Indirect GHG emissions from CRF 1.A.4 Other sectors were estimated as well. SO_2 had the biggest decrease by 94.4% in 1990–2014. It can be explained with fuel switching from coal, peat and heavy fuel oils to natural gas and biomass from what sulphur dioxide emissions are not emitted. Also a strict national legislation was approved to improve the quality of used liquid fuels in country. NOx emissions have also decreased by 65.6% in 1990-2014, NMVOC emissions – by 32.6%, and CO emissions – by 39.8%. The decrease can also be explained with fuel switch from solid to natural gas and biomass, which have lower emission factors.

Methodological issues.

Country specific CO_2 values for year are compared with default ones available on 2006 IPCC Guidelines, Volume 2, Chapter 2 *Stationary combustion*, Table 2.2. Whether country specific CO_2 emission factor is or is not in the confidence interval, can be seen in Table 3.46.

Table 3.46 Comparison of country specific and 2006 IPCC default CO_2 emission factor values (kt/PJ)

	Lower	CS	Upper	LV ETS
Gasoline	67.50	71.18	73.00	
Diesel oil	72.60	74.00	74.80	74.75
RFO	75.50	76.59	78.80	77.36
LPG	61.60	62.44	65.60	62.75
Jet fuel	69.70	71.51	74.40	
Other kerosene	70.80	71.50	73.70	
Other liquid	72.20	72.59	74.40	
Shale oil	67.80	76.35	79.20	74.75

	Lower	CS	Upper	LV ETS
Peat	100.00	103.87	108.00	105.99
Natural gas	54.30	54.26	58.30	55.44
Wood	95.00	107.78	132.00	
Sludge gas	46.20	50.87	66.00	
Landfill gas	46.20	50.87	66.00	
Other biogas	46.20	50.87	66.00	

Only natural gas country specific CO_2 emission factor is outside of confidence interval given by 2006 IPCC Guidelines. Main reasons are different carbon content in fuel, as well as different NCVs.

Emission verification:

To verify the CO_2 emissions, logical mistakes are checked by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogical changes in the activity data and emissions. The emissions for indirect GHGs in the database are cross-checked with emissions reported within CLRTAP for verification purposes.

CO_2 emissions are compared with emissions in Reference Approach estimations, and all significant differences (±5%) are explained in the corresponding subchapter.

3.2.7.5 Category-specific recalculations

Recalculations have been done in CRF 1.A.4.a sector due to activity data corrections. The largest recalculations have been done in CRF 1.A.4.b sector due to change of methodology from Tier 1 to Tier 2 as well as revised CH_4 and N_2O, and indirect GHGs' emission factors.

3.2.7.6 Category-specific planned improvements

It is planned to update CO_2 EFs for most widely used fuels in Latvia and estimate life cycle of lubricants and used oils.

3.2.8 Other (CRF 1.A.5)

3.2.8.1 Category description

Under the CRF 1.A.5.b Other Mobile sources emissions from liquid fuels – aviation gasoline, diesel oil and jet kerosene, used in military aircrafts and ships are reported. These emissions appear since 1996 (Table 3.47).

Table 3.47 Emissions from Other sources (CRF 1.A.5) in 1990–2014 (kt)

	CO_2	CH_4	N_2O	Aggregate GHGs	NO_x	CO	NMVOC	SO_2
	kt			kt CO_2 eq.	kt			
1990	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
1991	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
1992	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
1993	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
1994	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE

	CO_2	CH_4	N_2O	Aggregate GHGs	NO_x	CO	NMVOC	SO_2
	kt			kt CO_2 eq.	kt			
1995	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
1996	0.19	1.36E-06	5.45E-06	0.19	2.48E-04	0.07	1.18E-03	1.9E-05
1997	0.10	6.82E-07	2.73E-06	0.10	1.24E-04	0.04	5.89E-04	9.3E-06
1998	0.19	1.36E-06	5.45E-06	0.19	2.48E-04	0.07	1.18E-03	1.9E-05
1999	0.15	1.08E-06	4.31E-06	0.15	1.96E-04	0.06	9.30E-04	1.5E-05
2000	0.14	9.67E-07	3.87E-06	0.14	1.76E-04	0.05	8.35E-04	1.3E-05
2001	0.17	1.19E-06	4.75E-06	0.17	2.16E-04	0.06	1.03E-03	1.6E-05
2002	6.88	5.32E-04	1.87E-04	6.95	0.14	0.54	0.013	7.8E-03
2003	6.16	4.61E-04	1.68E-04	6.22	0.12	0.55	0.013	6.9E-03
2004	9.63	7.86E-04	2.61E-04	9.73	0.21	0.57	0.016	1.1E-02
2005	7.62	5.53E-04	2.08E-04	7.70	0.14	0.75	0.017	8.4E-03
2006	7.51	5.27E-04	2.05E-04	7.59	0.14	0.83	0.018	8.0E-03
2007	2.84	1.12E-04	7.85E-05	2.87	0.03	0.70	0.012	2.5E-03
2008	3.41	1.58E-04	9.40E-05	3.44	0.04	0.73	0.013	2.0E-03
2009	5.34	3.55E-04	1.46E-04	5.39	0.09	0.67	0.014	3.4E-03
2010	7.87	6.17E-04	2.14E-04	7.95	0.16	0.58	0.015	5.0E-03
2011	7.22	5.71E-04	1.96E-04	7.29	0.15	0.51	0.013	4.6E-03
2012	7.33	5.61E-04	1.99E-04	7.40	0.15	0.60	0.014	4.7E-03
2013	6.45	4.56E-04	1.76E-04	6.51	0.12	0.69	0.015	4.1E-03
2014	9.44	7.50E-04	2.56E-04	9.54	0.20	0.65	0.017	6.0E-03
Share of Energy total, 2014	0.14%	0.01%	0.07%	0.14%	0.66%	0.51%	0.08%	0.15%
2014 vs 2013	46.4%	64.3%	45.9%	46.5%	64.8%	-5.7%	13.6%	46.2%
2014 vs 1996	4848.1%	54904.0%	4603.6%	4854.9%	79382.4%	774.3%	1340.1%	32275%

Emissions from this sector are not influenced by the changes in national economy or in the economy of Latvia's trade partners, but still the emissions are decreasing since 2004. However, in the recent years until 2012 there has been an increase of fuel consumption, according to data given by CSB. In 2013 the GHG emissions decreased by 12% comparing with 2012. In 2014, GHG emissions increased by 46%, comparing with 2013.

3.2.8.2 Methodological issues

Methods

2006 IPCC Guidelines' Tier 1 method was used to calculate GHG emissions from the 1.A.5.b Other Mobile source sector.

Calculations of all emissions from fuel combustion are done with Excel databases developed by experts from LEGMC.

The general method for preparing inventory data was used:

$$Em = EF \times B_q$$

where:
Em – total emissions (kt)
EF – estimated or default emission factor (t/TJ)
B_q – amount of fuel in thermal units (TJ)

Emission factors and other parameters

Default emission factors for direct GHGs from Military aircrafts are taken from 2006 IPCC Guidelines, Volume 2, Chapter 3 *Mobile combustion*, Table 3.5.2 and Table 3.6.4 (Table 3.48).

Indirect GHGs emission factors were taken from EMEP/EEA 2013. Country specific emission factors were used to calculate sulphur dioxide (SO_2) emissions.

Table 3.48 CO_2, CH_4, N_2O, NOx, NMVOC, CO emission factors[22]

	CO_2	CH_4	N_2O	NO_x	NMVOC	CO
Aviation gasoline	69.3	0.0005	0.002	4	19	1200
Diesel oil	74.1	0.007	0.002	78.5	2.8	7.4
Jet fuel	71.5	0.0005	0.002	4	19	1200

3.2.8.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty in activity data of fuel combustion in sectors CRF 1.A.5.b is ±2% in 2014 because official statistical information from CSB is used.

Emission factors used for emission estimation were taken from 2006 IPCC Guidelines. For diesel oil the uncertainty for CO_2 emission factor, according to these Guidelines, Volume 2, Chapter 3 *Mobile combustion*, Section 3.5.1.7, is 2%, but for CH_4 and N_2O it is much higher - about 50%. For aviation gasoline and jet fuel, the uncertainty for CO_2 emission factor, according to 2006 IPCC Guidelines, Volume 2, Chapter 3 *Mobile combustion*, Section 3.6.1.7, is 5%, but for CH_4 and N_2O it is assumed that the uncertainty is very high – 100%.

Time series of the estimated emissions are consistent and complete because the same methodology, emission factors and data sources are used for sectors for all years in time series.

3.2.8.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the Energy sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

All documentation and information received for inventory purposes are archived in FTP folder. All findings are documented by using check-lists, available on Regulations of the Cabinet of Ministers No. 217 adopted on 27 March 2012 "The National Inventory System of Greenhouse Gas Emission Units".

Activity data verification

[22] *Units for GHGs are in kt/PJ, for indirect GHGs in kg/Mg.*

All sources of energy data are presented in the corresponding NIR chapter (3.2.8.2 Methodological issues) as well as disaggregated data at the finest level possible are presented in the corresponding Annex A.3.1. Data completeness has been explained in the previous subchapter.

Activity data have been checked at the data provider – Central Statistical Bureau, which has its own internal QA/QC procedures based on mathematic model and analysis to avoid logic mistakes. When activity data have been received, the sectoral expert responsible for the emission estimation and reporting are comparing all data changes with the previous inventory, and all changes are explained in the corresponding subchapter. All fluctuations or changes in NCVs are double checked and agreed with CSB.

All activity data used in Sectoral Approach are also compared with activity data used in Reference Approach estimations. All significant differences (±5%) are explained in the corresponding subchapter.

Emission factor verification

As all emission factors are taken from 2006 IPCC Guidelines, no additional verification procedures have been performed.

Emission verification

To verify the CO_2 emissions, logical mistakes are checked by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogical changes in the activity data and emissions. The emissions for indirect GHGs in the database are cross-checked with emissions reported within CLRTAP for verification purposes.

CO_2 emissions are compared with emissions in Reference Approach estimations, and all significant differences (±5%) are explained in the corresponding subchapter.

3.2.8.5 Category-specific planned recalculations

No recalculations are done in particular sector.

3.2.8.6 Category-specific planned improvements

No improvements are planned to be done until the next submission.

3.3 FUGITIVE EMISSIONS FROM SOLID FUELS AND OIL AND NATURAL GAS (CRF 1.B)

Under the 1.B Fugitive emissions category CO_2, CH_4 and NMVOC emissions from operations with natural gas and light liquid fuels are reported (Table 3.49).

Table 3.49 Reported fugitive CO_2, CH_4, NMVOC emissions in Latvia in 1990-2014 (kt)

	CO_2	CH_4	Aggregate GHGs	NMVOC
	kt	kt	kt CO_2 eq.	kt
1990	0.0115	9.90	247.59	4.18
1991	0.0111	9.54	238.49	3.88
1992	0.0101	8.70	217.43	3.59
1993	0.0097	8.32	207.94	3.45
1994	0.0094	8.13	203.20	3.35

	CO_2	CH_4	Aggregate GHGs	NMVOC
	kt	kt	kt CO_2 eq.	kt
1995	0.0092	7.92	197.89	3.19
1996	0.0089	7.63	190.68	3.10
1997	0.0083	7.12	177.96	2.88
1998	0.0079	6.83	170.75	2.75
1999	0.0076	6.51	162.79	2.63
2000	0.0070	6.03	150.64	2.48
2001	0.0073	5.84	146.09	2.47
2002	0.0074	6.10	152.57	2.52
2003	0.0055	4.76	119.08	2.12
2004	0.0055	4.71	117.87	2.11
2005	0.0062	5.33	133.19	2.28
2006	0.0044	3.82	95.53	1.91
2007	0.0046	3.92	98.07	2.72
2008	0.0047	4.03	100.70	2.50
2009	0.0044	3.81	95.13	2.44
2010	0.0043	3.66	91.61	2.35
2011	0.0054	2.52	63.03	1.40
2012	0.0049	3.18	79.61	1.44
2013	0.0080	4.04	101.01	1.71
2014	0.0138	5.41	135.33	2.34
Share of Energy total, 2014	0.0002%	43.5%	1.9%	10.8%
2014 vs 2013	72.2%	34.0%	34.0%	37.0%
2014 vs 1990	19.8%	-45.3%	-45.3%	-44.1%

It is possible to get data from hard coal transportation via railways but it is assumed that no GHG emissions are generated during this activity. Only particulate matters emissions are estimated from coal transportation in Latvia.

There are lasting peat mining and manufacturing traditions in Latvia. As stated in 2006 IPCC Guidelines, Volume 4 *Agriculture, Forestry and Other Land Use*, Chapter 1 *Introduction*, with current state of scientific knowledge, it is possible to provide methods for estimating CO_2 and N_2O emissions associated with management of peatlands, and CO_2 from conversion to wetlands by flooding. However, according to 2006 IPCC Guidelines, Volume 4, Chapter 7 *Wetlands*, all on-site sources of greenhouse gas emissions should be reported under AFOLU *Wetlands* category regardless of the end-use of peat.

There are no coal mines in Latvia and therefore no fugitive emissions from mining processes occur.

3.3.1 Fugitive emission from oil (CRF 1.B.2.a)

3.3.1.1 Category description

CRF sector 1.B.2.a Oil includes NMVOC emissions from refined oil products storage and distribution. There are no oil refineries in Latvia; therefore NMVOC emissions from gasoline distribution only were calculated for 1990–2014.

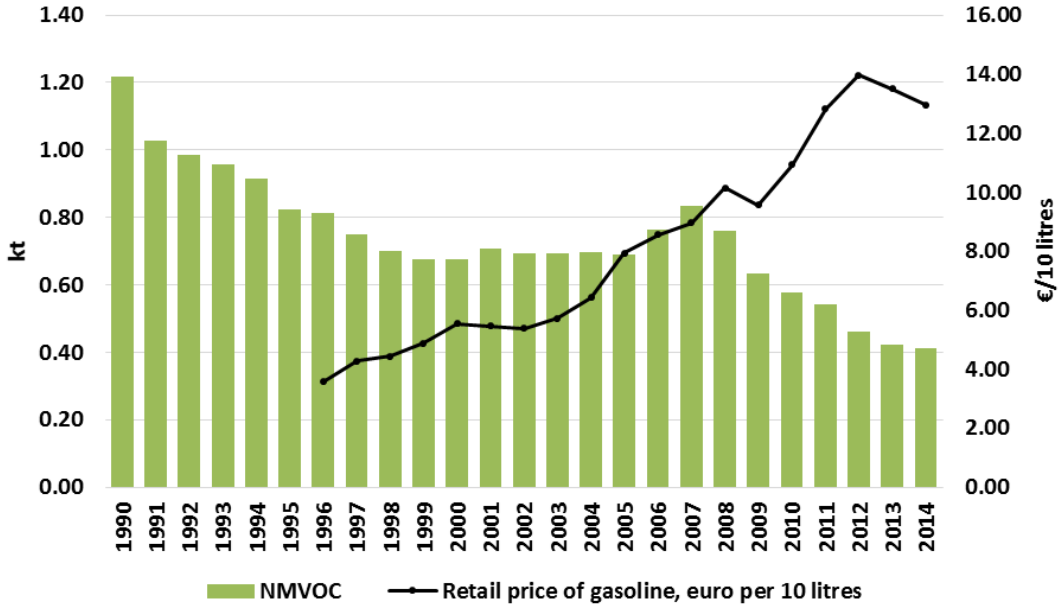

Figure 3.45 Fugitive NMVOC emissions from oil products in 1990–2014 and retail price for gasoline in 1996-2014

Decrease of NMVOC emissions in whole time series can be generally explained with increasing costs of gasoline therefore it was used less. In 2005-2007 there can be seen a rise in emissions which can be explained with economic growth and prosperity, however, in 2008 due to global crisis, the use of gasoline, as well as NMVOC emissions decreased, and continued to decrease after that because of rapid increase in retail price (Figure 3.45). Since 1990 up to 2014 the NMVOC emissions have decreased by 66%.

3.3.1.2 Methodological issues

Methods

EMEP/EEA 2013 Tier 1 methodology is used to estimate fugitive NMVOC emissions from operations with gasoline in 1990–2014. It uses the general equation, where emissions are obtained by multiplying the total amount of gasoline sold with the emission factor.

Emission factors

NMVOC emission factor – 2 kg/Mg oil – for emission from gasoline distribution was taken from EMEP/EEA 2013, Chapter 1.B.2.a.v Distribution of oil products, Table 3-1.

Activity data

Activity data for NMVOC emission calculation was used from CSB Energy Balance (Table 3.50).

Table 3.50 Gasoline consumption in Latvia in 1990–2014 (TJ)

1990	26796
1991	22616
1992	21692
1993	21032
1994	20108
1995	18128

1996	17908
1997	16456
1998	15400
1999	14872
2000	14831
2001	15535
2002	15228
2003	15214
2004	15346
2005	15126
2006	16753
2007	18299
2008	16672
2009	13941
2010	12667
2011	11926
2012	10146
2013	9282
2014	9018

3.3.1.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Activity data for fugitive emissions from operations with gasoline were taken from CSB and uncertainty was assumed as very low for about 2% as statistical frame mistake. Uncertainty for emission factor is assumed as 100%, according to 2006 IPCC Guidelines, Volume 2, Chapter 4 *Fugitive emissions*, Table 4.2 (refined product distribution).

Time series of the estimated emissions are consistent and complete because the same methodology, emission factors and data sources are used for sectors for all years in time series. Emissions from all sectors are estimated or reported as not occurring / not applicable therefore there are no "not estimated" sectors.

3.3.1.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the Energy sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

All documentation and information received for inventory purposes are archived in FTP folder. All findings are documented by using check-lists, available on Regulations of the Cabinet of Ministers No. 217 adopted on 27 March 2012 "The National Inventory System of Greenhouse Gas Emission Units".

Activity data verification

All sources of energy data are presented in the corresponding NIR chapter (3.3.1.2 Methodological issues) as well as disaggregated data at the finest level possible are

presented in the corresponding Annex A.3.1. Data completeness has been explained in the previous subchapter.

Activity data have been checked at the data provider – Central Statistical Bureau, which has its own internal QA/QC procedures based on mathematic model and analysis to avoid logic mistakes. When activity data have been received, the sectoral expert responsible for the emission estimation and reporting are comparing all data changes with the previous inventory, and all changes are explained in the corresponding subchapter. All fluctuations or changes in NCVs are double checked and agreed with CSB.

Emission factor verification

As all emission factors are taken from EMEP/EEA 2013, no additional verification procedures have been performed.

Emission verification

To verify the NMVOC emissions, logical mistakes are checked by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogical changes in the activity data and emissions. The emissions are also cross-checked with emissions reported within CLRTAP for verification purposes.

3.3.1.5 Category-specific recalculations

No recalculations are done in the particular subsector.

3.3.1.6 Category-specific planned improvements

No improvements are planned to be done until the next submission.

3.3.2 Fugitive emissions from natural gas (CRF 1.B.2.b, CRF 1.B.2.c, CRF 1.B.2.d)

3.3.2.1 Category description

CO_2, CH_4 and NMVOC emissions from operations with natural gas are reported in the following sub-sectors CRF 1.B.2.b Natural gas sector:

- 1.B.2.b.i Venting;
- 1.B.2.b.iii All other:
    - 1.B.2.b.iii 4 Transmission and storage;
    - 1.B.2.b.iii 5 Distribution;
    - 1.B.2.b.iii 6 Other (includes leakage at industrial plants and power stations and leakage at residential and commercial sectors)

Table 3.51 Fugitive CH_4, CO_2 and NMVOC emissions from natural gas 1990-2014 (kt)

	CO_2	CH_4	Aggregate GHGs	NMVOC
	kt		kt CO_2 eq.	kt
1990	0.0115	9.90	247.59	2.97
1991	0.0111	9.54	238.49	2.86
1992	0.0101	8.70	217.43	2.60
1993	0.0097	8.32	207.94	2.49

	CO_2	CH_4	Aggregate GHGs	NMVOC
	kt		kt CO_2 eq.	kt
1994	0.0094	8.13	203.20	2.43
1995	0.0092	7.92	197.89	2.37
1996	0.0089	7.63	190.68	2.28
1997	0.0083	7.12	177.96	2.13
1998	0.0079	6.83	170.75	2.05
1999	0.0076	6.51	162.79	1.95
2000	0.0070	6.03	150.64	1.80
2001	0.0073	5.84	146.09	1.76
2002	0.0074	6.10	152.57	1.83
2003	0.0055	4.76	119.08	1.43
2004	0.0055	4.71	117.87	1.41
2005	0.0062	5.33	133.19	1.60
2006	0.0044	3.82	95.53	1.14
2007	0.0046	3.92	98.07	1.89
2008	0.0047	4.03	100.70	1.74
2009	0.0044	3.81	95.13	1.81
2010	0.0043	3.66	91.61	1.77
2011	0.0054	2.52	63.03	0.86
2012	0.0049	3.18	79.61	0.98
2013	0.0080	4.04	101.01	1.28
2014	0.0138	5.41	135.33	1.93
Share of Energy total, 2014	0.0002%	43.5%	1.9%	8.9%
2014 vs 2013	72.2%	34.0%	34.0%	50.2%
2014 vs 1990	19.8%	-45.3%	-45.3%	-35.0%

The emissions have a decreasing trend in 1990-2014 with the reduction of GHGs by 45%. There are few years where the emissions increased, and in all cases the increase is related with repair works and modernisation of existing pipeline system. In 2014, there can be seen a rise in emissions by 115% comparing with 2011, and it can be explained with repair works in pipeline system. However, a detailed information about length of pipelines, materials used for the distribution network, pressure conditions, flow rates etc. is not possible to obtain due to confidentiality issues because "Latvijas Gāze" is the only company in Latvia which distributes natural gas.

3.3.2.2 Methodological issues

Methods

LEGMC are receiving data about CH_4 emissions from the natural gas holding company "Latvijas Gāze" for the time period 1990–2014, Consequently company "Latvijas Gāze" calculates emissions by itself, using data of natural gas density and other physical parameters, and measures the content of methane and other chemical compounds in natural gas, therefore it is assumed as Tier 2 method, using country-specific data and calculations.

LEGMC has methodological material, which describes how the amounts of natural gas leaked are calculated. The methodology is translated in English and a brief essence of methods is available on Annex 3.4.

Activity data

CH_4 emissions are obtained from the holding company "Latvijas Gāze" and the activity data (millions m^3) are provided in Table 3.52.

Table 3.52 Amounts of natural gas leaked in 1990-2014 (10^6 m^3)

	1.B.2.b.i Venting	1.B.2.b.iii 4 Transmission and storage	1.B.2.b.iii 5 Distribution	1.B.2.b.iii 6 Other	Total
1990	5.61	0.13	0.69	12.44	18.87
1991	5.38	0.13	0.69	11.98	18.17
1992	4.83	0.13	0.59	10.92	16.47
1993	4.58	0.13	0.69	10.44	15.85
1994	4.46	0.13	0.69	10.21	15.48
1995	4.32	0.13	0.69	9.94	15.08
1996	4.13	0.13	0.69	9.58	14.53
1997	3.80	0.13	0.69	8.94	13.56
1998	3.63	0.11	0.69	8.58	13.01
1999	3.42	0.11	0.69	8.18	12.40
2000	3.11	0.11	0.69	7.57	11.48
2001	0.30	0.10	0.69	10.03	11.14
2002	0.98	0.10	0.69	9.86	11.63
2003	1.09	0.10	0.69	7.20	9.07
2004	1.56	0.09	0.69	6.63	8.98
2005	3.25	0.09	0.69	6.12	10.15
2006	1.80	0.08	0.69	4.71	7.28
2007	1.76	0.07	0.69	4.95	7.47
2008	2.44	0.07	0.69	4.48	7.67
2009	1.78	0.06	0.69	4.71	7.25
2010	1.64	0.06	0.69	4.59	6.98
2011	1.77	0.05	0.69	1.70	4.21
2012	1.34	0.05	0.69	3.35	5.43
2013	1.09	0.04	0.69	4.06	5.89
2014	1.53	0.04	0.66	5.69	7.93

3.3.2.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

The level of uncertainty was determined by natural gas distributing company „Latvijas Gāze". The uncertainty both for activity data (gas amounts) and CH_4, CO_2 and NMVOC emissions from gas venting and natural gas leakages in gas distribution and transmission systems, as well as in gas storage facility is assigned as quite low – 10%, as these were estimated by only enterprise operated with natural gas in Latvia – "Latvijas Gāze" by methodology developed for enterprise. However, for other leakage (CRF 1.B.2.b.iii 6) the uncertainty for the emissions is assumed as 35%.

Emissions from all sectors are estimated or reported as not occurring / not applicable therefore there are no "not estimated" sectors.

3.3.2.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the Energy sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

"Latvijas Gāze", that reports fugitive CH_4 emissions from the operations with natural gas, estimates CH_4 and CO_2 emissions according to methodology prepared especially for the organization that is internationally verified and approved by the Environment State Bureau. Underground storage "Inčukalns" also has an ISO standard and all the information obtaining procedures are controlled and verified.

3.3.2.5 Category-specific recalculations

No recalculations are done in the particular subsector.

3.3.2.6 Category-specific planned improvements

No improvements are planned to be done until the next submission.

3.4 CO_2 TRANSPORT AND STORAGE (CRF 1.C)

There is no CO_2 captured and further storaged in Latvia. There is a research done to find the potential sites for CO_2 geological storage in Latvia within international project "Assessing European Capacity for Geological Storage of Carbon Dioxide" (EU GeoCapacity)[23,24]. Latvia has a storage potential in local structures in the Cambrian water-saturated sandstone. In one of such geological structures, an underground storage of natural gas was established already in 1968 – the Inčukalns natural gas storage. For modelling the potential costs, the largest CO_2 source in Latvia in 2005 from ETS was taken, and as potential storages were selected the two largest ones. The modelling results demonstrated that the efficiency of the establishment of CO_2 storages there is too low. The unsatisfactory results are associated with the inefficient injection of small volumes of CO_2 in the storages, and the cost of the establishment of infrastructure is quite high, and the expenditure is unfounded with the low level of CO_2 injection.

[23] *http://www.co2geonet.com/NewsData.aspx?IdNews=44&ViewType=Old&IdType=18*
[24] *http://meteo.lv/fs/CKFinderJava/userfiles/files/Geologija/Potential%20sites.pdf*

4 INDUSTRIAL PROCESSES AND PRODUCT USE (CRF 2)

4.1 OVERVIEW OF SECTOR

Greenhouse gas emissions from Industrial Processes and Product Use (IPPU) contributed 7.4% to the total anthropogenic greenhouse gas emissions excluding LULUCF in 2014 (Figure 4.1) totalling 837 kt CO_2 eq.

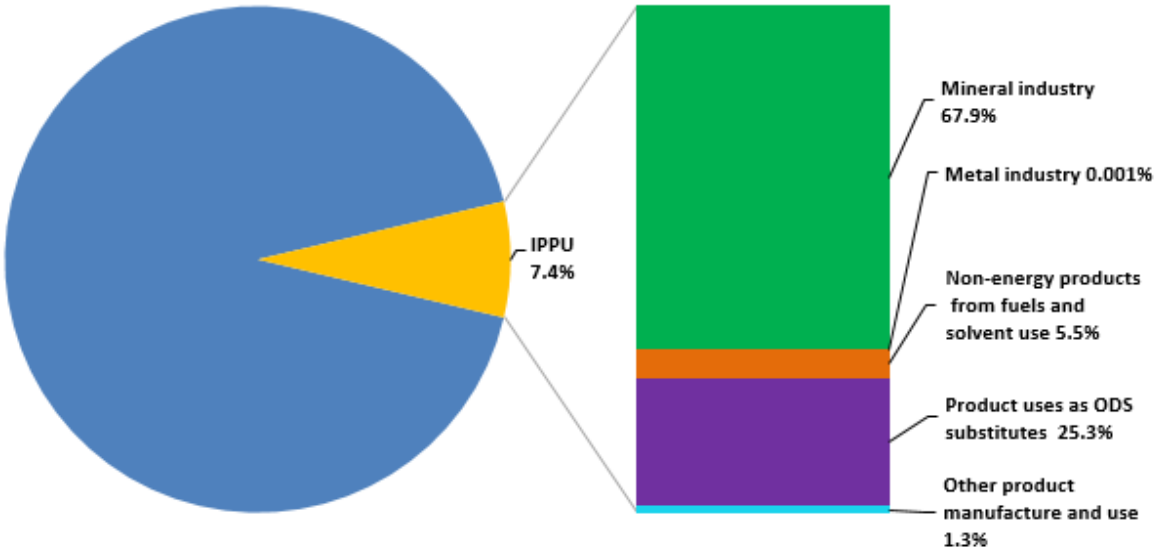

Figure 4.1 Emissions from the industrial processes and product use sector compared with the total emissions in 2014

The majority (67.9%) of IPPU emissions originate in 2.A Mineral industry (CO_2 emissions from Cement and Lime production, Other process uses of carbonates and Glass production). The second largest emission category under IPPU sector is 2.F Product uses as substitutes for ODS constituting 25.3% from IPPU emissions and 1.9% from total GHG emissions in Latvia (excluding LULUCF). Almost all 2.F. emissions comes from 2.F.1 Refrigeration and air conditioning appliances. Remaining sectors generating emissions in IPPU are 2.D Non-energy products from fuels and solvent use (5.5%) and 2.G Other product manufacture and use constituting 1.3% from total IPPU emissions in 2014.

Sources of emissions from IPPU sector reported in Latvia`s GHG inventory are as follows:

- Mineral Industry (CRF 2.A)
  - Cement Production (clinker production) (CRF 2.A.1)
  - Lime Production (as non-marketed lime for steel production in Iron & Steel production plant) and limestone and dolomite use in lime production (CRF 2.A.2)
  - Glass Production (CRF 2.A.3)
    - Raw material use in glass production – potash, fluorspar and witherite
    - Limestone and dolomite use in glass production
    - NMVOCs and indirect CO_2 from glass fibre production
    - Soda ash use in glass production
  - Other Process Uses of Carbonates (CRF 2.A.4)

        - Ceramics (Bricks and tiles production) (CRF 2.A.4.a)
        - Other (NOx, CO and NMVOC emissions from clinker production) (CRF 2.A.4.d)
- Metal Industry (CRF 2.C)
    - Iron and Steel Production (CRF 2.C.1)
        - CO_2 emissions from use of crude iron as raw material
        - CH_4 and indirect GHG emissions from total iron and steel production
        - CO_2 emissions from limestone and dolomite use in steel production
- Non-energy products from fuels and solvent use (CRF 2.D)
    - Lubricant Use (CRF 2.D.1)
    - Paraffin Wax Use (CRF 2.D.2)
    - Other (CRF 2.D.3)
        - Solvent use
        - Road paving with asphalt
        - Asphalt roofing
        - Urea use
- Product uses as Substitutes for ODS (CRF 2.F)
    - Refrigeration and Air Conditioning (CRF 2.F.1)
        - Commercial Refrigeration (CRF 2.F.1.a)
        - Domestic Refrigeration (CRF 2.F.1.b)
        - Industrial Refrigeration (CRF 2.F.1.c)
        - Transport Refrigeration (CRF 2.F.1.d)
        - Mobile Air-Conditioning (CRF 2.F.1.e)
        - Stationary Air-Conditioning (CRF 2.F.1.f)
    - Foam Blowing Agents (CRF 2.F.2)
        - Closed Cells (CRF 2.F.2.a)
    - Fire Protection (CRF 2.F.3)
    - Aerosols (CRF 2.F.4)
        - Metered Dose Inhalers (CRF 2.F.4.a)
- Other product manufacture and use (CRF 2.G)
    - Electrical Equipment (CRF 2.G.1)
    - N_2O From Product Uses (CRF 2.G.3)
- Other Production (CRF 2.H)
        - NMVOC emissions from food and drink production (2.H.1)
        - CO_2 emissions from limestone use in sugar production for time period 2005-2006 (2.H.1)
        - SO_2 emissions from Pulp and Paper production for time period 1990 – 1996 (2.H.2).

Emissions from the Chemical Industry (CRF 2.B) and Electronics Industry (CRF 2.E) are not occurring (NO) in Latvia. In CRF Reporter some information and data in the parent categories (green and grey cells) in corresponding CRF tables might be missing due to CRF internal issue which does not allow to directly enter NO in green and grey cells without adding child nodes. It was confirmed by CRF help desk that this issue be improved in the future releases of the software.

4.1.1 Description

Emissions from IPPU have been increased by 18.3% since 1990 (Figure 4.2, Table 4.1). IPPU emissions in 2014 increased by 1% compared to 2013.

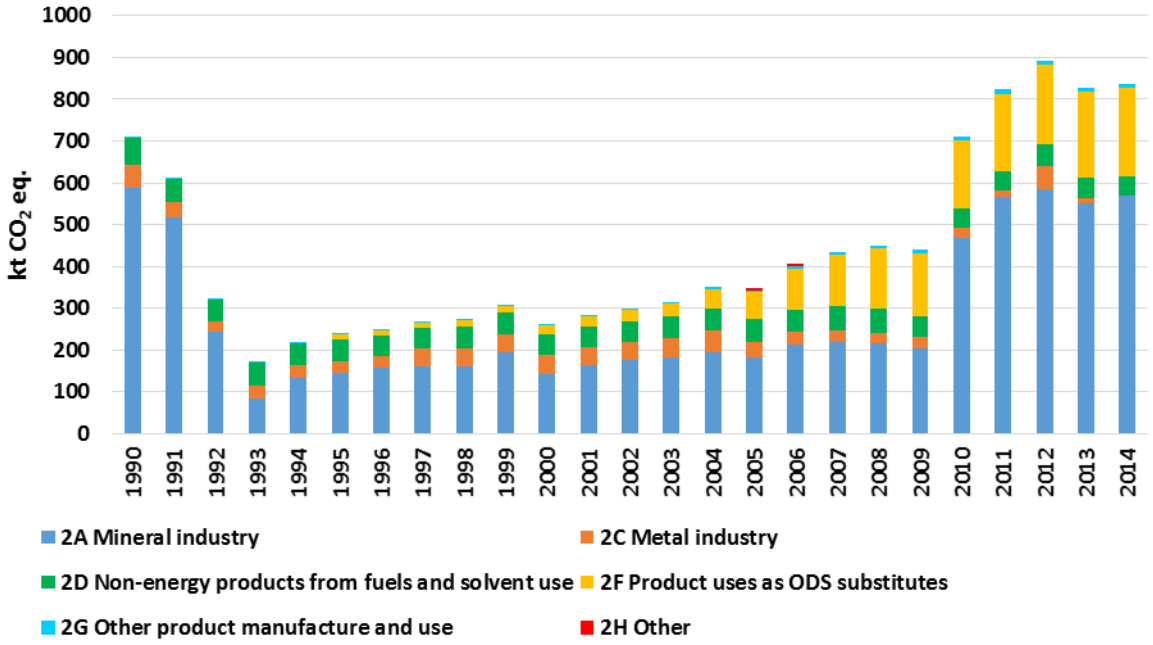

Figure 4.2 GHG emissions from Industrial Processes and Product Use in 1990–2014 (kt CO_2 eq.)

Emission fluctuations through years are mainly linked with the economic situation in the country. The largest decrease in emissions occurred between years 1991 and 1993, when industry was affected by a crisis. It has to be noted that at the beginning of 1990s during the countrywide change in government system the national economy statistics was not well kept. Therefore there is a lack of statistical data regarding industry during this time period or they are vague. The data extrapolation was carried out for the sectors where it was possible.

A key drivers for IPPU emission growth starting from 1994 are overall increase of activity in industrial production processes (cement and lime production). Since that time sharp development of construction activities has been observed and industrial production of building materials also increased. Changes in export of products from Latvia to Commonwealth of Independent States (CIS) countries has also caused emission fluctuations 1998-2000.

Since 2010 rapid emission growth could be observed in Mineral industry where CO_2 emission increase was a result of setting up of new dry process technological plant in cement production. In 2014 the CO_2 and CH_4 emissions from metal industry have decreased by 100% compared to 1990 due to insolvency of the only metal production plant in Latvia.

Emissions of F-gases have been increasing significantly since 1995. The sharp increase of F-gases emissions is related to growing demand for refrigeration and air conditioning equipment along with improving economic situation in Latvia. There is no manufacturing of F-gases containing products in the country thus emissions mainly depend on consumption of imported products.

Table 4.1 Greenhouse gas emission trend in 1990–2014 (kt CO_2 eq.)

Year	Total	2.A Mineral Industry	2.C Metal Industry	2.D Non-Energy Products from Fuels and Solvent	2.F Product Uses as Substitutes for ODS	2.G Other Product Manufacture and Use	2.H. Other
1990	707.49	589.20	52.66	64.32	NO,NA,NE	1.30	NA,NO
1991	610.71	518.03	35.76	55.62	NO,NA,NE	1.30	NA,NO
1992	322.83	244.42	23.54	53.58	NO,NA,NE	1.29	NA,NO
1993	169.86	84.68	28.76	55.16	NO,NA,NE	1.26	NA,NO
1994	217.84	132.13	31.20	53.27	NO,NA,NE	1.24	NA,NO
1995	237.25	146.12	26.17	52.07	11.50	1.40	NA,NO
1996	249.20	158.70	24.91	51.62	12.59	1.38	NA,NO
1997	266.26	159.33	42.61	50.02	12.73	1.56	NA,NO
1998	273.35	159.41	45.43	51.49	15.33	1.70	NA,NO
1999	307.50	193.31	44.07	51.17	17.07	1.88	NA,NO
2000	260.31	143.39	43.64	50.77	20.46	2.05	NA,NO
2001	283.27	163.78	42.75	50.28	23.92	2.54	NA,NO
2002	298.08	174.49	42.88	49.76	27.20	3.75	NA,NO
2003	315.17	182.33	47.16	50.61	31.18	3.88	NA,NO
2004	350.66	194.38	51.47	52.91	47.54	4.36	NA,NO
2005	347.38	183.35	36.11	54.72	63.48	4.88	4.85
2006	404.92	212.85	30.92	53.18	98.09	5.16	4.73
2007	432.84	218.14	27.69	57.80	123.59	5.63	NA,NO
2008	447.99	214.83	24.81	60.21	142.02	6.13	NA,NO
2009	441.11	203.94	26.88	49.30	152.14	8.85	NA,NO
2010	711.12	467.40	25.26	45.18	164.42	8.87	NA,NO
2011	823.16	567.21	15.20	46.31	184.97	9.45	NA,NO
2012	892.51	584.98	55.98	51.75	190.21	9.59	NA,NO
2013	828.38	550.26	13.92	49.39	204.35	10.46	NA,NO
2014	837.00	568.01	0.01	46.33	212.06	10.59	NA,NO
Share of total % in 2014	7.4%	5.0%	0.0001%	0.4%	1.9%	0.1%	0.0%
2014 versus 2013	+1.0%	3.2%	-99.9%	-6.2%	3.8%	1.3%	0.0%
2014 versus 1990	+18.3%	-3.6%	-100.0%	-28.0%	1743.8%[25]	713.4%	0.0%

Key categories under IPPU sector are listed in Table 4.2. Information regarding approaches used for key category analysis available in Chapter 1.5 and Annex 1.

Table 4.2 Key categories of IPPU sector in 2016 submission

IPCC category/Group	Gas	Identification criteria	with LULUCF	without LULUCF
2.A.1.Cement Production	CO_2	L1, L2,T1,T2	X	X
2.A.2. Lime Production	CO_2	T1,T2	X	X
2.A.4. Other process uses of carbonates	CO_2	T1,T2		X
2.C.1 Iron and Steel Production	CO_2	T1		X

[25] *2014 versus 1995*

IPCC category/Group	Gas	Identification criteria	with LULUCF	without LULUCF
2.D.3. Solvent Use	CO_2	L1		X
2.F.1. Refrigeration and air conditioning	HFCs	L1, L2	X	X

4.2 MINERAL INDUSTRY (CRF 2.A)

4.2.1 Category description

2.A Mineral industry sector is the major emission source under IPPU sector. Most important sources of non-energy CO_2 emissions under 2.A sector is a cement production, limestone use in glass production as well as metal and lime production. Mineral industry sector GHG emissions amounts to 568.01 kt (5.0%) of total anthropogenic GHG emissions in Latvia in 2014.

Emissions from Mineral industry have decreased by 3.6% since 1990 and increased by 3.2% compared to 2013 (Figure 4.3 and Table 4.1).

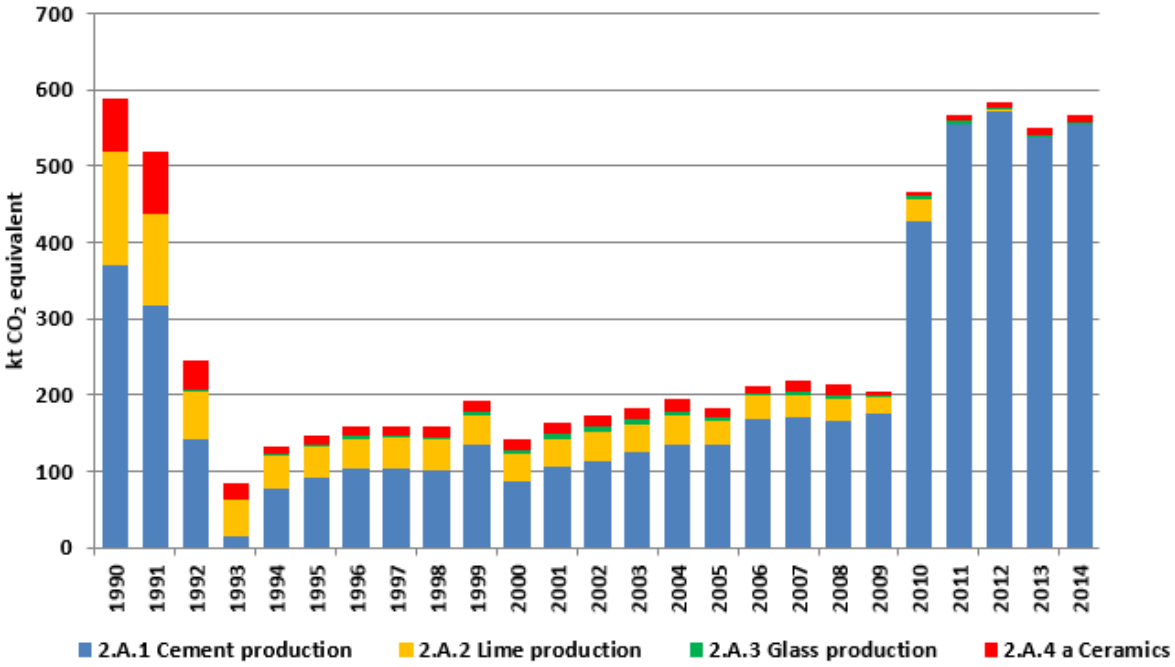

Figure 4.3 Emissions from Mineral industry in 1990–2014 (kt CO_2 eq.)

CO_2 emissions are strongly influenced by economic situation in the country. Emission curve reflects economic crisis in time period 1991–1993 after transition of national economy due to broke down of the former Soviet Union market when significant amount of industrial producers stopped their activity (Table 4.3). Also radical decreases of CO_2 emissions from 1998 to 2000 are explainable with markably decreased export from Latvia to Commonwealth of Independent States (CIS).

Table 4.3 Emissions from 2.A Mineral Industry in 1990–2014 (kt)

	CO_2					NOx	CO	NMVOC	SO_2
	2.A	2.A.1	2.A.2	2.A.3	2.A.4.a				
1990	589.20	370.80	148.86	0.36	69.18	0.90	NO,NA,NE	0.16	3.41
1995	146.12	91.07	40.66	3.40	10.98	0.24	NO,NA,NE	0.04	0.90

	CO_2					NOx	CO	NMVOC	SO_2
	2.A	2.A.1	2.A.2	2.A.3	2.A.4.a				
2000	143.39	86.33	36.85	5.82	14.39	0.23	NO,NA,NE	0.04	0.85
2005	183.35	134.46	32.22	5.71	10.96	0.36	NO,NA,NE	0.07	1.35
2006	212.85	168.59	30.37	2.69	11.20	0.45	NO,NA,NE	0.08	1.69
2007	218.14	170.73	30.21	4.44	12.76	0.46	NO,NA,NE	0.09	1.73
2008	214.83	167.48	28.42	4.03	14.90	0.45	NO,NA,NE	0.09	1.71
2009	203.94	176.18	21.80	2.61	3.36	0.55	NO,NA,NE	0.04	1.74
2010	467.40	428.87	28.59	4.47	5.47	0.49	0.81	0.02	0.07
2011	567.21	555.14	0.27	4.33	7.48	1.02	1.73	0.03	0.38
2012	584.98	572.33	1.34	3.78	7.53	1.52	3.53	0.01	0.39
2013	550.26	537.64	0.27	3.29	9.05	1.54	2.58	0.01	0.17
2014	568.01	555.78	0.46	0.94	10.83	1.80	2.23	0.02	0.15
Share of IPPU total in 2014, %	67.9%	66.4%	0.1%	0.1%	1.3%	-	-	-	-
2014 versus 2013	+3.2%	+3.4%	+67.4%	-71.4%	+19.7%	+17.9%	-13.7%	+41.2%	-11.2%
2014 versus 1990	-3.6%	+49.9%	-99.7%	+165.0%	-84.3%	+95.7%	+176.5%[26]	-88.1%	-95.6%

Due to Latvia's economic downturn in 2007–2008 the industry development was slowing down as the financing and real estate sectors started to dominate in national economy. In 2009-2010 emissions from 2.A.1 Cement production have been increasing due to cement production plant set up new technology and installations that increased its capacity approximately 2.4 times. In 2013 there are decreased produced amount of clinker by 6.6%. There is increased activity in Mineral industry sector about 3.1% in 2014.

Under 2.A Mineral industry NMVOC emissions from glass fibre production and also SO_2, NO_x and NMVOC emissions from cement production are reported. Indirect CO_2 emissions were estimated from NMVOC emissions in 2.A.3 sector from glass fibre production. NO_x, CO and NMVOC emissions from cement production are reported in 2.A.4.d Other sector due to structure of CRF Reporter software when it is not possible to report NO_x, CO and NMVOC emissions in 2.A.1 Cement Production sector and NMVOC emissions from glass fibre production.

Reported emissions, calculation methods and type of emission factors for the 2.A Mineral Industry in the Latvian inventory are summarized in Table 4.4.

Table 4.4 GHG emission categories, methods and gases reported from 2.A Mineral Industry

Category	Method used	Gases reported
2.A Mineral Industry		
1. Cement Production	Tier2	CO_2, CO, NMVOC, SO_2, NOx
2. Lime Production	Tier1, 2, 3	CO_2
3. Glass Production	Tier1,2	CO_2
Production of Glass (Use of fluorspar)	Tier1	CO_2
Production of Glass (Use of potash)	Tier1	CO_2
Production of Glass (Use of witherite)	Tier1	CO_2
Production of Glass Fibre	Tier1,2	CO_2, NMVOC

[26] *2014 versus 2010*

Category	Method used	Gases reported
4.Other Process Uses of Carbonates		
4.a Ceramics		
Production of bricks	Tier2	CO_2
Production of tiles	Tier1,2	CO_2

4.2.2 Cement Production (CRF 2.A.1)

4.2.2.1 Category description

CO_2, NOx, CO, NMVOC and SO_2 emissions are estimated from Cement production sector.

In 2014 GHG emissions from Cement production amounted 555.78 kt CO_2 eq (4.9%) from Latvia`s total CO_2 equivalent emissions without LULUCF and 66.4% from total IPPU sector emissions. Compared to 2013 emissions have increased by 3.4%, but compared to 1990 emissions have increased by 49.9% (Table 4.3 and Figure 4.4).

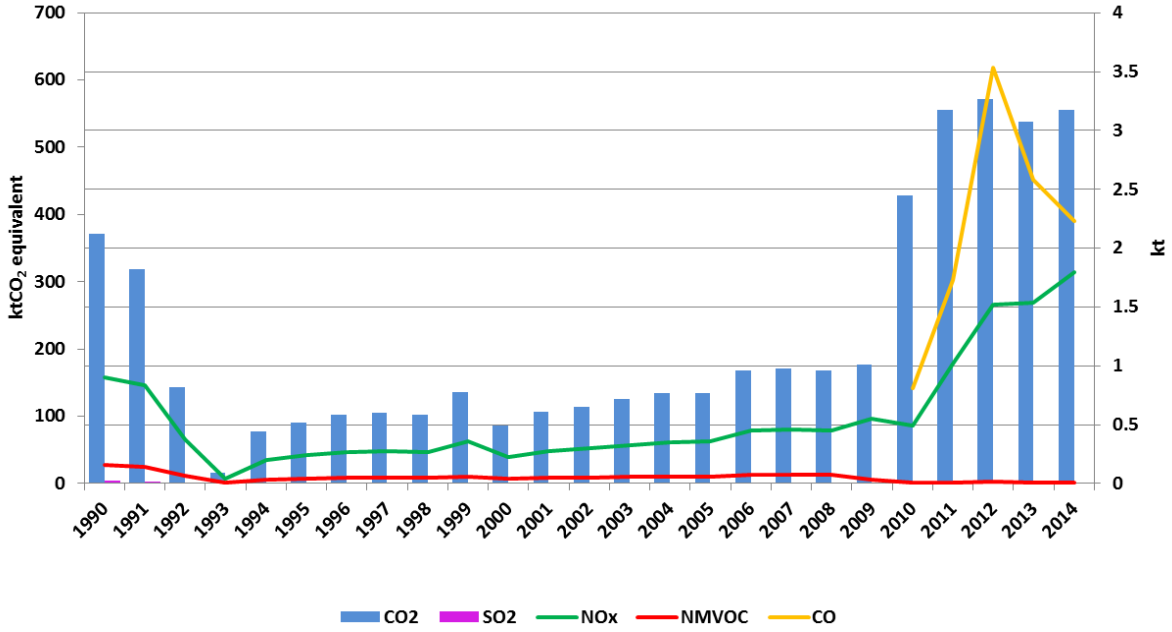

Figure 4.4 Emissions from Cement production in 1990–2014 (kt CO_2 eq.)[27]

The emission curve represents the total situation in national economy when the big decrease happened in the beginning of the 1990s due to changes in national economy, domestic market and production demand. CO_2 emissions from Cement Production had decreased by 95.6% in 1990-1993. Increase of emissions in period 2000-2007 by 97.8% represents the development of construction sector and development of external market. Still in the middle of 2009 new production plant with dry process kiln production technology was built instead of the old one where the wet process kiln technology was used. Consequently the cement kiln dust recovery was stopped and further cement kiln dust was collected and transported to landfill for storage. Therefore amount of cement kiln dust and CKD/clinker ratio increased sharply in 2010-2014 that affected CO_2 emissions.

[27] *SO_2, NOx and NMVOC on secondary axis*

NMVOC emissions have decreased in 2009-2010 by 72%. That is explained with adjustment of emission factor for new dry production process that is lower than for the old production plant's wet kiln process technology. SO_2, NOx and CO emissions are automatically detected at plant site.

Starting from 2010 fully dry process kiln is used in cement production. For 2009 both kiln processes - dry and wet was used in cement production. Previously (1990 – 2009 partly) only wet process kiln was used in cement production. Due to increasing activity for cement clinker production in 2010, decrease of SO_x emissions can be observed. As raw materials tyres and lube oil consisting of sulphur compounds were used. For 2010 SO_x, NO_x and CO data are not representative as new technology began with full capacity only in July on 2nd half of year 2010 and fully in 2011. Emissions from 2.A.1 sector increased in 2010 due to capacity building in cement production comparing with previous years. Produced clinker amount are decreased about 6.6% and CO_2 emissions about 6.1% in 2013. Production of cement clinker is depending on the demand in internal and external market. In 2014 produced amount of clinker have increased by about 3.6% compared to 2013.

4.2.2.2 Methodological issues

Tier 2 method from 2006 IPCC Guidelines was used to estimate clinker production data from final cement production amount when clinker / cement ratio for different types of cement is known. The same method is used for CO_2 emission factor and emission estimation. CO_2 emissions from clinker production are estimated using 2006 IPCC Guidelines equation 2.2[28]

$$CO_2\ Emissions = M_{cl} \times EF_{cl} \times CF_{ckd}$$

where:
CO_2 Emissions- emissions of CO_2 from cement production, tonnes
M_{cl} – weight (mass) of clinker produced, tonnes
EF_{cl} – emission factor for clinker, tonnes CO_2 /tonne clinker. This clinker emission factor (EF_{cl}) is not corrected for CKD
CF_{ckd} – emissions correction factor for CKD, dimensionless

Tier 2 approach from EMEP/CORINAIR 2007 was used to calculate NOx, NMVOC, SO_2 emissions from cement production taking into account produced amount of clinker in wet and dry process kiln and technology based EFs.

CO_2 emission factor is calculated for all years in time series 1990–2014 according to CaO content in used limestone that is measured in laboratory of cement production facility (Table 4.5). LEGMC is able to use all laboratory measurements data from cement production plant as CaO content in limestone is available to estimate CO_2 emission factor for clinker. This emission factor corresponds to Tier 2 emission factor estimations from 2006 IPCC Guidelines as CO_2 emissions from Cement Production sector.

CO_2 emission factor is calculated using equation 2.4 from 2006 IPCC Guidelines[29] taken into account country-specific data on CaO content of clinker and the fraction of CaO that was derived from a carbonate source (generally $CaCO_3$):

$$EF_{clc} = (0.785 \times CaO_{\ content}) \times CKD_{correction}$$

[28] http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol3.html, *Mineral industry emissions, p 2.9*
[29] http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol3.html , *Mineral industry emissions ,p 2.12*

where:
EF_{clc} – clinker production EF (kt/kt)
0.785 – molecular weight ration of CO_2 to CaO in the raw material ($CaCO_3$)
CaO – CaO content (weight fraction) in produced clinker (%)
$CKD_{correction}$ – correction factor for cement kiln dust

CKD correction factor is calculated using equation 2.5 from 2006 IPCC Guidelines:

$$CF_{ckd} = 1 + (M_d/M_{cl}) \times C_d \times F_d \times (EF_c/EF_{cl})$$

where:
CF_{ckd}- emissions correction factor for CKD, dimensionless
M_d- weight of CKD not recycled to the kiln, tonnes
M_{cl}- weight of clinker produced, tonnes
C_d- fraction of original carbonate in the CKD (i.e., before calcination), fraction
F_d – fraction calcination of the original carbonate in the CKD, fraction
EF_c – emission factor for the carbonate (2006 IPCC Guidelines Chapter 2 Table 2.1), tonnes CO_2 /tonne carbonate
EF_{cl} -emission factor for clinker uncorrected for CKD (i.e., 0.51 tonnes CO_2/ tonne clinker), tonnes CO_2/ tonne clinker

Table 4.5 Average CaO content in clinker (%) and average CO_2 emission factor in 1990–2014 (t CO_2 / t clinker)

	Average CaO content (%)	CO_2 EF without CKD factor	CKD correction factor	CO_2 EF with CKD factor
1990	64.60	0.507	1.094	0.555
1995	64.06	0.503	1.031	0.518
2000	64.41	0.506	1.021	0.516
2005	64.41	0.506	1.002	0.507
2006	64.75	0.508	1.003	0.510
2007	64.06	0.503	1.004	0.505
2008	63.72	0.500	1.001	0.501
2009	65.27	0.512	1.008	0.517
2010	65.24	0.512	1.003	0.514
2011	64.34	0.505	1.004	0.507
2012	64.30	0.505	1.004	0.507
2013	64.65	0.508	1.004	0.510
2014	64.50	0.506	1.004	0.509

For 1996–2005 average CaO content data (64.41%) of 1995 and 2006 was used in emission calculation since data for average CaO content in produced clinker for years 1996–2005 was not available in cement production plant. Afterwards data of average CaO content were available from plant laboratory and reported to LEGMC for CO_2 emission factor calculation.

Indirect GHG emission factors

As the EFs for NO_x, NMVOC and SO_2 are not available in EMEP/EEA 2013[30] (marked as "Not Estimated") the EFs from EMEP/CORINAIR 2007[31] were used as these emissions are emitted in the production according to cement production plant. Till 2010 the EFs were divided for dry and wet process kiln.

NO_x, CO and SO_2 emissions as plant-specific data that are detected automatically from dry process production plant are reported since 2010. To estimate NOx, CO, SOx emissions from cement production (2A1 sector under IPPU), national database "2-Air" is used. "Cemex", the only cement production plant, has indicated in its "2-Air" report that these emissions arise from technological processes which include also heat generation to maintain certain temperatures during particular process. Until 2010 indirect GHG emissions under 2A1 sector were calculated using EMEP/CORINAIR 2007 and EMEP/EEA 2009 methodology, but afterwards these emissions were automatically detected at plant site, and measurements are taken in the main chimney. However, as these values are measured directly in the chimney, there is no way to allocate emissions under Energy and IPPU sectors separately (there are both emissions from fuel combustion and technological processes). Regarding calculation of indirect GHGs, to avoid double counting, the following fuel types (used tyres, ecofuel, coal, natural gas consumed in "Cemex") are subtracted from Energy part and their emissions can be considered as included elsewhere "IE" (2A1 sector under IPPU) in case of cement producer "Cemex". As for GHGs, these emissions are taken from EU ETS reports (CO_2) or calculated (CH_4, N_2O), therefore can be allocated under appropriate sectors. Evaporation from raw materials depends on composition of this material. Mainly it is raw material containing sulphates and sulphides that evaporates in very small amount before to the production process. Mainly SOx reaction happens in middle of process in high temperatures. At the end of the process all necessary SOx amount is fixed in clinker contain and residual SOx are detected in chimney and emitted to the air. For both technologies only NMVOC emissions are estimated using EFs provided in EMEP/CORINAIR 2007 (Table 4.6).

Table 4.6 EFs for cement clinker production emission estimation (kt/kt)

	NOx	NMVOC	SO_2
wet process kiln	0.00135	0.00023	0.0051
dry process kiln	0.00175	0.00001	0.0051

Activity data

The produced clinker is not weighted in cement production plant but estimated from final produced amount of cement clinker. As plant produce many types of cement, clinker activity data are estimated taking into account different cement types multiplying with cement/clinker ratio and also mass balance of cement, clinker and used additives in cement production. Cement production activity data from plant is available according to annual EU ETS GHG report by plant. As data of produced clinker is not available (plant has non-stop production process) the alternative is to take total amount of cement clinker data and estimate clinker amount back to clinker production data. In the cement production plant it is done for the EU ETS annual reporting by taking into account clinker and cement ratio for the

[30] http://www.eea.europa.eu/publications/emep-eea-guidebook-2013 , *Mineral products (pages 12-13)*

[31] http://www.eea.europa.eu//publications/EMEPCORINAIR5 , *Group 4: Production processes, B3311pdf. (pages 12-13)*

particular types of produced cement. Activity data of cement and clinker is plant- specific data reported by cement clinker producer. Final clinker data are calculated using plant mass balance approach in two steps:

1) Clinker production = ((cement export – cement stock changes) * clinker/cement ratio)) - clinker export – clinker stock changes ;
2) Produced clinker = used clinker + clinker export – clinker import + clinker stock change.

Approach (1) is used for each produced cement type to calculate produced clinker amount that is produced in respective plant.

CaO content is measured in the cement production companies and CO_2 EF for produced clinker is estimated according to equation 2.4 from 2006 IPCC Guidelines[32]. As it is stated by cement producer and verified by ISO accredited verifiers the cement kiln dust is weighted at the plant before the transportation outside the company for the storage.

In 2010 amount of clinker is produced almost 2.4 times more as in previous year. It is explained with new dry process kiln technology and increasing capacity of clinker production plant. Full capacity of dry process cement clinker production has caused the CO_2 emission increase starting from 2010. Cement clinker are produced for internal use but mainly for export.

Table 4.7 CKD correction factor in 1990–2014

	Produced clinker (kt)	Produced cement kiln dust (kt)	CKD / clinker ratio (%)	Corrected CKD / clinker ratio (%)
1990	668.50	175.49	26.25	0.094
1995	175.69	15.00	8.54	0.031
2000	167.18	10.00	5.98	0.021
2005	265.40	1.53	0.58	0.002
2006	330.65	2.89	0.87	0.003
2007	338.31	3.35	0.99	0.004
2008	334.46	0.99	0.30	0.001
2009	340.99	8.08	2.37	0.008
2010	834.94	7.02	0.84	0.003
2011	1095.23	10.87	0.99	0.004
2012	1129.11	13.29	1.18	0.004
2013	1054.95	12.43	1.18	0.004
2014	1093.04	12.92	1.18	0.004

As it can be seen in (Table 4.7) the plant specific data resulted in a higher CKD ratio (26.25%) in 1990, while the CKD in 2008 is much lower (0.30%). Still to ensure comparability, as required by the IPCC GPG 2000 and also reflect the national circumstances, Latvia uses the

[32] http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol3.html , *Mineral industry emissions ,p 2.12*

maximum permissible good practice guidance limit of CKD – 6-8% where the plant specific data exceeds 8% for the calculation of CO_2 emissions from cement production. CKD ratio was changed to 8% that is maximum permissible good practice guidance limit of CKD (6%–8%) although official statistical data resulted in different CKD ratio and it changed year to year depending on produced amount of clinker and cement kiln dust. In latest years there are quite stable situation in clinker production and CKD ratio is aproximately 1.18%.

According to cement production plant the CKD amount is weighted before it is sent to disposal site. The amount of weighted CKD as well as procedures of all data obtaining is verified by the accredited verifier within EU ETS. According to Verification Company all production facilities as well as data obtaining and storage was inspected at the production company personally by the lead verificator. All verification reports also are publicly available till 2012 through LEGMC web page http://www.meteo.lv/lapas/uznemumi-kuriem-izsniegtas-siltumnicefekta-gazu-emisijas-atlaujas-2-pe?id=1253&nid=575, after responsible for such information publication is State Environmental Service of Latvia - http://www.vvd.gov.lv/izsniegtas-atlaujas-un-licences/seg-atlaujas/, internal verification documentation is confidential. The cement clinker is produced only from limestone and CKD amount changes due to production technology. For the years 2005-2008 CKD has decreased due to improvement of used technology.

4.2.2.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty of cement production data is assumed as 10% as clinker production data is estimated from final cement production data because produced clinker is not weighted separately before the final cement mixture is produced.

CO_2 emission factor for 2.A.1 sector is estimated based on plant specific data of used limestone characterizations so average uncertainty of 5% is assumed.

Time series of the estimated emissions are consistent and complete because the same methodology, emission factors and data sources are used for sectors for all years. GHG emissions from the sector are estimated or reported as not occurring / not applicable therefore there are no "not estimated" sectors.

All industrial production data used in emission estimation from 2.A Mineral Products sector is taken from the annual GHG reports that industrial producers submit within EU ETS. According to EU ETS legislation all GHG reports have to be verified by the ISO accredited verifiers that checks that all reported information – activity data, CO_2 emission factors, estimated emissions as well as estimation methodology, is correct and corresponds to certain requirements from the legislation. Cement and lime production facilities certify that all additional information for CO_2 emission estimation is verified. Regional Environmental Board also checks the annual GHG reports and compares the data in the reports with the data reported by the enterprise to database "2-AIR" and to CSB.

Time series consistency was checked by verifying IEF, AD and emission changes and attention was paid to important changes that increase/decrease and are explained in NIR.

4.2.2.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the IPPU sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

QA/QC check is performed with Tier 2 method from 2006 IPCC Guidelines.

Emissions are checked using time series consistency check for the IEF estimated in CRF Reporter and all IEF changes - in time series are double-checked and reasonable explanation for IEF changes has to be found under each subsector source category description.

Quality control check list is filled for each category taking into account criteria given in QA/QC plan approved in national legislation. All findings were documented and introduced in GHG inventory. All corrections are archived.

Checks performed pursuant to Article 7(1)(l) of Regulation (EU) No 525/2013 are done to compare EU ETS data with GHG inventory emissions. These checks results with differences represented in Table 4.8.

Table 4.8 Differences between CO_2 emissions under ETS and inventory data of cement production for 2013 and 2014

2.A.1 Cement Production			Difference
Year	IPCC methodology 2006 IPCC Guidelines Volume 3 Chapter 2 equation 2.2	Monitoring and reporting Regulation[33] Art.30 and 31.	
2013	537.64 kt	560.37 kt	4.22%,
2014	555.77 kt	580.63 kt	4.47%

Differences between CO_2 emissions under European Union Emission Trading system (EU ETS) and GHG inventory are caused by use of different emission calculation methodologies from cement production under UNFCCC reporting (IPCC GPG 2000 and 2006 IPCC Guidelines) and EU ETS reporting[34]. There is only one cement plant in Latvia which uses Tier 1 method in ETS reporting (according to EU Monitoring and reporting Regulation). Default EFs are taken for CO_2 emission calculation as it is not possible to obtain all necessary laboratory measurements in plant laboratory to apply higher Tier method as this laboratory is not accredited.

4.2.2.5 Category-specific recalculations

No specific recalculations were done in this sector.

4.2.2.6 Category-specific planned improvements

No improvements are planned for this sector.

[33] *http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0601&from=EN*

[34] *Under EU ETS up to 2012 the calculation methodologies from EU ETS directive 2003/87/EC and Monitoring and Reporting guidelines were used but starting the EU ETS Phase 3 in 2012 the Monitoring and reporting Regulation is used for the emission calculation.*

4.2.3 Lime Production (CRF 2.A.2)

4.2.3.1 Category description

Under this sector CO_2 emissions from lime production in Iron & Steel production are reported as these emissions are estimated based on total produced quicklime (CaO) data and limestone and dolomite use in one lime production plant.

Lime production sector CO_2 emissions amounts to 0.46 kt (0.1%) of total IPPU emissions in Latvia in 2014.

CO_2 emissions from 2.A.2 sector are decreased about 99.7% since 1990 and increased by about 67.4% compared to 2013 (Figure 4.5 and Table 4.9).

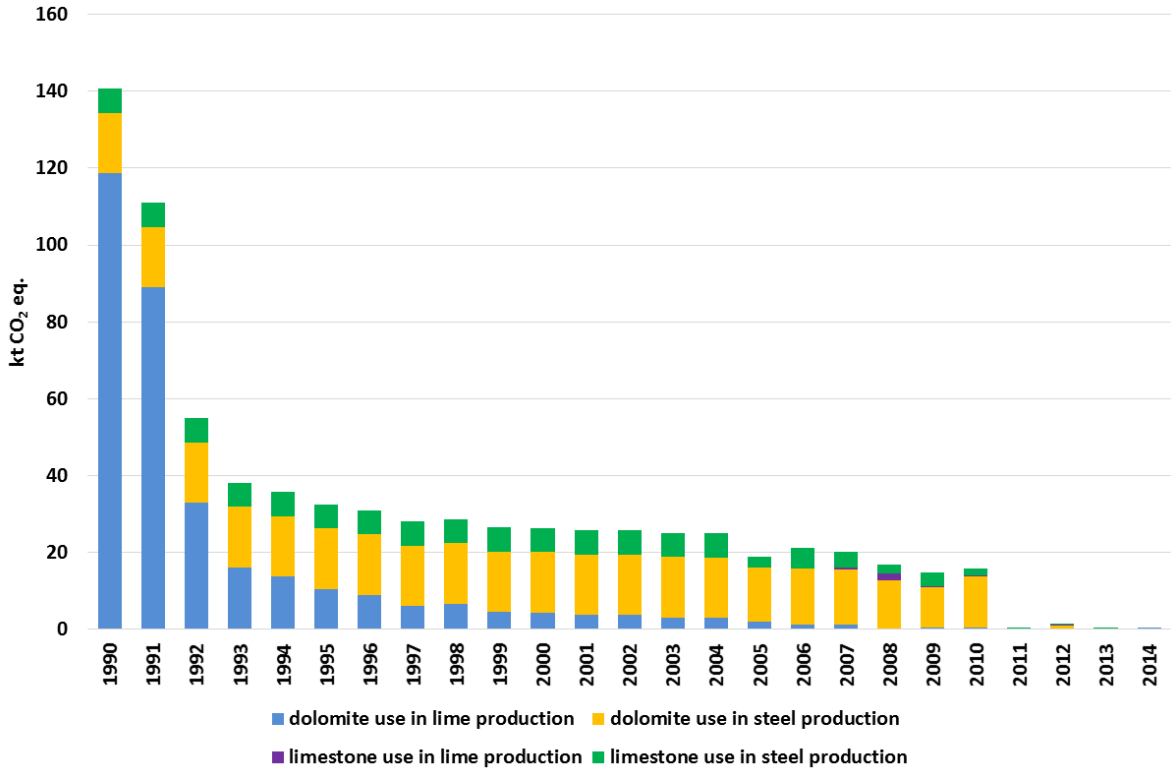

Figure 4.5 CO_2 emission from limestone and dolomite use in lime and steel production in 1990–2014 (kt)[35]

As it can be seen in Figure 4.5 the CO_2 emissions from dolomite use in lime production plant as well as dolomite and limestone use in steel production are continuously decreasing since the beginning of 1990s due to recession of overall national economy. In 2013-2014 dolomite in steel production and limestone in lime production are not used anymore. As raw materials very small amount of limestone in steel production is used. Dolomite are still used in lime production.

In iron & steel production facility lime is necessary for steel smelting in open hearth furnaces. Quicklime is produced only from limestone in vertical shaft kiln. The plant reports

[35] *dolomite use (steel production), limestone use (steel production), dolomite use (lime production), on secondary axis*

their non-marketed quicklime production data for 2005-2013 within EU ETS so the estimated emissions as well as used activity data and emission factors are taken from plant's annual GHG report (Table 4.9).

Table 4.9 CO_2 emissions from lime production in 1990–2014 (kt)

	In steel production	In lime production
1990	30.238	118.620
1995	30.238	10.422
2000	32.565	4.283
2005	30.374	1.849
2006	29.065	1.306
2007	28.628	1.582
2008	26.537	1.887
2009	21.357	0.438
2010	28.050	0.542
2011	0.118	0.154
2012	0.980	0.356
2013	0.000	0.275
2014	NO	0.460

In 2008-2009 emissions have decreased significantly due to the economic crisis. In 2010 emissions from lime production are increased by about 23.8% due to overall increase of activity in IPPU. In 2011 emissions of produced lime that are used for metal production are decreased by 99.6% due to changes in metal production technology as plant switched on steel production in Electric arc furnace (EAF). Operation of this plant was partially suspended due to reconstruction. Previously open hearth furnace (OHF) technology was used for steel making.

In latest years CO_2 emissions from 2.A.2 have decreased due to steel production plant`s reconstruction and insolvency which was the reason why plant was not operating full time anymore.

4.2.3.2 Methodological issues

Methods

CO_2 emissions from lime production in steel production plant are estimated using Tier 1 method based on total produced quicklime data and default emission factor.

$$EM = EF \times AD$$

where:
EM – CO_2 emissions from quicklime production (kt)
EF – default EF according to IPCC GPG 2000 (tCO_2/t lime)
AD – quicklime production data (kt)

CO_2 emissions from Lime production in two direct lime production plants are calculated on the basis on data of carbonates – dolomite and limestone use. Purity factor from IPCC GPG 2000 is taken into account in estimation of CO_2 emissions from dolomite use in lime production. CO_2 emissions from limestone use in lime production processes are estimated with Tier 2 method based on plant specific activity data and default IPCC 1996 emission

factors. Tier 3 method is used in CO_2 emission estimation from dolomite use in lime production processes as plant specific activity data as well as plant specific CO_2 emission factors are available.

Emission factors

Default CO_2 emission factor from IPCC GPG 2000 was used by steel production plant as per tonne of high calcium quicklime – 0.785 tCO_2/t lime[36]. Lime in the particular plant is produced from limestone and dolomite.

Emission factors of limestone and dolomite use in steel production are default ones taken from IPCC 1996 (Table 4.10).

Table 4.10 CO_2 emission factors for limestone and dolomite use (t CO_2/t raw material)

	1990–2014
Limestone use in steel and lime production	0.440
Dolomite use in steel production	0.477

Plant specific CO_2 emission factor for dolomite use in lime production

The used CO_2 emission factor of dolomite use in Lime production is considered as plant specific as CaO and CaO*MgO content is taken into account.

According to laboratory measurements made in the only lime production plant in Latvia average content of dolomite is:

$CaCO_3$ – 51.83%;

$MgCO_3$ – 40.80%;

SiO_2; Fe_2O_3; Al_2O_3 – 5.88%;

Others – 1.49%.

According to laboratory data:

- average content of water in dolomite is 5.24%;
- average content of water in produced lime is 0%;
- average content of CO_2 in lime is 16.99%;
- average content of dolomite (dry) is 94.76% or 947.6 kg dolomite.

947.6 kg dolomite contains:

491.14 kg $CaCO_3$ (51.86%)

386.62 kg $MgCO_3$ (40.80%)

55.72 kg SiO_2; Fe_2O_3; Al_2O_3 (5.88%)

14.12 kg Others (1.49%)

947.6 kg dolomite complete decomposes and pullulates:

[36] http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol3.html *(page 2.22)*

491.14 kg $CaCO_3$ × 0.440 (emission factor) = 216.10 $_{kg}$ CO_2

386.62 kg $MgCO_3$ × 0.522 (emission factor) = 201.82 $_{kg}$ CO_2.

Oxides capture:

491.14 kg $CaCO_3$ × 0.560 (emission factor) = 275.04 kg CaO

(or 491.14 kg $CaCO_3$ – 216.10 kg CO_2 = 275.04 kg CaO)

386.62 kg $MgCO_3$ × 0.478 (emission factor) = 184.80 kg MgO

(or 386.62 kg $MgCO_3$ – 201.82 kg CO_2 = 184.80 kg MgO)

216.10 kg CO_2 + 201.82 kg CO_2 + 275.04 kg CaO + 184.80 kg MgO = 877.76 kg

947.6 kg – 877.76 kg = 69.84 kg ballast

Lime is made (theoretical):

275.04 kg CaO + 184.80 kg MgO + 69.84 kg ballast = 529.69 kg lime

CO_2 content in lime is 16.99% (practical):

529.69 kg lime – 83.01%

Lime is made (practical):

638.09 kg lime + CO_2 – 100%

CO_2 content in lime is:

638.09 kg lime + CO_2 – 529.69 kg lime = 108.41 kg CO_2

CO_2 emissions (1 tonne complete decomposition) pullulate:

216.10 kg CO_2 + 201.82 kg CO_2 – 108.41 kg MgO = 309.51 kg CO_2

0.3095 t CO_2 proceed from practical decomposition of 1 tonne of dolomite.

Average content of water (5.24%) in used dolomite is taken into account when CO_2 emission factor is estimated:

CO_2 EF dolomite use in lime production = 309.51 kg CO_2 × 94.76% = 0.29329167 t CO_2 / t dolomite.

Activity data

In this sector activity data from two facilities of lime production and one plant of steel production are collected.

Activity data were taken from industrial production plants. Industrial producers are participants of the EU ETS and the GHG reports of these enterprises have to be freely available according to EU ETS regulations. The GHG reports of EU ETS operators are published on LEGMC home page (http://www.meteo.lv/lapas/uznemumi-kuriem-izsniegtas-siltumnicefekta-gazu-emisijas-atlaujas-2-pe?id=1253&nid=575) (Table 4.11).

Table 4.11 Amount of produced lime in 1990–2014 (kt)

	In steel production	In lime production
1990	10.452	214.225
1995	10.452	19.208
2000	13.416	7.894
2005	17.097	20.435
2006	11.758	14.116
2007	12.939	15.510
2008	14.842	17.283
2009	8.851	9.581
2010	16.325	17.211
2011	NO	0.185
2012	NO	0.558
2013	NO	0.496
2014	NO	0.831

For 1995-2004 the iron production plant reported their activity data additionally based on the information request. Due to the lack of official data it was decided to use year's 1995 activity data for emission estimation for 1990-1995.

Changes of national economy and whole data exchange system in early 1990s were the reason why many data is lost even in production plants. Still to improve CO_2 emission estimation in all time series the activity data of first year's data available was used to estimate emissions for the prior years, for example, for Iron & Steel production plant year 2005 data was used to estimate the emissions for 1990-2004. In year 2005 Iron and steel production plant became as ETS participant and detailed activity data is available.

Activity data fluctuates in whole time series. Largest decrease could be observed at the beginning of 1990s when enonomic situation in the county was unstable due to change from a centrally planned economy to a market economy.

In 2010 activity data are raised by 84.4% due to overall increasing of activity in all industrial sectors. Exception is limestone use in steel production. There is no activity of produced quick-lime in Iron & Steel production process due to changes of steel production technological changes. In 2011 the overall decrease of total emissions from lime production by 74.1% could be observed due to changes in steel production technology and fact that operation of this plant was partially suspended due to reconstruction. In latest years there are overall decrease of activity in sector 2.A.2 (Table 4.12). Mainly that could be explained with technological changes in steel production plant as limestone and dolomite is not used anymore.

Table 4.12 Limestone and dolomite use activity data in lime production (t CO_2/t raw material)

	Dolomite use (steel production)	Limestone use (steel production)	Dolomite use (lime production)	Limestone use (lime production)
1990	33.000	14.300	404.442	NO
1995	33.000	14.300	35.535	NO
2000	33.000	14.300	14.604	NO
2005	29.707	6.326	6.303	NO
2006	30.491	12.025	4.452	NO
2007	30.405	9.017	3.776	1.078
2008	26.245	5.378	0.954	3.654
2009	22.393	8.472	1.149	0.229
2010	28.115	4.147	1.323	0.349
2011	0.246	0.002	NO	0.350
2012	1.555	0.541	0.730	0.323
2013	NO	0.000	0.936	NO
2014	NO	NO	1.568	NO

4.2.3.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Although according to IPCC GPG 2000 the uncertainty of non-marketed lime production data could reach 100% and more[37] it is assumed that the uncertainty of activity data for non-marketed lime production data in 2.A.2 sector is 2% as only one plant specific data verified by accredited verifier and approved by Regional Environmental Board is used.

As default emission factors for lime production from IPCC GPG 2000 as well as Monitoring Reporting Regulation are used and the uncertainty is assumed 50% due to unavailability of the plant specific data of produced lime and due to the fact that this is default emission factor for quicklime production.

Time series of the estimated emissions are consistent and complete because the same methodology, emission factors and data sources are used for sectors for all years in time series. All other GHG emissions except CO_2 emission are not relevant and could not be reported in CRF.

Time series consistency was checked by verifying IEF, AD and emission changes and attention was paid to important increase/decrease that are explained in NIR.

4.2.3.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed

[37] *http://www.ipcc-nggip.iges.or.jp/public/gp/english/3_Industry.pdf (page 3.23)*

according to the QA/QC plan in the IPPU sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

QA/QC check is performed with Tier 1 method from IPCC GPG 2000.

Activity data, CO_2 emission factor and estimated emissions are taken from the annual GHG reports that steel production plant submit within EU ETS.

According to EU ETS legislation all GHG reports have to be verified by the ISO accredited verifiers that checks that all reported information is correct and corresponds to certain requirements from the legislation. Steel production facility certifies that all additional information for CO_2 emission estimation is verified. Regional Environmental Boards also checks the annual GHG reports and approves the report if everything reported is correct.

Emissions are checked using time series consistency check for the IEF estimated in CRF Reported and all IEF changes in time series are double-checked and reasonable explanation for IEF changes has to be found under each subsector source category description.

The QC form has been filled in for each category taking into account criteria given in QA/QC plan approved in national legislation. Form then is archived.

Checks performed pursuant to Article 7(1)(l) of Regulation (EU) No 525/2013 are done to comparing EU ETS data with GHG inventory emissions. There were no differences in this sector for 2013 and 2014. Such consistency checks are done in all IPPU sectors.

4.2.3.5 Category-specific recalculations

Recalculations were made for 2011 and 2012 due to the input mistake (there were no activity in lime production facility in 2012 due to reconstruction regarding introduction of best available technologies (BAT)). The same activity data mistakenly was taken into account for 2011 and 2012.

4.2.3.6 Category-specific planned improvements

No improvements are planned for the sector.

4.2.4 Glass production (CRF 2.A.3)

4.2.4.1 Category description

Glass production sector GHG emissions amounts to 0.94 kt which constitute 0.1% of total IPPU emissions in Latvia in 2014.

CO_2 emissions from 2.A.3 sector have been increasing by 165% since 1990 and decreased by 71.4% comparing with 2013 (Figure 4.6 and Table 4.12).

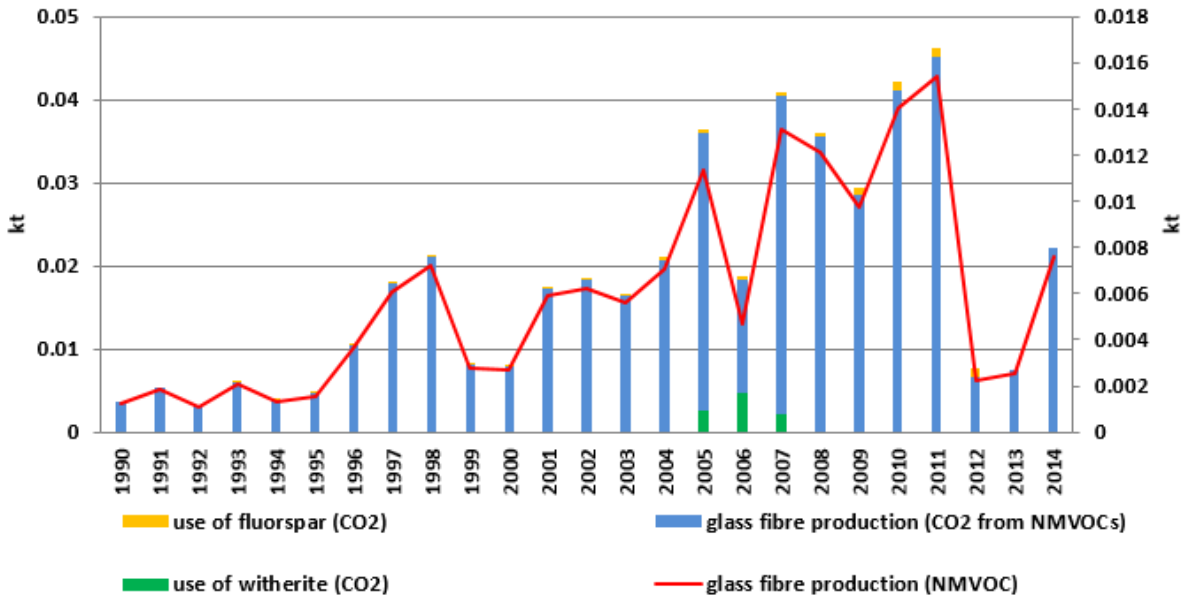

Figure 4.6 Emissions from raw materials used in glass production 1990-2014 (kt)[38]

Under 2.A.3 CO_2 emissions from use of additional raw materials used in glass production plants – fluorspar, potash and witherite (barium carbonate) are reported, as well as NMVOC emissions from glass production and glass fibre production reported by production facilities. CO_2 emissions from glass fibre production processes are estimated from NMVOC emissions due to lack of CO_2 emission factors and activity data to CO_2 emissions directly.

Use of potash as well as NMVOC emissions from glass production stopped in 2005 when the glass production plant stopped its activity although the use of raw materials in last years of glass production plant increased sharply. Use of witherite is occurring only in 2005-2007 in glass production manufacturing plant but in 2008 and 2009 the plant has suspended it activity. Since 2005 NMVOC emissions are still emitted but in smaller amounts from glass fibre production (Figure 4.6).

NMVOC emissions for time period 1997-2014 were taken from national database "2-AIR" where glass fiber production plant reported its emissions divided by NMVOC sub-type (Table 4.13). For time period 1990-1996 only butylacetate data is available from glass fiber production company's application for GHG permit within EU ETS. For year 2005, also glass production company had reported NMVOC emissions (these emissions are reported under 2.A.4.d sector in CRF Reporter) but since then glass production is not operating therefore NMVOC emissions from glass production are reported only for 2005.

[38] *Emissions from glass fiber production on secondary axis*

Table 4.13 NMVOC emissions from glass fibre and glass production in 1990–2014 (kt)

	Acetone	Butylacetate	Acetic acid	Formaldehyde	Isopropanol (isopropyl)	Methanol (methyl alcohol)	Kerosene	Propan (propyl alcohol)	Propylene glycol methyl ether	Formic acid	**total NMVOC in glass fibre production**	**total NMVOC in glass production**	**total NMVOC (kt)**
1990	NO	0.001	NO	NO	NO	NO	NO	NO	NO	NO	**0.00128**	NO	**0.00128**
1995	NO	0.002	NO	NO	NO	NO	NO	NO	NO	NO	**0.00158**	NO	**0.00158**
2000	0.140	0.664	0.294	0.066	NO	NO	1.570	NO	NO	NO	**0.00273**	NO	**0.00273**
2005	NO	1.493	0.909	0.107	0.276	0.084	0.659	1.200	NO	0.233	**0.00496**	**0.00642**	**0.01138**
2006	NO	1.486	0.960	0.101	0.360	0.232	0.094	1.274	NO	0.188	**0.00469**	NO	**0.00469**
2007	NO	1.315	1.704	NO	1.722	2.414	NO	5.920	NO	NO	**0.01307**	NO	**0.01307**
2008	NO	0.968	1.548	NO	1.599	2.173	NO	5.810	NO	NO	**0.01210**	NO	**0.01210**
2009	NO	1.172	0.402	NO	1.071	0.401	NO	6.715	NO	NO	**0.00976**	NO	**0.00976**
2010	NO	1.684	1.673	NO	1.355	2.613	NO	6.712	NO	NO	**0.01404**	NO	**0.01404**
2011	NO	1.622	1.908	NO	2.351	2.873	NO	6.640	NO	NO	**0.01539**	NO	**0.01539**
2012	NO	1.908	NO	NO	2.873	NO	NO	NO	NO	NO	**0.00478**	NO	**0.00478**
2013	NO	0.205	0.935	NO	NO	NO	NO	1.429	NO	NO	**0.00257**	NO	**0.00257**
2014	NO	0.293	0.143	NO	NO	NO	NO	1.988	5.167	NO	**0.00759**	NO	**0.00759**

The sharp decrease of limestone use in glass production plant in 1997 and accordingly decrease in CO_2 emissions is explained with changes in plant's production technology and overall changes in structure as since 1997 the plant is Joint Stock Company.

The economic crisis is obviously reflecting in CO_2 emissions from limestone, dolomite and soda ash use in mineral production (Table 4.14). Also the increase of taxes influenced the ability of industrial producers to invest in future development. In 2010 CO_2 emissions from limestone increased by 72% comparing with previous year due to increasing activity in all industrial sectors. In latest years emissions of limestone use in glass production have decreased. In 2012 acetic acid, methanol and propane were not used in production. In 2013 emissions from NMVOC used in glass fibre production increased by 100.7% compared to 1990 when only butylacetate was used as raw material. In 2014 NMVOC emissions increased by 195% due to fact that there are additionally used 5.167 kt propylene glycol methyl ether never used before that cause 0.00759 kt NMVOC emissions from used propylene glycol methyl ether, butyl acetate, acetic acid and propane (propyl alcohol) together. In years 2012-2014 CO_2 emissions have been increasing because the new high SiO content technological installation was set up that helps to dectect used amount of soda ash used in production process.

Table 4.14 CO_2 emissions from limestone, dolomite and soda ash use in glass fibre and glass production in 1990–2014 (kt)

	From limestone use	**From Dolomite use**	**From soda ash use**
1990	0.352	NO	NO
1995	1.947	0.809	0.643

	From limestone use	From Dolomite use	From soda ash use
2000	2.698	1.372	1.743
2005	3.111	0.996	1.554
2006	2.196	NO	0.466
2007	4.355	NO	0.037
2008	3.992	NO	NO
2009	2.575	NO	NO
2010	4.432	NO	NO
2011	4.279	NO	NO
2012	3.729	NO	0.039
2013	2.977	NO	0.309
2014	0.554	NO	0.366

4.2.4.2 Methodological issues

Default methodology from 2006 IPCC Guidelines was used to estimate emissions from Glass production. CO_2 emission factors used to estimate emissions from use of raw materials in glass production are plant specific and taken from plants annual GHG reports within EU ETS (Table 4.11). NMVOC emissions for time period 1997-2014 are taken from national database "2-AIR" where both glass production and glass fibre production companies report their emissions. NMVOC emissions for 1990-1996 are estimated only for butylacetate use that glass fibre production company reported in its application for GHG permit during the implementation of ETS in Latvia.

CO_2 emissions from limestone and dolomite use and soda ash use in glass production are estimated using Tier 2 method based on plant- specific activity data and default IPCC 1996 emission factors.

Indirect CO_2 emissions from glass fibre production processes were estimated according to 2006 IPCC Guidelines. An explanation of indirect CO_2 emission estimation based on carbon conversion factor and average default carbon content amount is provided. CO_2 emission factor is not provided in methodology and it is not possible to obtain activity data for direct CO_2 emission estimation.

NMVOC emissions were taken as activity data for CO_2 calculation and CO_2 emissions were estimated using carbon conversion factor.

$$E_{CO_2} = EF_{CO_2} \times NMVOC$$

where:
E_{CO2} – CO_2 emissions (kt)
EF_{CO2} – estimated CO_2 emission factor
NMVOC – NMVOC emissions (kt)

Emission factors

CO_2 emission factors from additional raw materials use in glass production processes were taken from reports of glass production plants submitted within EU ETS and from applications to GHG permits. These are plant specific emission factors. Emission factors of limestone and dolomite use in production of glass as well soda ash use in glass production are default ones taken from IPCC 1996 (Table 4.15).

Table 4.15 Emission factors for materials use in glass production (t emissions / t product or raw material)

	1990 – 2014
Fluorspar use	0.0017
Potash use	0.32
Barium carbonate (witherite) use	0.223
Butylacetate use (NMVOC)[39]	1.0
Limestone use	0.440
Dolomite use	0.477
Soda ash use	0.415

For CO_2 emission from glass fibre production estimation 80% of carbon content conversion factor are used. According to 2006 IPCC Guidelines[40], indirect emissions of CO_2 from atmospheric oxidation of emitted NMVOC are calculated and reported in the inventory. The average amount of carbon in NMVOC is assumed to be 80%[41].

The CO_2 emission factor from 2006 IPCC Guidelines was estimated using following equation:

$$EF_{CO_2} = 80\% \times 44.0098/12.011$$

where:
EF_{CO_2} – CO_2 emission factor (kt/kt)
80% – the average amount of carbon in NMVOC
44.0098 / 12.011 – carbon dioxide and carbon molmass ratio

This leads to an emission factor for indirect CO_2 release of 2.931299642 kg CO_2/kg NMVOC.

Activity data

Amount of raw materials used in glass production is quite small and fluctuates in whole time series. Although use of potash increased sharply in 2004-2005, the use stopped in 2005 due to closure of glass production plant (Table 4.16).

Table 4.16 Activity data for raw materials use in glass production 1990-2014 (kt)

	Use of potash	Use of fluorspar	Use of barium carbonate	Use of butylacetate	Use of dolomite	Use of limestone	Soda ash use
	kt						
1990	NO	NO	NO	0.001	NO	0.800	NO
1995	NO	0.116	NO	0.002	1.697	4.425	1.549

[39] *For emission estimation only for year 1990-1996, since 1997 the plant reported data from national database "2-AIR" is used*
[40] *http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_7_Ch7_Precursors_Indirect.pdf (page 7.6)*
[41] *Basing of the most often used average carbon conversion factor*

	Use of potash	Use of fluorspar	Use of barium carbonate	Use of butylacetate	Use of dolomite	Use of limestone	Soda ash use
	kt						
2000	NO	0.084	NO	NO	2.875	6.133	4.200
2005	0.038	0.265	0.012	NO	2.088	7.070	3.743
2006	0.020	0.222	0.021	NO	NO	4.991	1.122
2007	0.009	0.201	0.010	NO	NO	9.899	0.090
2008	NO	0.255	NO	NO	NO	9.073	NO
2009	NO	0.408	NO	NO	NO	5.853	NO
2010	NO	0.622	NO	NO	NO	10.072	NO
2011	NO	0.591	NO	NO	NO	9.726	NO
2012	NO	0.639	NO	NO	NO	8.475	0.095
2013	NO	NO	NO	NO	NO	6.766	0.745
2014	NO	NO	NO	NO	NO	1.260	0.883

Activity data fluctuates in whole time series. Considerable decrease occur in the beginning of 1990s as a consequence of changes in structure of country's national economy. Dolomite use in glass production ended in 2005 as one glass production plant stopped it`s activity. The total amount of raw material used was affected by the closing of glass production plant and suspending of activity of another glass production plant.

In 2008-2012, only use of fluorspar in glass fibre production plant is occurring as other two glass production plants or either stopped its activity or suspended it. In 2013-2014 only limestone and soda ash as raw materials in glass production are used.

4.2.4.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

The uncertainty of activity data for this sector is assumed as 2% as plant specific reported data is used. Accredited verifiers and Latvia's Regional Environmental Boards verify the activity data reported in production plant's annual GHG reports within EU ETS so the activity data is adequately verified.

As default emission factors for limestone, dolomite and soda ash use are used the uncertainty is assumed 50%.

Other CO_2 emission factors for this sector are taken from glass production plant so the uncertainty could be assumed as quite low. Still the estimation of the emission factor can't be adequately verified so the uncertainty is assumed as quite high – 70%.

The combined CO_2 emission factor uncertainty for this sector is 86%.

Time series of the estimated emissions are consistent and complete because the same methodology, emission factors and data sources are used for sectors for all years in time series. All emissions with exception of CO_2 emissions for use of fluorspar and potash as well as NMVOC emissions for glass fibre production are not estimated due to lack of estimation methodology.

Time series consistency was checked by verifying IEF, AD and emission changes and attention was paid to important increase/decrease that are explained in NIR.

4.2.4.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the IPPU sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

QA/QC check is performed with Tier1 method from IPCC GPG 2000.

Activity data, CO_2 emission factors and estimated emissions from glass production plants are taken from the annual GHG reports that plants submit within EU ETS. All GHG reports are verified by the ISO accredited verifiers that checks that all reported information is correct and corresponds to certain requirements from the legislation. Regional Environmental Boards also check the annual GHG reports and approves the report if everything reported is correct.

Checks performed pursuant to Article 7(1)(l) of Regulation (EU) No 525/2013 are done to comparing EU ETS data with GHG inventory emissions. There are differences in this sector in 2013 and 2014 due to fact that in the GHG inventory there are not taken into account CO_2 emissions from soda that is used for waste water nautralization but are taken into account soda that are used for glass smelting. Differences are represented in Table 4.17.

Table 4.17 Differences between CO_2 emissions under ETS and inventory data of glass production for 2013 and 2014

2.A.3 Glass production			Difference
Year	IPCC methodology IPCC 2000 GPG Volume 3 Chapter 3 equation 3.6B	Monitoring and reporting Regulation[42] Annex IV section 11	
2013	3.28 kt	3.91 kt	19.02%
2014	0.92 kt	1.55 kt	68.22%

4.2.4.5 Category-specific recalculations

For submission 2016 CO_2 emissions from soda ash use in 2012-2014 are also included as high SiO content technological installation were set up that helps to detect used amount of soda ash. Recalculations are presented in Table 4.18.

Table 4.18 Recalculations of CO_2 emissions including soda ash for years 2012-2014 (kt)

	CO_2 emissions without soda ash (kt)	Total CO_2 emissions from glass production (kt)	Difference (kt)
2012	3.737	3.776	0.039
2013	2.984	3.293	0.309
2014	0.576	0.943	0.366

[42] *http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0601&from=EN*

4.2.4.6 Category-specific planned improvements

No improvements are planned.

4.2.5 Ceramics (2.A.4.a)

4.2.5.1 Category description

Under Ceramics sector CO_2 emissions from bricks and tiles production are reported.

Ceramics sector emissions amounts to 10.8 kt (1.3%) of total IPPU emissions in Latvia in 2014.

CO_2 emissions from 2.A.4.a sector are decreased by 84.3% since 1990 and increased by 19.7% comparing with 2013 (Figure 4.7).

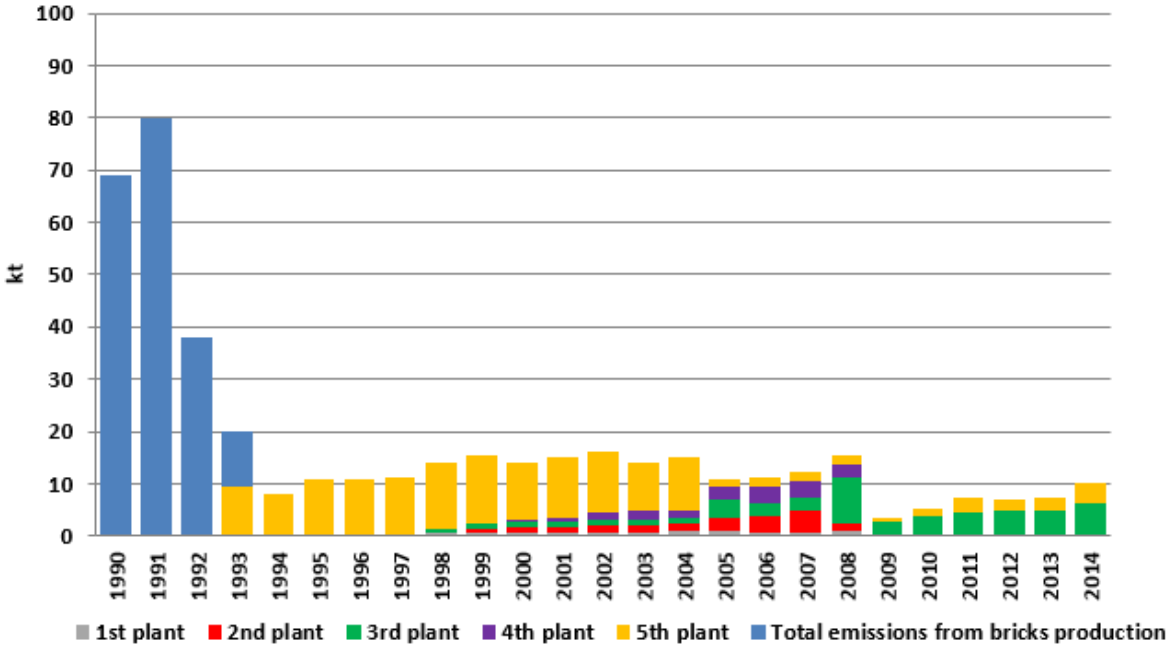

Figure 4.7 CO_2 emissions from bricks and tiles production 1990-2014 (kt)

Bricks production has strong traditions in Latvia as production plants operate many decades, for example in bricks production plant "LODE" the brick production was started in 1964. Still from 5 now operating bricks production plants only two were operating up to 1990. There is no information if the other companies were working for time period 1990-1993 what is not covered by GHG permit application requirements.

Only plants No 1 and No 5 were operating in time period 1990-1993 so the indicator IE was previously used for both these plants in time period 1990-1993. As it was not possible to obtain the data for raw materials used in Bricks production companies No 1 and No 5, there wasn't possible to estimate the emissions using the same methodology for 1993-2008 and to follow the consistency. Therefore the CO_2 emissions were estimated only using total produced bricks amount for 1990-1993 for these two plants. And after 1993 it was possible to increase methodology level and estimate CO_2 emissions for each plant separately.

There is only one tiles production plant in Latvia and CO_2 emissions from use of clay in tile production process in 1995-2014 are reported in 2.A.4.a sector. The tiles production plant and all bricks production plants are participants of EU ETS so the data from plant's annual GHG reports is available for inventory.

Emissions are decreasing since 2005 with some fluctuation due to decrease of activity of tiles production plant. Still in 2009 the CO_2 emissions have decreased approximately 4 times as the building and construction sector became inactive. In 2010 activity of tiles and bricks production is increased by 62.76%. From 2010-2014 activity of ceramics production is increased about 88.61%. Due to demand of such production in market in 2014 there is increased produced ceramics about 42.66% (Figure 4.7).

4.2.5.2 Methodological issues

Emissions from used carbonates, additives and clay in tiles and bricks production are included in the sub category ceramics.

Emissions from this sector are calculated by multiplying emission factors with activity data. Activity data are collected mainly directly from the tiles and bricks producers but industrial statistics have also been used to calculate emissions for years 1990-1993.

The emission factors are mainly default ones but they depend on carbon content and overall composition of raw materials. This information is available and reported by producers under EU ETS. Mostly there is used methodology from Monitoring Reporting Regulation.

Information about methodology used in ceramics production is presented in NIR Annex 3.6.

4.2.5.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

The uncertainty of activity data for this sector is assumed as 2%. The activity data reported in production plant's annual GHG reports within EU ETS is verified by accredited verifiers and Latvia's Regional Environmental Boards so the activity data is adequately verified.

CO_2 emission factors used in emission calculation from tiles production are the default from MRG so the uncertainty of emission factors is assumed as 50%.

Time series of the estimated emissions are consistent and complete because the same methodology, emission factors and data sources are used for sectors for all years in time series. Only CO_2 emissions from tiles and bricks production are estimated. Other emissions are not estimated due to lack of official emission estimation methodology and emission factors.

The uncertainty of activity data for the bricks production sector is assumed as 10% although the plants' reported data is used. Plants are used several emission estimation methodologies and for some historical years the reported data seems to be less reliable.

CO_2 emission factors used in emission calculation from bricks and tile production are the default ones from Monitoring and Reporting Regulation within EU ETS[43] so the uncertainty of emission factors is assumed as 50%.

For years 1990-1992 and 1993-2008 two different emission estimation methodologies are used still the time series is assumed as consistent as for 1990-1992 default Tier1 methodology is used but for 1993-2008 already plant specific emission estimation methodology assumed as Tier2 level is used.

For time period 1993-2008 two different methodologies are used for 3rd bricks production plant so that could lead to inconsistent time series although it is assumed that these are plant specific data and there is no need to recalculate them with using default emission factors or average carbonates content data.

Time series consistency was checked by verifying IEF, AD and emission changes and attention was paid to important increase/decrease that are explained in NIR.

4.2.5.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the IPPU sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

Activity data, CO_2 emission factor and estimated emissions are taken from the annual GHG reports that tiles production plant submit within EU ETS.

CO_2 emission factors for tiles production are taken from Monitoring Reporting Guidelines and are the default ones therefore there is no need to re-check correctness of emission factors.

QA/QC check is performed with Tier1 method from IPCC GPG 2000.

Quality control check list is filled for each category taking into account criteria given in QA/QC plan approved in national legislation. All findings were documented and introduced in GHG inventory. All corrections are archived.

All estimations of the emissions done in the LEGMC also are checked on the logical mistakes by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogic changes in the activity data and emissions.

Checks performed pursuant to Article 7(1)(l) of Regulation (EU) No 525/2013 are done to comparing EU ETS data with GHG inventory emissions. Such consistency checks are done in all IPPU sectors. There were no differences in this sector for 2013 and 2014.

4.2.5.5 Category-specific recalculations

No recalculation has been done for the sector.

4.2.5.6 Category-specific planned improvements

No improvements are planned in this sector.

[43] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF

4.2.6 Other Process Uses of Carbonates (2.A.4.d)

Under sector 2.A.4.d Other emissions of NOx, CO from cement production and NMVOC emissions from cement production and glass production are reported as it is not technically possible to report in CRF Reporter software these emissions under 2.A.1 Cement production sector and 2.A.3 Glass production sector directly. Detailed description about indirect emissions from cement production are included in NIR Chapter 4.2.2.2 Methodological issues.

In 2014 NMVOC emissions from 2.A.3 Glass production were calculated and added to 2.A.4.d as these emissions were calculated but not previously included in CRF Reporter as it was not technically possible to report under 2.A.3 Glass production sector directly. Therefore NMVOC emissions from Glass production are reported under sector 2.A.4.d and summed up with NMVOCs from cement production that are reported under this sector due to the same reason.

4.3 CHEMICAL INDUSTRY (CRF 2.B)

4.3.1 Category description

Although there are strong traditions of the chemical industry in Latvia there are no chemical industry production processes listed in 2006 IPCC Guidelines or EMEP/EEA 2013 generating GHG emissions.

The biggest part of chemical industry is medicine production and then small part of paints and varnishes production.

In 2.B.10.a sector particular matters from phosphate fertilizers are calculated but these emissions are not reported under Climate Convention as GHGs.

There are no F-gases emissions under sectors 2.B.9.a By-Product Emissions and 2.B.9.2 Fugitive emissions so there are no child nodes added under these categories in CRF Reporter. Corresponding CRF tables are left blank due to CRF internal issue which does not allow to directly enter NO in green and grey cells without adding child nodes. It was confirmed by CRF help desk that this issue will be improved in the future releases of the software. Some F-gases data in the parent categories (green and grey cells) in corresponding CRF tables are missing due to this reason.

4.4 METAL INDUSTRY (CRF 2.C)

CO_2, CH_4 and indirect GHG (NOx, CO, NMVOC, SO_2) from 2.C.1 Iron and Steel production are reporter under 2.C Metal Industry. There are no GHG emissions under rest of the sectors under 2.C. therefore these categories are NO in CRF Reporter.

There are no F-gases emissions under sectors 2.C.3. Aluminium production, 2.C.4. Magnesium production in Latvia therefore in CRF Reporter the corresponding CRF tables are left blank due to CRF internal issue which does not allow to directly enter NO in green and grey cells without adding child nodes. Some F-gases data in the parent categories (green and grey cells) in corresponding CRF tables are missing due to this reason.

4.4.1 Iron and Steel Production (CRF 2.C.1)

4.4.1.1 Category category description

Metal industry sector emissions amounts to 0.01 kt CO_2 eq (0.001%) of total IPPU emissions in Latvia in 2014. CO_2 emissions from 2.C.1 sector have decreased by 100% since 1990 and by 99.9% comparing with 2013 (Figure 4.8 and Table 4.19).

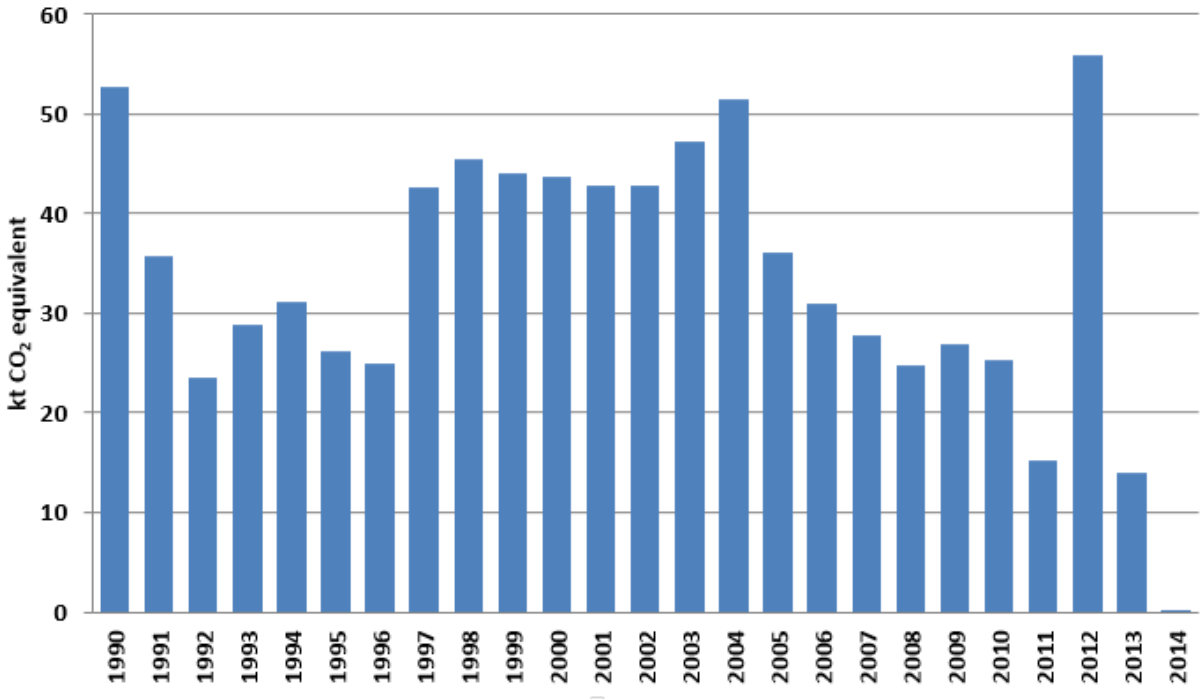

Figure 4.8 CO_2 emissions from Metal industry 1990-2014 (kt CO_2 eq.)

CO_2 emissions from crude iron as input material in iron and steel production in open-heart furnaces as well as crude iron used in electric arc furnaces are included in the inventory according to 2006 IPCC Guidelines excluding scrap metal use in crude steel production. The indirect GHG emission sources are also included under iron and steel production.

Table 4.19 Emissions from 2.C Metal Production in 1990–2014 (kt)

	CO_2	CH_4	NOx	CO	NMVOC	SO_2
1990	52.596	0.003	2.805	0.0006	0.011	0.088
1995	26.133	0.001	1.425	0.0003	0.006	0.045
2000	43.580	0.003	2.551	0.0005	0.010	0.080
2005	36.037	0.003	2.827	0.0006	0.011	0.089
2006	30.848	0.003	2.828	0.0006	0.011	0.089
2007	27.621	0.003	2.847	0.0006	0.011	0.089
2008	24.740	0.003	2.705	0.0005	0.011	0.085
2009	26.827	0.002	2.246	0.0004	0.009	0.070
2010	25.189	0.003	2.730	0.0005	0.011	0.086
2011	15.184	0.001	0.022	0.0002	0.008	0.010

	CO_2	CH_4	NOx	CO	NMVOC	SO_2
2012	55.872	0.004	0.109	0.0008	0.038	0.050
2013	13.900	0.001	0.025	0.0003	0.009	0.012
2014	0.010	0.000	0.000	0.0000	0.000	0.000
2014 versus 2013	-99.9%	-100.0%	-100.0%	-99.9%	-100.0%	-100.0%
2014 versus 1990	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%

Considerable decrease occurred in time period 1990–1992 due to changes in Latvia's national economy (Table 4.19). Decrease of CO_2 emissions in 1990–1996 also occurred due to decrease of used crude iron in open-hearth furnaces (OHF) as CO_2 emissions are estimated only from crude iron use excluding used scrap metal part. It is explained with modification of production process when biggest part of primary and final steel products is produced by smelting of scrap metal.

CO_2 emissions increased almost twice in 2002–2003 when amount of used crude iron increased but amount of used scrap metal remains in same level. Final amount of steel products produced in the only metal industry facility fluctuates in small range in latest years. After the crisis in 2008-2009 all emissions from Metal production are increased in 2010. In 2011 there are sharp decrease of emissions due to changing technology of metal production, so also decreased amount of steel produced in electric arc furnaces (EAF) (about 75.11%) and mass of steel produced in OHF (about 68.67 %). Since mid-2011 the OHF is not used in this company (the installations are dismantled). At the end of 2010 installation was dismantled and new one was set up. In 2011 plant was working only 4 months. All crude steel is produced from scrap metal only in EAF. In 2011-2013 entire amount of crude steel is produced in EAF only and plant worked only 5-7 months in a year. In 2014 only 0.09 kt crude steel were produced from scrap metal that caused 0.01036 kt CO_2 emissions. At the moment Steel production plant is in a process of insolvency.

4.4.1.2 Methodological issues

Reported emissions, calculation methods and type of emission factors for the 2.C Metal Industry in the Latvian inventory are summarized in Table 4.20.

Table 4.20 GHG emission categories, methods and gases reported from 2.C

Category	Method used	Gases reported
C. Metal Industry		
1. Iron and Steel Production	Tier1,2	CO_2, NOx, CO, NMVOC, SO_2

IPCC 1996, IPCC GPG 2000 Tier2, EMEP/CORINAIR 2009 and EMEP/EEA 2013 are used to calculate direct and indirect GHG emissions from the 2.C.1 Steel Production sector. There is only one Iron & Steel production plant in Latvia that produces crude steel by melting crude iron and not only by melting scrap metals. The plant is participant of EU ETS and submits their annual GHG reports to LEGMC. It is possible to obtain more accurate and complete activity data and emission factors from enterprise that is involved in the emission trading system. Till Submission 2008 CO_2 emissions from plant's GHG reports were taken to report emissions from crude steel production.

After the In-country review 2007 the CO_2 emissions were completely recalculated according to IPCC GPG 2000 as methodology of CO_2 emission estimation from Monitoring and Reporting Regulation[44] within EU ETS didn't correspond to production technology used in plant.

CO_2 emission estimations from crude steel production

IPCC GPG 2000 Tier2 method is based on estimation of carbon losses through the production processes when remaining carbon is emitted to air.

CO_2 emissions were estimated only from crude iron used. In steel production plant mostly steel is produced by melting scrap metal that doesn't produce CO_2 emissions by leaking carbon. The only amount of total produced steel is reported by steel production company that means that the total amount of steel produced by using crude iron and melting scrap metal is known. Therefore it is needed to estimate the crude steel amount that is produced only by using crude iron and that caused CO_2 emissions. This amount is then used as activity data.

Following equation from IPCC GPG 2000 is used to calculate CO_2 emissions from steel production:

$$Emissions_{crude\ steel} = (\text{Mass of Carbon in the Crude Iron used for Crude Steel Production} - \text{Mass of Carbon in the Crude Steel}) \times 44/12 + \text{Emission factor}_{EAF} \times \text{Mass of Steel Produced in EAF}$$

According to information reported by steel producer:

- Average carbon content of crude iron using in steel production is 3 – 4% in 1990-2006, 4% for 2007, 2009-2013 and 3% for 2008;
- Average carbon content of produced steel is 0.1 – 0.4% for 1990-2006, 0.3% for 2007-2008 and 0.2% for 2009-2013.

Carbon emitted from consumed electrodes in electric arc furnaces has to be taken into account. These emissions are estimated by multiplying emission factor with mass of steel produced in electric arc furnaces.

Emission factors

Till 2008 there were used default emission factor- 1.5 kg carbon per tonne of steel and after there are used data reported by steel production plant. There are used as far as possible plant provided activity data and emission factors and as possible applicable higher tier method according to available data.

Activity data

For year 1990-2006 the used amount of raw materials in different types of production installations – open-hearth furnaces and electric arc furnaces according to the data reported by CSB to LEGMC even though the data potentially are confidential. Total produced amount of crude steel was known without division into particular production installations. So it was

[44] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF

necessary to divide amount of crude steel produced in open-hearth furnaces and in electric arc furnaces. These amounts are estimated by using amount of raw materials used in open-hearth furnaces and electric arc furnaces (used raw materials in different furnaces related to total used raw materials) and the same percentage is related to amount of produced steel. Accordingly amount of steel produced in open-hearth furnaces and in electric arc furnaces is divided from total produced crude steel.

For years 2007-2008 the total produced crude steel amount as output by used production technologies in OHF and EAF was reported by plant but the plant couldn't report the used raw materials as input divided by production technologies. The steel producer reported that it's not possible to divide these two amounts, as plant doesn't do it.

So the used raw material amount in 2007-2009 was divided by the same percentage raw material divided in 2006:

- 99.59% of total used scrap metals were used in open hearth furnaces;
- 95.52% of total used crude iron was used in open hearth furnaces.

Since large amount of scrap metals is used in crude steel production it is necessary to exclude this amount from total crude steel amount and to estimate only the amount of crude steel that is produced from crude iron. It is estimated by using crude iron / scrap metal ratio since amounts of used scrap metal in open-hearth furnaces and used crude iron in the same furnaces are known. Then this ratio number is multiplied with amount of steel produced in open-hearth furnaces to estimate amount of crude steel produced directly from crude iron.

Coke, coke fine and carburizators in crude steel production process is used as reducing agent to decrease the carbon content in final produced crude steel. The coke is combusted in production process and emissions from coke use was previously reported in 1.A.2.a Iron & Steel sector of Energy sector. For submission 2016 there were made allocation of used coke, coke fine and carburizators from Energy sector to IPPU as only crude steel production plant use these high carbon content carburizators only for process not for combustion to get energy.

Data for CO_2 emission estimations from steel production are given in Table 4.21 below.

Table 4.21 Data for estimation of CO_2 emissions from steel production

	Crude steel production(t)	**Used carburizators (coke, etc.) (t)**	% mass of steel produced in OHF	**Mass of steel produced in OHF(t)**	Used scrap metal in open hearth furnaces in steel production(t)	Crude iron used in open heart furnaces(t)	Crude iron/scrap metal ratio	% mass of steel produced in EAF	**Mass of steel produced in EAF(t)**	**Amount of crude steel in what production crude iron where involved(t)**	Carbon content in crude iron	Carbon content in crude steel	Use 1.5kg per tonne EAF for 2% crude iron	EF of carburizators (coke, etc.)	Conversion factor	**Total CO_2 emissions from steel production (kt)**
1990	**550000**	**11362.493**	98.74%	**543074**	537227	107732	20.05%	1.26%	**6925.57**	**110293.41**	3.50%	0.25%	0.0015	3.489	3.664	**52.596**
1995	**279326**	**6207**	98.72%	**275747**	285015	37086	13.01%	1.28%	**3578.85**	**36345.75**	3.50%	0.25%	0.0015	3.489	3.664	**26.133**
2000	**500292**	**10061**	99.23%	**496434**	503123	70637	14.04%	0.77%	**3858.06**	**70239.54**	3.50%	0.25%	0.0015	3.489	3.664	**43.580**
2005	**554345**	**6757.14**	98.94%	**548472**	527950	104010	19.70%	1.06%	**5872.56**	**109210.01**	3.50%	0.25%	0.0015	3.489	3.664	**36.037**
2006	**554546**	**5206.69**	98.90%	**548419**	531026	105769	19.92%	1.10%	**6126.89**	**110453.68**	3.50%	0.25%	0.0015	3.489	3.664	**30.848**
2007	**558156**	**3731.081**	99.76%	**556814**	463940	109248	23.55%	0.24%	**1342**	**131433.86**	4.00%	0.30%	0.0015	3.489	3.664	**27.621**
2008	**530462**	**4575.172**	99.34%	**526964**	492450	88319	17.93%	0.66%	**3498**	**95136.30**	3.00%	0.30%	0.0018	3.489	3.664	**24.740**
2009	**440458**	**4950.337**	99.90%	**440016**	413058	68784	16.65%	0.10%	**442**	**73346.75**	4.00%	0.20%	0.0064	3.489	3.664	**26.827**
2010	**535301**	**3985.918**	99.79%	**534168**	476868	81340	17.06%	0.21%	**1133**	**91306.99**	4.00%	0.20%	0.0061	3.489	3.664	**25.189**
2011	**167624**	**3948.519**	NO	NO	NO	NO	1.81%	100.00%	**167624**	**167624**	4.00%	0.20%	0.0018	3.489	3.664	**15.184**
2012	**836431**	**15190.37**	NO	NO	NO	NO	1.49%	100.00%	**836431**	**836431**	4.00%	0.20%	0.0014	3.489	3.664	**55.872**
2013	**193190**	**3710.187**	NO	NO	NO	NO	1.40%	100.00%	**193190**	**193190**	4.00%	0.20%	0.0030	3.489	3.664	**13.900**
2014	**92.51**	**2.97**	NO	NO	NO	NO	0.00%	100.00%	**92.51**	**92.51**	4.00%	0.20%	NO	3.489	3.664	**0.010**

CH_4 and indirect GHG emission estimations from crude steel production

Methods

The CH_4, NMVOC, CO, NO_x and SO_2 emissions from iron and steel production are calculated at the LEGMC based on activity data from the CSB and steel production plant according to EMEP/CORINAIR 2007 and EMEP/EEA 2013 emission factors.

Emission factors

Emission factors of methane and indirect GHG emissions are taken from EMEP/CORINAIR 2007 methodology (Table 4.22).

Table 4.22 Emission factors of metal production (t/t)

	CH_4	NO_x	CO	NMVOC	SO_2
Iron and Steel Production					
In open hearth furnace	0.000005	0.0051	0.000001	0.00002	0.00016
In electric arc furnace	0.000005	0.00013	0.0017	0.000046	0.00006

Emission factors for NO_x, NMVOC and SO_2 emissions are taken from EMEP/EEA 2013 according to methodology for estimations of emissions from processes in open-hearth furnaces, where 95% of total steel production is produced till 2010 and for electric arc furnace starting from year 2011.

It has to be noted that for CH_4, NMVOC, CO, NO_x and SO_2 emissions estimations total produced crude steel data is used but for CO_2 emission estimation only crude steel produced from crude iron is taken into account and reported in CRF Reporter.

4.4.1.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Only one enterprise operates in iron and steel industry category in Latvia and this facility reports data of production and raw materials used in production processes. Still used raw materials data divided by technological processes aren't available and are estimated by using approximate percentage. So the uncertainty of activity data of iron and steel industry is assumed 25%.

CO_2 emission factor is estimated according to plant specific data reported by steel producer using IPCC GPG 2000 equations so the uncertainty of CO_2 emission factor is assumed as 5%.

Uncertainty of CH_4 emission factor taken from EMEP/CORINAIR 2007 methodologies is assigned as 10% so it is apposite for open-hearth furnaces – technology mainly used in facility operated in iron and steel industry in Latvia till 2010. After there are produced all steel in electric arc furnaces.

Time series of the estimated emissions are consistent and complete because the same methodology, emission factors and data sources are used for sectors for all years in time series. GHG emissions from all sectors are estimated or reported as not occurring / not applicable therefore there are no "not estimated" sectors.

Time series consistency was checked by verifying IEF, AD and emission changes and attention was paid to important increase/decrease that are explained in NIR.

4.4.1.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the IPPU sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

QA/QC check is performed with Tier1 method from 2000 IPCC GPG.

All estimations of the emissions done in the LEGMC also are checked on the logical mistakes by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogic changes in the activity data and emissions.

Quality control check list is filled for each category taking into account criteria given in QA/QC plan approved in national legislation. All findings were documented and introduced in GHG inventory. All corrections are archived.

All estimations of the emissions done in the LEGMC also are checked on the logical mistakes by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogic changes in the activity data and emissions.

Checks performed pursuant to Article 7(1)(l) of Regulation (EU) No 525/2013 are done to comparing EU ETS data with GHG inventory emissions. There are differences in sector 2.C.1 in 2013 and 2014 between ETS and inventory data. See Table 4.23 below.

Table 4.23 Differences between CO_2 emissions under ETS and inventory data of steel production for 2013 and 2014

2.C.1 Iron and Steel			Difference
Year	IPCC methodology IPCC 2000 GPG Volume 3 Chapter 3 equation 3.6B	Monitoring and reporting Regulation[45] Art.25	
2013	13.900 kt	14.072 kt	1.22%
2014	0.01036 kt	0.0109 kt	5.18%

Difference is caused by different emission calculation methodologies that are used under UNFCCC reporting (IPCC GPG 2000 and 2006 IPCC Guidelines) and European Union Emission Trading system (EU ETS) reporting. According to IPCC 2000 GPG the CO_2 emissions from 2.C.1 are estimated taking into account only particular part of used raw materials that generate CO_2 emissions in production process. As mostly scrap metals are used in production of crude steel in Latvia, only amount of used crude iron as input material in crude steel production is taken into account. During remelting of scrap metal the CO_2 emissions are not generated. The crude iron/ scrap metal ratio is used in emission calculation.

Under EU ETS CO_2 emissions by plant are calculated by multiplying AD (used raw materials) with EF without any division into used technologies that gives very approximately calculated CO_2 emissions that differ from emissions reported in GHG inventory.

[45] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0601&from=EN

4.4.1.5 Category-specific recalculations

For 2.C.1 sector CO_2 emissions of used carburizators (coke, coke fine) was taken into account and recalculations are done in all time series. These emissions was previously reported in Energobalance and under Energy sector and multiplied with different emission factor. Recalculations are represented in Table 4.24.

Table 4.24 Recalculations made in 2.C.1

	CO_2 emissions without carburizators (kt)	Total CO_2 emissions from steel production (kt)	Difference (kt)
1990	12.816	52.596	39.644
1991	8.703	35.717	26.921
1992	5.728	23.509	17.720
1993	7.000	28.726	21.652
1994	6.546	31.158	24.545
1995	4.429	26.133	21.656
1996	3.482	24.875	21.360
1997	7.993	42.555	34.524
1998	8.499	45.367	36.830
1999	7.709	44.011	36.272
2000	8.421	43.580	35.103
2001	8.037	42.685	34.593
2002	7.597	42.816	35.166
2003	12.160	47.090	34.890
2004	12.904	51.404	38.379
2005	12.347	36.037	23.576
2006	12.562	30.848	18.166
2007	14.569	27.621	13.018
2008	8.726	24.740	15.963
2009	9.547	26.827	17.272
2010	11.260	25.189	13.907
2011	0.302	15.184	14.468
2012	1.171	55.872	52.999
2013	0.585	13.900	12.945
2014	NO	0.010	0.000

4.4.1.6 Category-specific planned improvements

No improvements are planned in this sector.

4.5 NON-ENERGY PRODUCTS FROM FUELS AND SOLVENT USE (CRF 2.D)

Under 2.D Non-energy Products from Fuels and Solvent Use sector there are reported emissions from Paraffin wax, Lubricant use and Other (including Solvent use, Asphalt roofing and Road paving with asphalt, urea use).

Non-energy products from fuels and solvent use sector GHG emissions amounts to 46.33 kt (0.4%) of total CO_2 equivalent emissions without LULUCF in Latvia in 2014. CO_2 emissions from 2.D sector are decreased about 28.0% since 1990 and by 6.2% comparing with 2013 (Figure 4.9). The main part of this sector emissions constitute 2.D.3 Other subsector with 33.12 kt (71.5%) from total 2.D sector emissions. 2.D.3 Other subsector includes emissions

from Solvent use, Asphalt roofing, Road paving with asphalt and Urea use. Solvent use sector constitutes 97.2% of 2.D.3 Other sector. Remaining part of emissions (2.8%) from 2.D.3 Other constitute Asphalt roofing, Road pawing with asphalt and Urea Use.

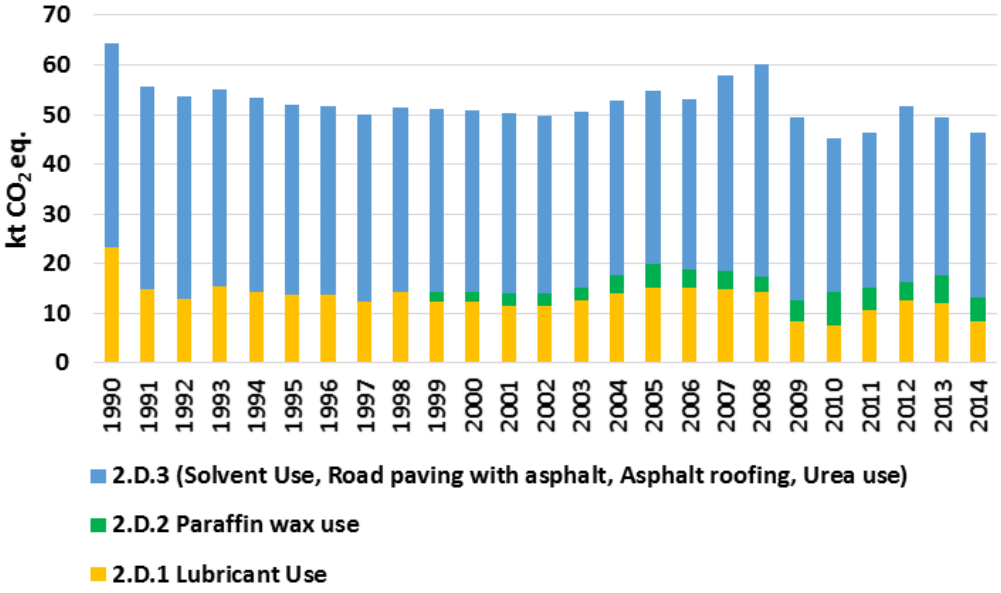

Figure 4.9 Emissions from Non-energy Products from Fuels and Solvent Use sector 1990-2014[46] (kt CO_2 eq.)

Reported emissions, calculation methods and type of emission factors for the 2.D Non-energy Products from Fuels and Solvent Use in the Latvian inventory are summarized in Table 4.25.

Table 4.25 GHG emission categories, methods and gases reported from 2.D

Category	Method used	Gases reported
D. Non-energy Products from Fuels and Solvent Use		
1.Lubricant Use	Tier1	CO_2
2. Paraffin Wax Use	Tier1	CO_2
3. Other		
Solvent Use	Tier1,2	CO_2, NMVOC
Road paving with asphalt	Tier1	CO_2, NMVOC
Asphalt roofing	Tier1	CO_2, NMVOC, CO
Urea use	Tier1	CO_2

4.5.1 Lubricant Use (CRF 2.D.1)

4.5.1.1 Category description

Lubricant use subsector emissions amounts 8.3 kt (17.9%) of total Non-energy sector products` emissions in Latvia in 2014. CO_2 missions from 2.D.1 sector decreased by 64.3% since 1990 and decreased by 31.0% comparing with 2013 (Figure 4.10 and Table 4.26).

[46] *2.D.1 Lubricant Use and 2.D.2 Paraffin Wax Use on secundary axis*

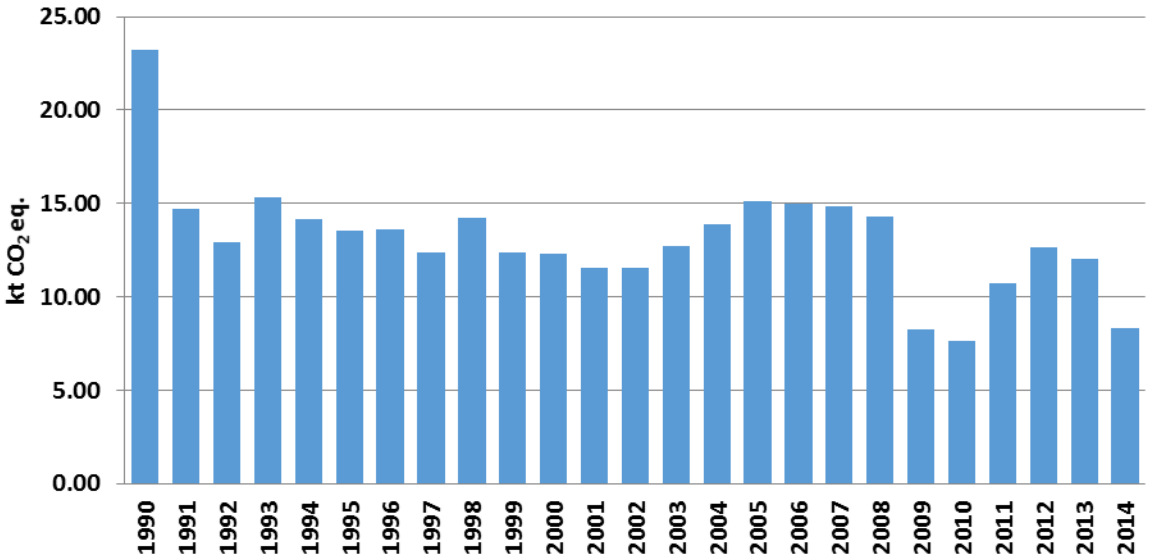

Figure 4.10 CO_2 emissions from Lubricant use 1990-2014 (kt)

Under this category lubricant consumption are reported as feed stocks in Latvia. Emissions from lubricant is reported as „CO_2 not emitted" because it is assumed that CO_2 emissions is captured and not emitted to the air.

Consumption and emissions of lubricants are reported in sector 2.D.1 for all years in time series 1990-2014 (Table 4.26).

Table 4.26 CO_2 emissions from lubricant use 1990-2014

	CO_2 emissions (kt)
1990	23.25
1995	13.57
2000	12.31
2005	15.09
2006	14.99
2007	14.86
2008	14.31
2009	8.28
2010	7.62
2011	10.73
2012	12.66
2013	12.03
2014	8.30
Share in IPPU total in 2014	1.0%
2014 versus 2013	-64.3%
2014 versus 1990	-31.0%

4.5.1.2 Methodological issues

Emission factors

CO_2 emissions are calculated according to Tier 1 method and emission factors as well as default carbon content are taken from 2006 IPCC Guidelines. Carbon content for lubricant is

20.0 kg/GJ as default one taken from 2006 IPCC Guidelines Volume 2 Energy Chapter 1 Table 1.3.

Net calorific value (NCV) for lubricants is 41.86 TJ/10^3 t and is reported in energobalance[47] from Central Statistical Bureau (CSB) of Latvia.

CO_2 emissions are calculated using 2006 IPCC Guidelines equation 5.2[48]:

$$CO_2\ Emissions = LC \times CC_{Lubricant} \times ODU_{Lubricant} \times 44/12$$

where:
CO_2 emissions= CO_2 Emissions from lubricants, tonne CO_2
LC= Total lubricant consumption, TJ
$CC_{Lubricant}$=carbon content of lubricants (default), tonneC/TJ (=kg/ C/TJ)
$ODU_{Lubricant}$ =ODU(Oxidised during use) factor (based on default composition of oil and grease) fraction
44/12= mass ratio of CO_2/C

Activity data

Activity data prepared by CSB and reported to EUROSTAT in EUROSTAT Annual Questionnaire formats were used.

Lubricants are mainly used in Transport sector. According to Transport sector expert the percentage of lubricants that are combusted in mobile vehicles system was estimated. Approximately 99.7% in 2010-2013 from total lubricants consumption are used as feedstocks and therefore 99.7% of carbon is reported as stored. Only 0.3% of total lubricant consumption is assumed as combusted and the emissions for the activity are included in Road Transport sector.

Table 4.27 Activity data for lubricant use 1990-2014

	Consumption of lubricants (TJ)	Net calorific value for lubricants (TJ/10^3t)
1990	1632.54	41.86
1995	962.78	41.86
2000	879.06	41.86
2005	1088.36	41.86
2006	1088.36	41.86
2007	1088.36	41.86
2008	1046.5	41.86
2009	627.9	41.86
2010	586.04	41.86
2011	795.34	41.86
2012	920.92	41.86
2013	879.06	41.86
2014	627.9	41.86

[47] http://data.csb.gov.lv/pxweb/lv/vide/vide__ikgad__energetika/EN0020.px/?rxid=a7ccdc56-327e-45d0-9488-41a1f701ae14
[48] *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 5: Non-Energy Products from Fuels and Solvent Use, p.5.7*

4.5.1.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

As the default ODU factor is used, the uncertainty (50%) from 2006 IPCC Guidelines is applied for ODU emission factor.

The carbon content coefficients is taken from 2006 IPCC Guidelines and are based on two studies of the carbon content and heating value of lubricants, from which an uncertainty range of about 3%.

Activity data are taken from CSB of Latvia and uncertainty are assumed as 2%.

4.5.1.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the IPPU sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

QA/QC check is performed according to 2006 IPCC Guidelines. There are compared the amounts discarded, recovered and combusted in Transport sector with total consumption figures in the calculation to check the internal consistency data and ODU factors if they are used in the calculation of different source categories across sectors.

4.5.1.5 Category-specific recalculations

During quality control procedures mistake in CO_2 emission calculation were found and therefore emissions were recalculated for all time series.

4.5.1.6 Category-specific improvements

No specific improvements are planned in this sector.

4.5.2 Paraffin Wax Use (CRF 2.D.2)

4.5.2.1 Category description

Paraffin wax use subsector emissions amounts to 4.91kt (10.6%) of total Non-energy sector emissions in Latvia in 2014. CO_2 emissions from 2.D.2 sector have been increased by 166.7% since 1999 and decreased by 11.1% comparing with 2013 (Figure 4.11 and Table 4.28).

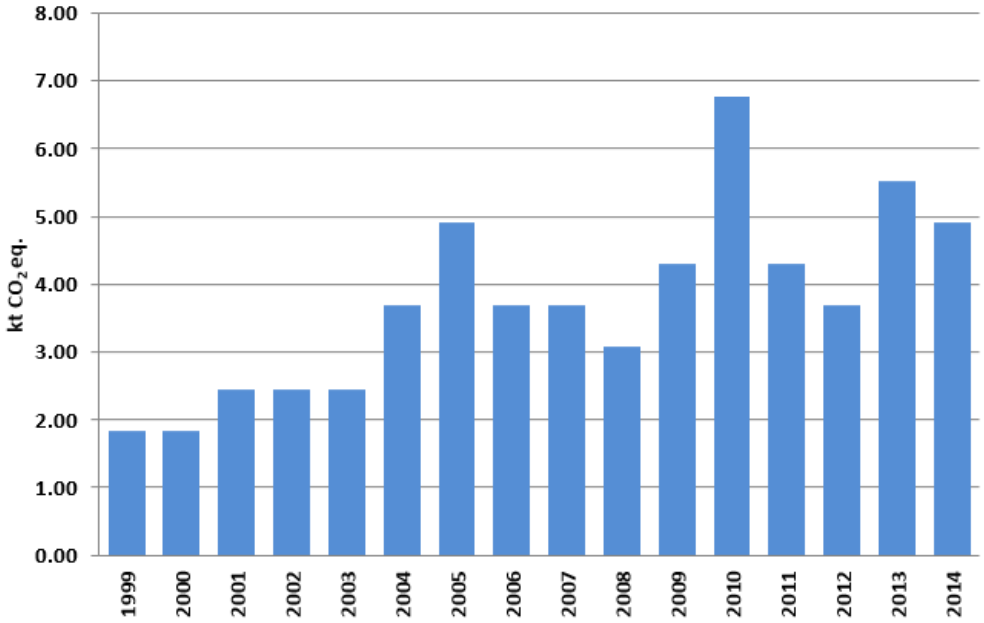

Figure 4.11 CO_2 emissions from Paraffin wax use 1990-2014 (kt)

Under this category paraffin wax consumption is reported as feedstocks in Latvia. Paraffin wax mainly is used in chemical substances and chemical production as well as plastic, rubber and furniture production. Emissions from paraffin wax is reported as „CO_2 not emitted" because it is assumed that CO_2 emissions is captured and not emitted into the air.

Consumption and emissions of paraffin wax are reported in sector 2.D.2 for all years in time series 1999-2014 (Table 4.28).

Table 4.28 CO_2 emissions from paraffin wax use 1990-2014

	CO_2 emissions (kt)
1990	NO
1995	NO
2000	1.84
2005	4.91
2006	3.68
2007	3.68
2008	3.07
2009	4.30
2010	6.75
2011	4.30
2012	3.68
2013	5.52
2014	4.91
Share in IPPU total in 2014	10.6%
2014 versus 2013	-11.1%
2014 versus 1999	166.7%

4.5.2.2 Methodological issues

Emission factors

CO_2 emissions are calculated according to Tier1 method and emission factors as well as default carbon content are taken from the 2006 IPCC Guidelines. Carbon content for paraffin wax is 20.0 kg/GJ as default one taken from 2006 IPCC Guidelines Volume 2 Energy Chapter 1 Table 1.3.

Net calorific value (NCV) for lubricants is 41.86 TJ/10^3 t and is reported in Energy Balance from CSB[49].

CO_2 emissions are calculated using 2006 IPCC Guidelines equation 5.4[50]:

$$CO_2\ Emissions = PW \times CC_{Wax} \times ODU_{Wax} \times 44/12$$

where:
CO_2 emissions= CO_2 Emissions from waxes, tonne CO_2
LC= Total wax consumption, TJ
CC_{Wax}=carbon content of paraffin wax (default), tonneC/TJ (=kg/ C/TJ)
ODU_{Wax}= Oxidised during use (ODU) factor for paraffin wax, fraction
44/12= mass ratio of CO_2/C

Activity data

Activity data prepared by CSB and reported to EUROSTAT in EUROSTAT Annual Questionnaire formats were used. Data from statistics about paraffin wax consumption are available only from 1999.

Table 4.29 Activity data from paraffin wax use 1990-2014

	Consumption of paraffin wax (TJ)	Net calorific value for paraffin wax (TJ/10^3t)
1990	NO	41.86
1995	NO	41.86
2000	125.58	41.86
2005	334.88	41.86
2006	251.16	41.86
2007	251.16	41.86
2008	209.3	41.86
2009	293.02	41.86
2010	460.46	41.86
2011	293.02	41.86
2012	251.16	41.86
2013	376.74	41.86
2014	334.88	41.86

[49] *http://data.csb.gov.lv/pxweb/lv/vide/vide__ikgad__energetika/EN0020.px/?rxid=a7ccdc56-327e-45d0-9488-41a1f701ae14*
[50] *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 5: Non-Energy Products from Fuels and Solvent Use, p.5.11*

4.5.2.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

The default ODU factor for paraffin wax is taken from 2006 IPCC Guidelines. Due to lack of information regarding application of paraffin wax in the country, the uncertainty of ODU factor is assumed 100 %.

The carbon content coefficient is taken from 2006 IPCC Guidelines and uncertainty is 5%.

Activity data are taken from CSB of Latvia and uncertainty is assumed 2%.

4.5.2.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the IPPU sector in order to achieve these quality objectives. Quality meetings are held annually between experts

QA/QC check is performed according to 2006 IPCC Guidelines. There are compared the amounts discarded, recovered and combusted with total consumption figures in the calculation to check the internal consistency data and ODU factors if they are used in the calculation of different source categories across sectors.

4.5.2.5 Category-specific recalculations

During quality control procedures mistake in CO_2 emission calculation were found and therefore emissions were recalculated for all time series.

4.5.2.6 Category-specific improvements

No specific improvements are planned in this sector.

4.5.3 Other (CRF 2.D.3)

4.5.3.1 Category description

This chapter describes emissions from Solvent Use, Road paving with asphalt and Asphalt roofing sector under Other (CRF 2.D.3).

Solvent Use

Solvent Use sector (2.D.3) is a key source of indirect CO_2 emissions of Latvian inventory. The Solvent use is estimated as a key category in level by using Approach 1 without LULUCF. Quantitative information regarding key categories is available in Annex 1 of this submission.

The use of solvents and products containing solvents results in emissions of non-methane volatile organic compounds (NMVOC). NMVOC emissions are regarded as an indirect greenhouse gases as it over a period of time will oxidize into CO_2 when emitted to the atmosphere. The CO_2 emissions from Solvent Use sector have been constantly decreasing since the beginning of 1990s till 2006 mostly due to the industry was affected by a crisis.

According to 2006 IPCC Guidelines and EMEP/EEA 2013 Solvent Use sector covers emissions from the four SNAP (Selected Nomenclature for Air Pollution) subcategories:

- SNAP 0601: Paint application (Including such activities as paints and varnishes from decorative, industrial and other coating applications);
- SNAP 0602: Degreasing, Dry cleaning (Degreasing includes cleaning products from water-insoluble substances such as grease, fats, oils waxes and tars. Dry cleaning refers to any process to remove contamination from furs, leather, down leathers, textiles or other objects made of fibres using organic solvents);
- SNAP 0603: Chemical products manufacturing or processing (Including the processing of polyester, PVC, foams and rubber, manufacture of paints, inks, glues and adhesives and finishing of textile);
- SNAP 0604: Other use of solvents and related activities (Including such activities as "enduction" (i.e. coating) of glass wool and mineral, printing industry, fat and oil extraction, uses of glues and adhesives, wood preservation, domestic use (other than paint application) and vehicle underseal treatment and vehicle dewaxing).

Latvia`s reported NMVOC and indirect CO_2 emissions from NMVOC under Solvent Use sector in 2014 are shown in Table 4.30.

Table 4.30 Reported emissions from Solvent Use in Latvia in 2012

CATEGORY		TITLE	EMISSIONS
SNAP	NRF		
0601	2D3d	Paint application	NMVOC, indirect CO_2
0602	2D3e	Degreasing	NMVOC, indirect CO_2
0602	2D3f	Dry cleaning	NMVOC, indirect CO_2
0603	2D3g	Chemical products	NMVOC, indirect CO_2
0604	2D3h	Printing industry	NMVOC, indirect CO_2
0604	2D3a	Domestic solvent use (other than paint application)	NMVOC, indirect CO_2
0604	2D3i	Other solvent use	NMVOC, indirect CO_2

Solvent Use sector was the largest pollution source of NMVOC emissions in Latvia in 2014 and it covered over 32.8% (14.65 kt) from the total Latvia's NMVOC emissions. The main share of total indirect emissions contributed SNAP 0601: Paint application – 48.6% or 15.65 kt and SNAP 0604: Other use of solvents and related activities – 27.67% or 8.91 kt (Figure 4.12).

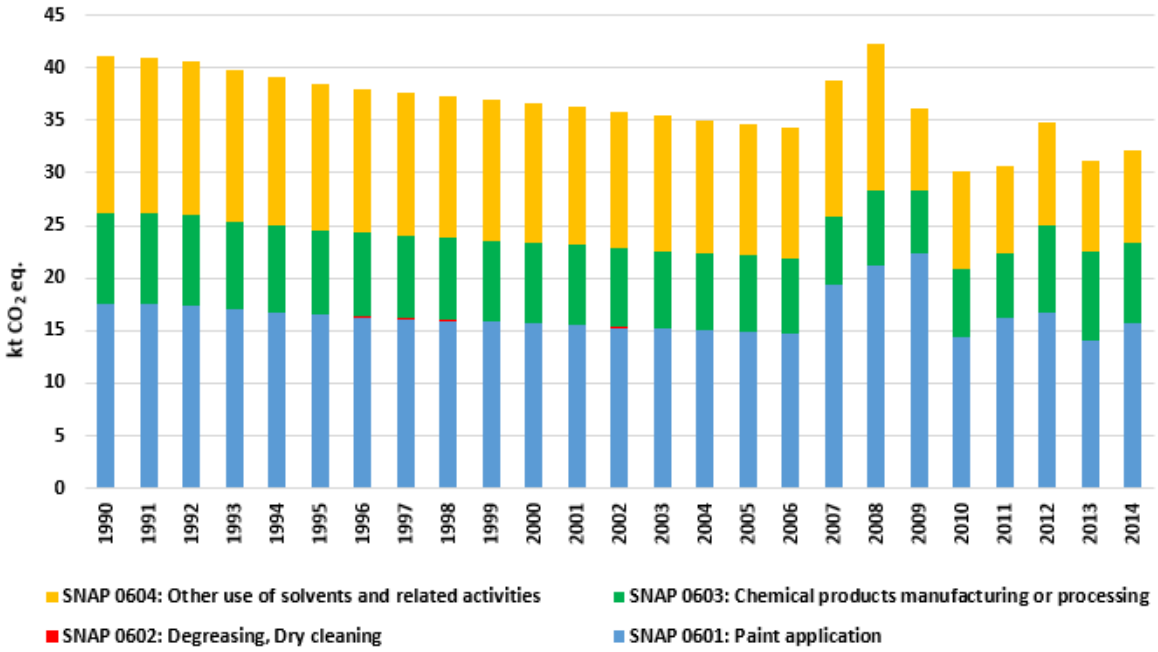

Figure 4.12 Emissions from Solvent Use in 1990-2014 (kt CO_2 eq.)

The CO_2 emissions from Solvent Use sector have been constantly decreasing since the beginning of 1990s till 2006 mostly due to the industry was affected by a crisis.

The emission increase in the period of 2006-2008 is explained with import growth of NMVOC containing products. In subsequent years there has been observed decrease back till 2010. At the end of 2008 the world was struck by the economic crisis which also affected the Solvent Use sector in Latvia.

As shown there is slight increase of CO_2 emissions of Solvent Use sector during the later period of 2010 till 2014 (except 2012 when rapid increase observed). For instance, emissions of CO_2 have decreased by 6.7 %, from 30.17 kt CO_2 in 2010 to 32.20 kt CO_2 eq in 2014 (see Table 4.31).

Table 4.31 Indirect CO_2 emissions from Solvent Use in 1990-2014 (kt CO_2 eq.)

Indirect CO_2	SNAP 0601: Paint application	SNAP 0602: Degreasing, Dry cleaning	SNAP 0603: Chemical products manufacturing or processing	SNAP 0604: Other use of solvents and related activities	Sum
1990	17.58	0.03	8.61	14.85	41.06
1991	17.51	0.03	8.58	14.79	40.91
1992	17.41	0.03	8.53	14.71	40.68
1993	17.03	0.03	8.34	14.39	39.80
1994	16.74	0.03	8.20	14.14	39.11
1995	16.47	0.03	8.07	13.92	38.49
1996	16.27	0.03	7.97	13.74	38.01
1997	16.11	0.03	7.89	13.61	37.63
1998	15.95	0.03	7.81	13.47	37.26
1999	15.81	0.03	7.74	13.35	36.93
2000	15.66	0.02	7.67	13.23	36.59

Indirect CO_2	SNAP 0601: Paint application	SNAP 0602: Degreasing, Dry cleaning	SNAP 0603: Chemical products manufacturing or processing	SNAP 0604: Other use of solvents and related activities	Sum
2001	15.50	0.02	7.59	13.10	36.22
2002	15.29	0.02	7.49	12.92	35.72
2003	15.15	0.02	7.42	12.80	35.39
2004	15.00	0.02	7.35	12.67	35.04
2005	14.82	0.02	7.26	12.52	34.62
2006	14.68	0.02	7.19	12.40	34.29
2007	19.30	0.03	6.53	12.85	38.71
2008	21.22	0.02	7.10	13.87	42.21
2009	22.29	0.02	6.08	7.79	36.18
2010	14.38	0.03	6.36	9.39	30.17
2011	16.21	0.03	6.11	8.28	30.64
2012	16.66	0.04	8.35	9.70	34.75
2013	14.07	0.06	8.33	8.74	31.19
2014	15.65	0.04	7.60	8.91	32.20

It is assumed that the NMVOC containing products imported in the country in a particular year are utilized in the same year as the data of the actual use is not available or is confidential. At the same time enterprises tend to provide a stockpiles taking into account economic situation. This in turn affects amount of CO_2 emission, causing fluctuations of time series.

Road paving with asphalt (2.D.3.b) and Asphalt roofing (2.D.3.c)

In this sector emissions from construction materials production as well as Road paving activities are reported.

Table 4.32 Activity data for Road paving and Asphalt roofing 1990-2014

	Amount of bitumen mixtures used (kt)	% of asphalt used for Road Paving	% of asphalt used for Asphalt roofing	Road Paving with asphalt (kt)	Asphalt roofing (kt)
1990	39.000	80%	20%	31.200	7.800
1995	116.990	80%	20%	93.592	23.398
2000	423.643	90%	10%	381.278	42.364
2005	1165.015	90%	10%	1048.514	116.502
2006	1116.697	90%	10%	1005.027	111.670
2007	1492.517	90%	10%	1343.265	149.252
2008	1536.659	90%	10%	1382.993	153.666

	Amount of bitumen mixtures used (kt)	% of asphalt used for Road Paving	% of asphalt used for Asphalt roofing	Road Paving with asphalt (kt)	Asphalt roofing (kt)
2009	838.446	90%	10%	754.602	83.845
2010	937.177	90%	10%	843.459	93.718
2011	1481.480	90%	10%	1333.332	148.148
2012	1584.974	90%	10%	1426.476	158.497
2013	1255.138	90%	10%	1129.624	125.514
2014	1289.971	90%	10%	1160.974	128.997

According to CSB data the biggest share of NMVOC and CO_2 emissions are originating during road paving with asphalt. Just small part of all bitumen mixtures is used in asphalt roofing sector (Table 4.32).

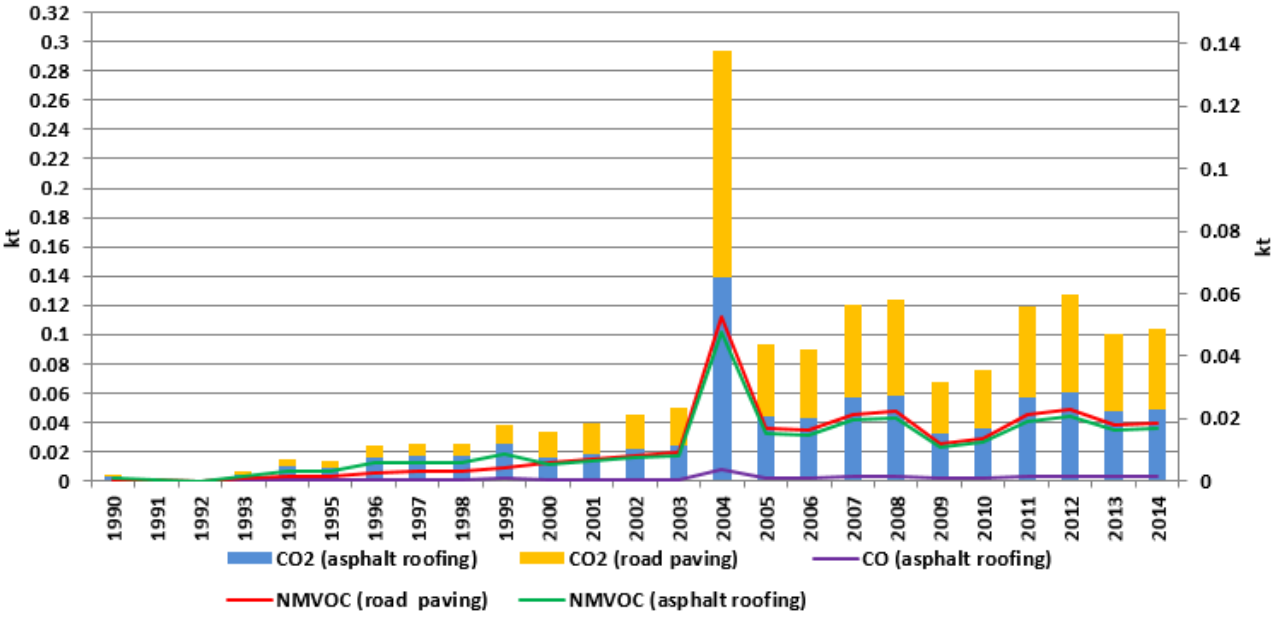

Figure 4.13 Emissions from asphalt roofing and road paving in 1990–2014 (kt)[51]

The emissions from these two particular sectors are constantly increasing since the beginning of 1990s. Slight emission decrease in 1999-2000 could be explained with the change of percentage that is used to divide activity data used in roofing and road paving. The sharp emission increase in 2003-2004 could be explained with Latvia's accession to EU in the May of 2004 before and after when the road paving works were very active and there were built VIA Baltic that connects all Baltic States. In 2011 and 2012 there are raised activity for road paving and asphalt roofing about 58.08% and 6.99% respectively. In 2013 there is decreased overall activity of bitumen use in industrial processes about 20.81% and it

[51] *NMVOC emissions from road paving with asphalt,and asphalt roofing and CO emissions from asphalt roofing on secondary axis*

depends on financial resources that are assigned directly to this sector for road paving or asphalt roofing. In 2014 there are quite stable situation in this sector (Figure 4.13).

Urea use

Urea are used as catalyst in fuel consumption and calculated under 1.A.3 Transport sector but emissions are reported under 2.D Non- energy Products from Fuels and Solvent Use (Table 4.33).

Table 4.33 Data from Urea use 2006-2014 (kt)

	Urea consumption	CO_2 emissions
1990	NO	NO
1995	NO	NO
2000	NO	NO
2005	NO	NO
2006	2.006	0.133
2007	2.007	0.419
2008	2.008	0.497
2009	2.009	0.471
2010	2.01	0.563
2011	2.011	0.521
2012	2.012	0.528
2013	2.013	0.538
2014	3.427	0.817

4.5.3.2 Methodological issues

Solvent Use

The NMVOC inventory is carried out to fulfil the obligations of the United Nations Economic Commission for Europe's Convention on Long-Range Transboundary Air Pollution (UNECE CLRTAP).

NMVOC emissions from Solvent Use sector (except 2D3f and partly 2D3g) were calculated according to EMEP/EEA 2013 methodology based on Tier 1 or Tier 2 approach and used particular emission factors for several source sub-categories (see Table 4.34).

Table 4.34 Approaches and emission factors for Solvent Use sector

Subcategories	NRF	EF	Tier	Unit
Cosmetics and toiletries (all)	2D3a	0.83	2	t/t solvent
Household products (all)	2D3a	0.65	2	t/t solvent
DIY/buildings (all), Adhesives, Paint/varnish removers and solvents	2D3a	0.95	2	t/t solvent
Car care products (all)	2D3a	0.94	2	t/t solvent
Pesticides	2D3a	0.865	2	t/t solvent
Domestic use of pharmaceutical products	2D3a	0.606	2	t/t product
Paint application: construction and buildings	2D3d	0.15	1	t/t paint applied
Paint application: domestic use	2D3d	0.15	1	t/t paint applied
Coating applications: manufacture of automobiles	2D3d	0.4	1	t/t paint applied
Paint application: car repairing	2D3d	0.4	1	t/t paint applied

Subcategories	NRF	EF	Tier	Unit
Paint application: coil coating	2D3d	0.4	1	t/t paint applied
Coating applications: Boat building	2D3d	0.4	1	t/t paint applied
Paint application: wood	2D3d	0.4	1	t/t paint applied
Coating applications: Other industrial paint application	2D3d	0.2	1	t/t paint applied
Other non industrial paint application	2D3d	0.2	1	t/t paint applied
Degreasing	2D3e	0.46	1	t/t cleaning products
Chemical products, manufacture and processing	2D3g	0.01	1	t/t product
Polystyrene foam processing	2D3g	0.06	2	t/t polystyrene
Rubber processing	2D3g	0.008	2	t/t rubber produced
Tyre production	2D3g	0.01	2	t/t tyres
Paints manufacturing	2D3g	0.011	2	t/t product
Glass Wool Enduction	2D3g	0.25	2	t/t solvent
Pharmaceutical products manufacturing	2D3g	0.3	2	t/t solvent
Printing	2D3h	0.5	1	t/t ink
Fat, edible and non-edible oil extraction	2D3i	0.002	1	t/t product used
Application of glues and adhesives	2D3i			
Preservation of wood	2D3i	0.945	2	t/t preservative (organic solvent-borne preservative)
Preservation of wood	2D3i	0.005	2	t/t preservative (waterborne preservative)
Other solvent and product use	2D3i	0.002	2	t/t product

From the 1990s till 2005 statistics for Solvent Use was not well kept due to the country-wide changes in the governmental system and national economy. For 2006-2014 activity data for Paint application, Degreasing, Chemical Products (partly), Printing industry, Domestic solvent use and Other solvent use was obtained from the Register of Chemical Substances and Chemical Mixtures (CR) at Ltd. Latvian Environment, Geology and Meteorology Centre. In the CR data of imported and produced amount of chemical products containing NMVOCs is collected together with the percentage of a particular NMVOC in imported or produced products. It is assumed that the NMVOC containing products imported in the country in a particular year are utilized in the same year as the data of the actual use is not available or is confidential. In the CR information on a particular year, amount of produced and imported chemicals (ton), NACE code, trade name, chemical name, CAS number and concentration (from … till %) is provided.

NMVOC emissions (kt) from Solvent Use sector (except 2D3f and partly 2D3g) were calculated for the time series 2006-2014 using the equation below.

$$E_{NMVOC} = EF_{NMVOC} \times AD$$

where:

E_{NMVOC} – non-methane volatile organic compounds emissions from solvents and other production use (kt)

EF_{NMVOC} – emission factor from EMEP/EEA 2013

AD – activity data from the Chemical Register (kt)

To obtain a comparable data in time series for years where statistics was not well kept NMVOC emissions were calculated using the same methodology as for years 2006-2014. Assuming that base year for NMVOC emissions is year 2006, NMVOC emissions for years where statistics was not well kept were calculated proportionally, taking into account the number of inhabitants taken from CSB database.

NMVOC emissions data from Dry cleaning and Chemical products subsectors is obtained directly from database "2-Air" at Ltd. Latvian Environment, Geology and Meteorology Centre for 2006-2014. From the 1990s till 2005 statistics for NMVOC emissions data also was not well kept. "2-Air" is database where enterprises (that do any pollution activity and have category A, B, or C polluting activity) report their emissions data; it is approximately 3000 enterprises in total every year. From these approximately 3000 enterprises data is used only from the enterprises that produced NMVOC emissions according to EMEP/EEA 2013. The enterprises have been reporting their produced NMVOC emissions dividing in a particular NMVOC.

Activity data from Dry cleaning and Chemical products subsectors reported by enterprises is not available as these data is not required to be reported and could be assumed as confidential.

Indirect CO_2 emissions from Solvent Use sector was estimated using methodology from the 2006 IPCC Guidelines:

$$Emissions_{CO2} = Emissions_{NMVOC} \cdot Percent\ carbon\ in\ NMVOCs\ by\ mass \cdot 44.0098/12.011$$

It was assumed that the average carbon content of NMVOC is 60% by mass for all categories under the sector of Solvent Use in accordance with the 2006 IPCC Guidelines.

This leads to an emission factor for indirect CO_2 release of 2.198474731 kg CO_2/kg NMVOC.

Road paving with asphalt (2.D.3.b) and Asphalt roofing (2.D.3.c)

EMEP/EEA 2013 Tier1 was used to estimate NMVOC emissions from the 2.D.3.b Road paving with asphalt and 2.D.3.c Asphalt roofing. According to CSB data the biggest part of bitumen mixtures amount is used for road paving. Only small part is used for roofing activities (Table 4.35).

NMVOC emissions are estimated using simpler default methodology:

$$E_{NMVOC} = AD_{bitumen} \times EF_{NMVOC}$$

where:
E_{NMVOC} – NMVOC emissions (kt)
$AD_{bitumen}$ – bitumen and bitumen mixtures used in CRF 2.D.3.b and 2.D.3.c activities (kt)
EF_{NMVOC} –NMVOC emission factor (kt/kt)

Indirect CO_2 emissions from asphalt roofing and road paving with asphalt activities were estimated according to 2006 IPCC Guidelines and explanation of indirect CO_2 emission estimation basing on carbon conversion factor and average default carbon content amount.

For the CO_2 emission estimation NMVOC emissions were taken as activity data and CO_2 emissions were estimated using carbon conversion factor:

$$E_{CO_2} = EF_{CO_2} \times NMVOC$$

where:
E_{CO2} – CO_2 emissions (kt)
EF_{CO2} – estimated CO_2 emission factor
NMVOC – NMVOC emissions (kt)

Emission factors

For CO_2 emission estimation 80% of carbon content conversion factor are used. According to 2006 IPCC Guidelines [52] indirect emissions of CO_2 from atmospheric oxidation of emitted NMVOC are included in the national emission inventory. The average amount of carbon in NMVOC is assumed as 80%[53].

Therefore the CO_2 emission factor from 2006 IPCC Guidelines was estimated using following equation:

$$EF_{CO_2} = 80\% \times 44.0098/12.011$$

where
EF_{CO2} – CO_2 emission factor (kt/kt)
80% – the average amount of carbon in NMVOC
44.0098 / 12.011 – carbon dioxide and carbon molmass ratio

This leads to an emission factor for indirect CO_2 release of 2.931299642 kg CO_2/kg NMVOC.

Default CO and NMVOC emission factors are taken from EMEP/EEA 2013.[54,55] Due to lack of the technology use information Tier1 EFs were used (Table 4.35).

Table 4.35 Emission factors for asphalt roofing and Road paving in 1990–2014

	CO_2 (t CO_2/t NMVOC)	**CO (kt/kt)**	**NMVOC (kt/kt)**
Asphalt Roofing	2.93	0.0000095	0.00013
Road Paving with Asphalt	2.93	NE	0.000016

Urea use

Description of methodology to calculate CO_2 emissions from Urea use is reported under sector 1.A.3 Transport.

4.5.3.3 Uncertainties and time series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Solvent use

[52] *http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_7_Ch7_Precursors_Indirect.pdf (page 7.6)*
[53] *Basing of the most often used average carbon conversion factor*
[54] *http://www.eea.europa.eu/publications/emep-eea-guidebook-2013, 2.D.3.b Road paving with atsphalt pdf (page8)*
[55] *http://www.eea.europa.eu/publications/emep-eea-guidebook-2013 2.D.3.c Asphalt roofing pdf (page 9)*

Uncertainty of activity data for estimations of NMVOC emissions from Solvent Use is calculated as 16%. Time series consistency was ensured by using one method for all time series.

Road paving with asphalt (2.D.3.b) and Asphalt roofing (2.D.3.c)

Uncertainty of activity data for estimations of CO_2 emissions from 2.D.3.c Asphalt roofing sector and 2.D.3.b Road paving with asphalt sector is assumed rather low as CSB data of used bitumen mixtures are used and the percentage of 2006 IPCC Guidelines is used to divide bitumen use for roofing and paving activities. Still as it is not clearly known how much of the total bitumen is used for asphalt paving and for asphalt roofing (bitumen use in construction sector) the uncertainty is assumed at least 20%.

The CO_2 emission factors for 2.D.3.b and 2.D.3.c sectors are assumed as high as 70% because default emission factors are used and CO_2 emissions are estimated from NMVOC emissions. The uncertainty of indirect emission factors for these two sectors taken from EMEP/EEA 2013 as Tier 1 EFs is assumed as high as 50% as the default emission factors are used.

Time series of the estimated emissions are consistent and complete because the same methodology, emission factors and data sources are used for sectors for all years in time series. NO_x, CO and SO_2 emissions are not estimated due to lack of estimation methodology and official emission factors.

Time series consistency was checked by verifying IEF, AD and emission changes and attention was paid to important increase/decrease that are explained in NIR.

4.5.3.4 Source-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the IPPU sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

Solvent use

All estimations of the emissions done in the LEGMC are checked on the logical mistakes by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogic changes in the activity data and emissions.

Quality control check list is filled for each category taking into account criteria given in QA/QC plan approved in the national legislation. All findings were documented and introduced in GHG inventory. All corrections are archived in centralized archiving system (common FTP folder).

Road paving with asphalt (2.D.3.b) and Asphalt roofing (2.D.3.c).

Activity data used in NMVOC and CO_2 emissions from asphalt roofing and road paving with asphalt was reported by CSB in Annual Questionnaire tables. Bitumen data used in emission estimation and reported in NIR are verified by CSB. Data also is compared to the data reported in 1A(d) sector.

CSB has the internal QA/QC procedures based on mathematical model and analysis to avoid logic mistakes.

The activity data used in estimations is repeatedly verified by CSB energy experts by checking the data input in data estimation database and reported in the NIR.

All estimations of the emissions done in the LEGMC also are checked on the logical mistakes by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogic changes in the activity data and emissions.

The QC form has been filled in for each category taking into account criteria given in QA/QC plan approved in national legislation. Form then is archived.

4.5.3.5 Source-specific recalculations

Solvent use

For period 1990-2014 recalculations have been carried out under Solvent Use sector mainly due to two reasons. The first one is that the list of NMVOCs substances was corrected, therefore recalculations were carried out for all time series. The second reason is change of method according to EMEP/EEA 2013 for all time series (see Chapter 4.5.3.2.).

Road paving with asphalt (2.D.3.b) and Asphalt roofing (2.D.3.c)

No recalculations were done in this sector.

4.5.3.6 Source-specific improvements

Solvent use

It is planned to implement electronic reporting for importers and producers in the Chemicals Register from 2016. According to that, possible changes in activity data are expected. It is planned to get more accurate division by subcategories taking into account that previously it was done by expert judgment.

Road paving with asphalt (2.D.3.b) and Asphalt roofing (2.D.3.c)

No improvements are planned for this sector.

4.6 ELECTRONICS INDUSTRY (CRF 2.E)

HFC, PFC, SF_6 and NF_3 emissions from manufacturing of integrated circuit of semiconductors, TFT flat panel displays, photovoltaics and heat transfer fluids are not occurring in Latvia.

There is one company in Latvia which manufactures liquid crystal displays (LCDs) and 3D products for industrial, professional, medical and defence applications. Directly contacting with the company they confirmed that NF_3 is not used in technology as well as company has no plans to use it in the future.

Other types of equipment listed in 2006 IPCC Guidelines, Volume 3, Chapter 6 under this sector are not being manufactured in Latvia. Currently using CRF Reporter software version 5.14 it is not possible to enter NO in green and grey cells although CRF Reporter User manual says that if disaggregated data is not available for certain categories, the CRF Reporter allows users to report information in the parent category. This can be done by directly entering data in the green cells (i.e. overwriting formulas).

Under Electronics industry subcategories Latvia doesn`t report emissions so child nodes (gases) are not added according to CRF User manual however it is not currently possible to

enter data in green cells so some information in the parent category (green cells) in corresponding CRF tables are missing. It was confirmed by CRF Reporter help desk that this is an CRF internal issue which will be improved in the future releases of the software. But for the moment it was suggested to leave cells blank.

4.7 PRODUCT USES AS SUBSTITUTES FOR OZONE DEPLETING SUBSTANCES (ODS) (CRF 2.F)

Under 2.F Latvia reports emissions from usage of hydrofluorocarbons (HFCs) occurring in following sectors:

- Refrigeration and air-conditioning equipment (CRF 2.F.1);
- Foam blowing products (CRF 2.F.2);
- Fire Protection (CRF 2.F.3);
- Aerosols (CRF 2.F.4).

In 2014 GHG emissions from Product uses as substitutes for ODS substances amounted 212.06 kt CO_2 eq (1.9%) from total CO_2 equivalent emissions without LULUCF. Compared to 2013 F-gases emissions have increased by 3.8%, but compared to 1995 emissions have increased by 1744%.

There is no production of HFCs in Latvia. Emissions of the perfluorocarbons (PFCs) and nitrogern trifluoride (NF_3) do not occur in Latvia for all time series. HFC and PFC emissions from Solvents (CRF 2.F.5) and Other Applications (CRF 2.F.6) are not occurring in Latvia (reported as "NO" in CRF Reporter). Currently using CRF Reporter software version 5.14 it is not possible to enter NO in green and grey cells therefore some information in the parent category (green cells) in corresponding CRF tables are missing.

The calculation of emissions under 2.F was carried out for following gases:

- HFC–23
- HFC–32
- HFC–125
- HFC–134a
- HFC–143a
- HFC–152a
- HFC-245fa
- HFC-365mfc
- HFC–227ea

The major part of 2F emissions constitutes 2.F.1 Refrigeration and Air Conditioning (97.3%) which is also a key category by of Latvia`s GHG inventory. Additionally 2.2% from 2F emissions comes from 2.F.4. Aerosols (metered dose inhalers), but less than 1% comes from 2.F.2 Foam blowing agents (0.5%) and 2.F.3 Fire protection in 2014 (0.01%) (Figure 4.14).

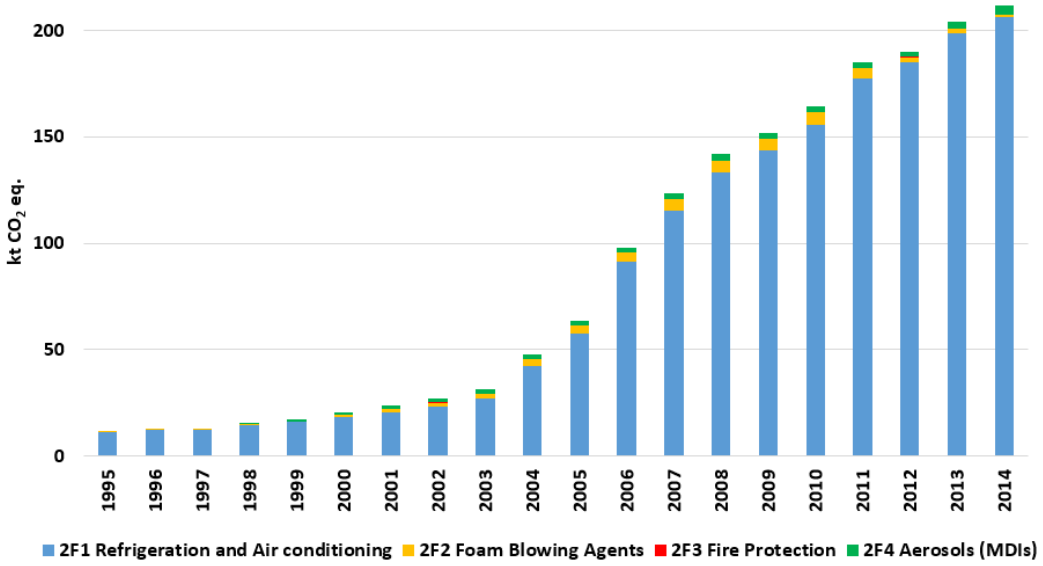

Figure 4.14 HFC emissions from 2.F Product Uses as ODS Substitutes (kt CO_2 eq.)

The total emissions from 2.F have increased significantly since 1995 (see Table 4.36 and Figure 4.14). The main reason which caused emission growth was substitution of ODS with nature friendlier alternatives commonly named F-gases in refrigeration and air conditioning appliances. The usage of products which substitute ODSs in Latvia mainly depends on import. The imported amounts could be associated with economic situation in the country consequently this led to F-gases emission growth. As the significant part of total F-gases emissions (32.3% in 2014) results from use of mobile air conditioning systems in road transport, the emission growth is also a result of increase of car population under this sector.

Table 4.36 HFC emissions from 2.F Product Uses as Substitutes for ODS, 1995-2014 (kt CO_2 eq.)

Year	2.F	2.F.1	2.F.2	2.F.3	2.F.4
	Product Uses as Substitutes for ODS	Refrigeration and Air Conditioning	Foam blowing agents/ foaming of polyether (for shoe soles)	Fire Protection	Aerosols (Metered dose inhalers)
1995	11.50	11.10	0.40	NO,NE	NO,NE
2000	20.46	18.44	0.78	NO,NE	1.24
2001	23.92	20.66	1.52	0.02	1.73
2002	27.20	23.18	1.97	0.02	2.03
2003	31.18	26.84	2.38	0.04	1.93
2004	47.54	42.34	3.21	0.08	1.91
2005	63.48	57.66	3.64	0.05	2.13
2006	98.09	91.46	4.22	0.02	2.39
2007	123.59	115.63	5.18	0.01	2.77
2008	142.02	133.19	5.81	0.01	3.00
2009	152.14	143.90	5.41	0.01	2.82
2010	164.42	155.49	6.19	0.02	2.72
2011	184.97	177.73	4.51	0.02	2.71
2012	190.21	184.97	2.63	0.06	2.55

Year	2.F	2.F.1	2.F.2	2.F.3	2.F.4
	Product Uses as Substitutes for ODS	**Refrigeration and Air Conditioning**	**Foam blowing agents/ foaming of polyether (for shoe soles)**	**Fire Protection**	**Aerosols (Metered dose inhalers)**
2013	204.35	198.93	1.84	0.06	3.52
2014	212.06	206.38	0.96	0.03	4.70
Share of total IPPU emissions in 2014 (%)	25.3%	24.7%	0.1%	0.003%	0.6%
2014 versus 2013	+3.8%	+3.7%	-47.7%	-55.4%	+33.4%
2014 versus 1995	+1744%	+1759.0%	+140.2%	+76.5%[56]	+2637%[57]

In 2004 the first investigation of F-gases sources and emissions in Latvia was carried out. Within the project "SF_6, HFC and PFC emission inventory in Latvia 1995-2003" [58] (hereinafter F-gases research (2004)) the areas and users of F-gases in Latvia were identified for the first time. The result of this project was initial activity and consumption data for F-gases emission estimation (in accordance with IPCC 1996 methodology). Activity data and assumptions derived during this project and shortly after were used for F-gases emission calculations.

In 2015 and 2016 the F-gases research within the EEA Financial Mechanism 2009-2014 Programme "National Climate Policy (hereinafter F-gases research (2016)) was carried out. The aim of this research was to improve activity data obtaining process and emission factors in 2.F.1 Refrigeration and Air conditioning sector as well as to split the activity data for years 2004-2014 between the 2.F.1 subcategories according to 2006 IPCC Gudelines.

The research has been bottom-up orientated. F-gases importers, suppliers, users and service companies were asked to supplement the information reported under EU Regulation (EU) No 517/2014[59] and national Regulations No.563[60] with the information regarding the sector and purpose of the substances they import, use or refill in equipment in the country. Data base containing information regarding amounts of ODS and F-gases imported, refilled and held in stocks is maintained by LEGMC according to previous mentioned regulations. As a result data from the particular database was divided by categories relevant to 2006 IPCC Gudelines 2.F.1 sector subcategories. Emission factors and assumptions were discussed and confirmed by Latvian Freezing Equipment Engineers` Association which is the responsible institution in certification of F-gases operators in Latvia.

[56] 2014 versus 2001 as time series for Fire Protection started in 2001

[57] 2014 versus 1998 as time series for Aerosols started in 1998

[58] Project report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003", Riga 2004

[59] EU Regulation (EU) No 517/2014 of The European Parliament and the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006

[60] Regulation No.563 of the Cabinet of Ministers of Latvia on special restrictions and prohibitions regarding activities with ozone-depleting substances and fluorinated greenhouse gases

4.7.1 Refrigeration and Air Conditioning (CRF 2.F.1)

4.7.1.1 Category description

The calculation of actual emissions from Refrigeration and Air Conditioning is done according to the 2006 IPCC Guidelines, Chapter 7 (Emissions of Fluorinated Substitutes for Ozone Depleting Substances) and Chapter 8 (Other Product Manufacture and Use).

Refrigeration and Air Conditioning Systems are responsible for about 93.5% of the Latvia`s F-gas emissions in 2014. Under 2.F. sector HFC emissions are reported covering 6 subcategories according to 2006 IPCC Gudelines:

- Commercial Refrigeration (refrigerators for supermarkets, shops etc.);
- Domestic Refrigeration (fridges and freezers in households);
- Industrial Refrigeration (refrigeration units in food and chemical industries);
- Transport Refrigeration (refrigerated vehicles);
- Mobile Air Conditioning (air conditioning systems in passenger cars, trucks and buses);
- Stationary Air Conditioning (room air-conditioning systems and heat pumps).

In 2014 HFC emissions from 2.F.1 Refrigeration and Air Conditioning totalled 206.38 kt CO_2 equivalent. Compared to 2013 the emissions were increased by 3.7%. In 2014 the mayority of F-gases emissions under 2.F.1 originates from 2.F.1.a Commercial Refrigeration (41.2%) 2.F.1.e Mobile air conditioning (34.6%), and 2.F.1.c Industrial Refrigeration (11.5%) Other less significant sources are 2.F.1.f Stationary Air Conditioning (9.7%), 2.F.1.d Transport Refrigeration (2.8%) and 2.F.1.b Domestic Refrigeration (0.2%) (Figure 4.15).

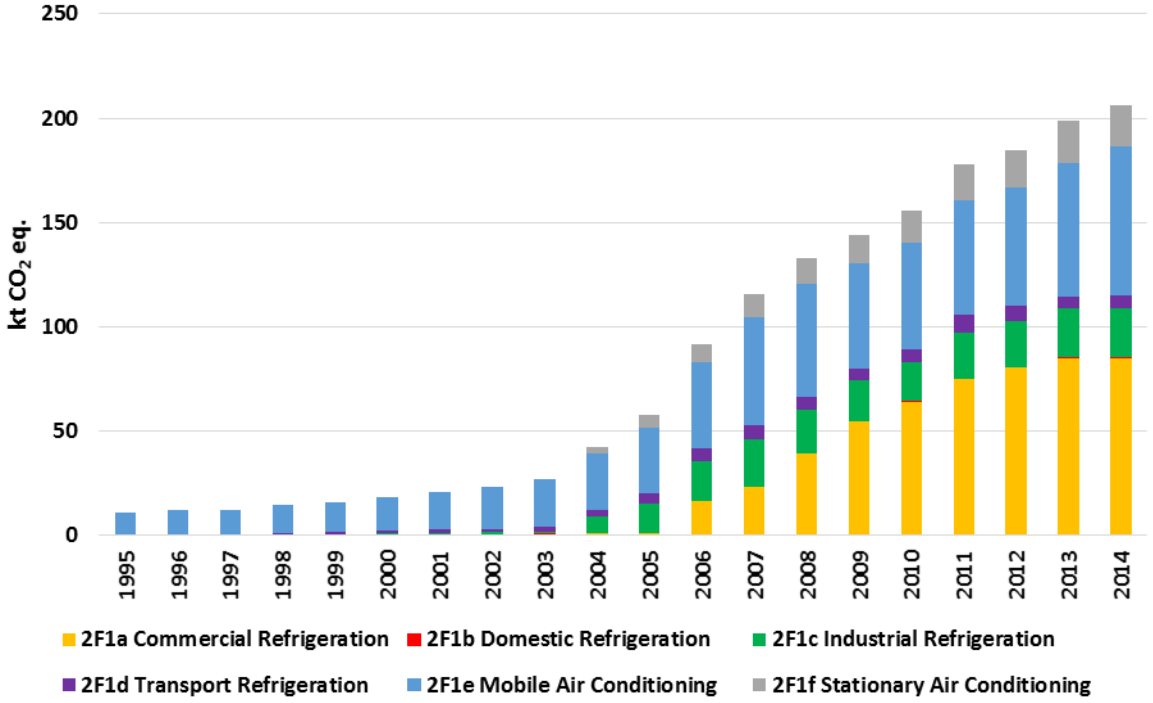

Figure 4.15 F-gases emissions from 2.F.1. Refrigeration and Air Conditioning equipment (kt CO_2 eq.)

4.7.1.2 Methodological issues

An overview of the methods used and gases reported under 2.F.1 sector is presented in Table 4.37.

Table 4.37 Summary of emission calculation methods and gases in CFR 2.F.1

CRF Category/subcategory	Method used	Gases reported
2.F.1 Refrigeration and Air Conditioning		
2.F.1.a Commercial Refrigeration	Tier 2a	HFC-134a HFC-32 HFC-125 HFC-143a HFC-152a HFC-23
2.F.1.b Domestic Refrigeration	Tier 2a	HFC-134a
2.F.1.c Industrial Refrigeration	Tier 2a	HFC-134a HFC-32 HFC-125 HFC-143a
2.F.1.d Transport Refrigeration	Tier 2a	HFC-134a HFC-32 HFC-125 HFC-143a HFC-23
2.F.1.e Mobile Air Conditioning	Tier 2a	HFC-134a
2.F.1.f Stationary Air Conditioning	Tier 2a	HFC-134a HFC-32 HFC-125 HFC-143a

- *Commercial Refrigeration (CRF 2.F.1.a)*

Activity data

Activity data for emission calculation is taken from annual reports by F-gases operators according to Regulation (EC) No. 517/2014 and national legislation No.563[61] "Regulations of ozone depleting substances and fluorinated greenhouse gases that are freezing agents". According to these regulations operators (merchants and other institutions) which perform activities with ozone depleting substances or F-gases annually shall report to LEGMC the following information:

- Name of the substance;
- Amount of substance at the beginning of the year;
- Imported amount;
- Exported amount;
- Charged amount in freezing equipment units;
- Recycled amount;
- Regenerated amount;

[61] *http://likumi.lv/ta/id/233736-noteikumi-par-ipasiem-ierobezojumiem-un-aizliegumiem-attieciba-uz-darbibam-ar-ozona-slani-noardosam-vielam-un-fluoretam-siltumn...*

- Disposed amount;
- Amount of substance at the end of the year.

245 operators reported data of their activities with F-gases in 2014. For historical years activity data were obtained from questionnaires within previous F-gases research. For 2004-2005 activity data were obtained from enterprises that responded on data request letters sent by LEGMC. For 2006-2014 data were obtained from reporting within previously mentioned regulation act or extrapolated.

Emission factors and calculations

Tier 2a – emission-factor approach from 2006 IPCC Guidelines was used to estimate emissions from commercial refrigeration. Emissions result from charging, lifetime and end-of-life of equipment and are calculated for each type of HFC separately.

According to the methodology, refrigerant emissions at a reporting year can be calculated separately for each stage of life of the equipment. These emissions come from:

- $E_{charge,\ t}$ – emissions related to the refrigerant charge: connection and disconnection of the refrigerant container and the new equipment to be charged;
- $E_{lifetime,t}$ – annual emissions from the banks of refrigerants during operation (fugitive emissions and ruptures) and servicing;
- $E_{end\text{-}of\text{-}life,}t$ – emissions at system disposal.

Equation 7.10 from 2006 IPCC Guidelines was used to sum up all the emissions occurring during the lifetime of the equipment:

$$E_{total,t} = E_{Charge,t} + E_{Lifetime,t} + E_{End\text{-}of\text{-}life,t}$$

There are no HFC-containing equipment manufacturing companies in Latvia and all appliances used in commercial refrigeration are imported.

Emission factors and assumptions used in emission calculation from commercial refrigeration are as follows:

- HFCs mainly charged in Commercial Refrigeration are HFC-134a, HFC-404a, HFC-422d, HFC-407c, HFC-507a and HFC-410a;
- Average emission factor during charging of equipment is 1.8%[62];
- Average emission factor during operation of equipment is 18%[63];
- Average life time of commercial applications assumed 15 years;
- Residual charge of HFC in equipment being disposed 80%[64];
- Recovery efficiency at disposal 70%[65].

Equation from 2006 IPCC Guidelines for charging emissions estimation:

$$E_{Charged,\ t} = M_t \times k/100$$

[62] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9 – Average value applied for commercial applications.*
[63] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9 – Average value applied for commercial applications.*
[64] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9*
[65] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9*

where:
$E_{charged}$ – emissions during system manufacture/assembly in year (kg)
Mt – amount of HFC charged into a new equipment in year (kg)
k – charging losses (%)

Equation from 2006 IPCC Guidelines for emission estimation stocks:

$$E_{lifetime,\ t} = B_t \times x / 100$$

where:
$E_{lifetime}$ – amount of emissions during equipment operation (t)
Bt – amount of HFC held in stocks in year t
x – losses during operation period (%)

Equation from 2006 IPCC Guidelines for emission estimation from disposal:

$$E_{end\text{-}of\text{-}life,\ t} = M_{t\text{-}d} \times p/100 \times 1\text{-}(\eta_{rec,\ d} / 100)$$

where:
$E_{lend\text{-}of\text{-}life}$ – amount of HFC emitted at system disposal in year (t)
Mt-d – residual charge of HFC in equipment being disposed of expressed in percentage of full charge (%)
ηrec, d – recovery efficiency at disposal, which is the ration of recovered HFC reffered to the HFC contained in the system (%)

The total amount of HFC charged into commercial refrigeration equipment in 2014 amounts to 23.45 t constituting 0.41 t manufacturing emissions. HFC in stocks amounts to 129.91 t constituting 23.38 t operating emissions. As the HFC amounts filled into refrigeration equipment are available since 1998, the decommissioning emissions according to 15 years lifetime could be estimated starting from 2013. The amount of HFCs remained in decommission is amount of refrigerant initially charged into the systems in 1999 (0.19 t) which constitutes 0.05 t disposal emissions in 2014.

- *Domestic Refrigeration (CRF 2.F.1.b)*

Activity data

This category includes all refrigeration units (fridges and freezers) for domestic use. As there is no production of such equipment in Latvia, emissions could be estimated taking into account data on imported units which are charged and used within the country. Prior to 1990 most refrigeration appliances used CFC-12. Since 1993 there was a shift to HFC-134a. Many countries have subsequently moved to systems using hydrocarbon HC-600a which is now the predominant refrigerant for new domestic refrigeration appliances.

HFC emissions in domestic refrigeration are estimated from HFC-134a.

The activity data for HFC-134a emission estimation from domestic refrigerators and freezers are:

- number of inhabitants in Latvia – data taken from CSB database „Resident population at the beginning of the year"[66];

[66] *http://data.csb.gov.lv/pxweb/en/Sociala/Sociala__ikgad__iedz__iedzskaits/IS0020.px/table/tableViewLayout1/?rxid=a79839fe-11ba-4ecd-8cc3-4035692c5fc8*

- number of households in Latvia – data taken from CSB database „Total number of households and the average size of a household"[67];
- number of new imported fridges and freezers – data taken from CSB database "Imports by countries 1995-2014"[68];
- share of annually sold new equipment filled with HFC-134a – taken from Finland according to Finnish research[69];
- percentage of households using refrigerators and freezers – for 1996, 2001, 2006 and 2010 years data taken from CSB database „Number of electrical appliances used in dwellings and average age of appliances" [70];
- percentage of refrigerators and freezers charged with HFC-134a from 1995 till 2005 were determined during first F-gases research in 2004. As from 2006 the F-gases regulation entered into force it was assumed that the share of HFC-134a containing domestic refrigerators (stocks) started to decrease since that time. All European manufacturers of household appliances have changed their production from HFC-134a to R600a some time ago and appliances containing HFC-134a have only been imported from outside the EU to a small extent in recent years. No new equipment entered the stock from 2011 onwards. It was confirmed by Latvian Freezing Equipment Engineers` Association that the share of HCF-134a in domestic refrigeration stock is 15%.

Emission factors and calculations

HFC-134a emissions from domestic refrigerators and freezers are estimated by using 2006 IPCC Guidelines Guidelines Tier 2a – Emission-factor approach.

Emission factors and assumptions used in emission calculation from domestic refrigeration are as follows:

- Country specific average refrigerant charge per unit: 150 g HFC-134a;
- Default manufacturing emission factor 0.6%[71];
- Default operating emission factor 0.3%[72];
- Default disposal emission factor 80%[73];
- Recovery efficiency at disposal 70%[74].

There are no manufacturing companies in Latvia and all domestic refrigerators and freezers are imported.

[67] *http://data.csb.gov.lv/pxweb/en/Sociala/Sociala__ikgad__iedz__iedzskaits/IS0210.px/?rxid=562c2205-ba57-4130-b63a-6991f49ab6fe*
[68] *http://data.csb.gov.lv/pxweb/en/atirdz/atirdz__detalizeta__8zim/?tablelist=true&rxid=cdcb978c-22b0-416a-aacc-aa650d3e2ce0*
[69] *http://www.vtt.fi/inf/pdf/tiedotteet/2001/T2099.pdf*
[70] *http://data.csb.gov.lv/pxweb/en/vide/vide__energ_pat/0201.px/table/tableViewLayout1/?rxid=a79839fe-11ba-4ecd-8cc3-4035692c5fc8*
[71] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9, average value applied for domestic refrigeration*
[72] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9, average value applied for domestic refrigeration*
[73] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9, value applied for domestic refrigeration*
[74] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9*

That gives approximate annual amount of HFC-134a charged that is estimated with equation from 2006 IPCC Guidelines:

$$HFC_{Charged,t} = R \times n/f$$

where:
$HFC_{charged}$ – amount of HFC-134a charged in year t (tonnes)
R – amount of refrigerators and freezers charged with HFC-134a (units)
n – average equipment lifetime (years)
f – amount of HFC-134a charged once in lifetime of equipment

Equation from 2006 IPCC Guidelines was used for charging emissions estimation:

$$E_{Charged,t} = Mt \times k/100$$

where:
$E_{charged}$ – emissions during system manufacture/assembly in year (kg)
Mt – amount of HFC-134a charged into a new equipment in year (kg)
k – charging losses (%)

Amount of HFC-134a in stocks is estimated according to data from CSB. Approximate amount of HFC-134a stored in domestic refrigerators and freezers was estimated based on CSB data on number of households and percentage of households using refrigerators and freezers as well as assumption of share (percentage) of refrigerators and freezers filled with with HFC-134a.

Equation from 2006 IPCC Guidelines for emissions estimation from equipment lifetime:

$$E_{lifetime,t} = B_t \times x/100$$

where:
$E_{lifetime}$ – amount of HFC emitted during system operation in year (kg)
Bt – amount of HFC banked in existing systems in year (kg)
x – annual emission rate (%)

According to 15 years lifetime it is assumed that first disposal emissions from domestic refrigerators and freezers appear in 2010. Equation from 2006 IPCC Guidelines for emission estimation from disposal:

$$E_{end\text{-}of\text{-}life,\ t} = M_{t\text{-}d} \times p/100 \times 1\text{-}(\eta_{rec,\ d}/\ 100)$$

where:
$E_{lend\text{-}of\text{-}life}$– amount of HFC emitted at system disposal in year t (kg)
Mt-d – residusl charge of HFC in equipment being disposed of expressed in percentage of full charge, (%)
ηrec, d – recovery efficiency at disposal, which is the ration of recovered HFC reffered to the HFC contained in the system (%)

In 2014 the total HFC emissions from HFC-134a used in domestic refrigeration amounts to 0.34 t or 0.49 kt CO_2 equivalent. The majority of HFC emissions from domestic refrigerators occur at end-of-life from 2010 onwords. Charging and stock emission rates are comparably low.

- *Industrial Refrigeration (CRF 2.F.1.c)*

Activity data

Activity data for emission calculation from Industrial Refrigeration is taken from annual reports by F-gases operators according to Regulation (EC) No. 517/2014 and national legislation No.563[75]. 245 operators reported data of their activities with F-gases in 2014. For historical years activity data were obtained from questionnaires within previous F-gases research. For 2004-2005 activity data were obtained from enterprises that responded on data request letters sent by LEGMC. For 2006-2014 data were obtained from reporting within previously mentioned regulation act or extrapolated.

Emission factors and calculations

Tier 2a – emission-factor approach from 2006 IPCC Guidelines was used to estimate emissions from industrial refrigeration. Emissions result from charging, lifetime and end-of-life of equipment and are calculated for each type of HFC separately.

According to the methodology, refrigerant emissions at a reporting year can be calculated separately for each stage of life of the equipment. These emissions come from:

- $E_{charge,\ t}$ – emissions related to the refrigerant charge: connection and disconnection of the refrigerant container and the new equipment to be charged;
- $E_{lifetime,t}$ – annual emissions from the banks of refrigerants during operation (fugitive emissions and ruptures) and servicing;
- $E_{end\text{-}of\text{-}life,}t$ – emissions at system disposal.

Equation 7.10 from 2006 IPCC Guidelines was used to sum up all the emissions occurring during the lifetime of the equipment:

$$E_{total,t} = E_{Charge,t} + E_{Lifetime,t} + E_{End\text{-}of\text{-}life,t}$$

There are no HFC-containing equipment manufacturing companies in Latvia and all appliances used in industrial refrigeration are imported.

Emission factors and assumptions used in emission calculation from industrial refrigeration are as follows:

- HFCs mainly charged in Industrial Refrigeration are HFC-134a, HFC-404a, HFC-422d, HFC-407c, HFC-507a and HFC-410a;
- Average emission factor during charging of equipment is 1.8%[76];
- Average emission factor during operation of equipment is 16%[77];
- Average life time of industrial applications 15 years[78];
- Residual charge of HFC in equipment being disposed 80%[79];

[75] http://likumi.lv/ta/id/233736-noteikumi-par-ipasiem-ierobezojumiem-un-aizliegumiem-attieciba-uz-darbibam-ar-ozona-slani-noardosam-vielam-un-fluoretam-siltumn...
[76] 2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9 – Average value applied for industrial applications.
[77] 2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9 – Average value applied for industrial applications.
[78] Assumed in accordance with similarities to Estonia and Lithuania
[79] 2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9

- Recovery efficiency at disposal 90%[80].

Equation from 2006 IPCC Guidelines for charging emissions estimation:

$$E_{Charged,\ t} = M_t \times k/100$$

where:
$E_{charged}$ – emissions during system manufacture/assembly in year (kg)
Mt – amount of HFC-134a charged into a new equipment in year (kg)
k – charging losses (%)

Equation from 2006 IPCC Guidelines for emission estimation stocks:

$$E_{lifetime,\ t} = B_t \times x\ /\ 100$$

where:
$E_{lifetime}$ – amount of emissions during equipment operation (t)
Bt – amount of F-gases held in stocks in year t (tonnes)
x – losses during operation period (%)

Equation from 2006 IPCC Guidelines for emission estimation from disposal:

$$E_{end\text{-}of\text{-}life,\ t} = M_{t\text{-}d} \times p/100 \times 1\text{-}(\eta_{rec,\ d}\ /\ 100)$$

where:
$E_{lend\text{-}of\text{-}life}$– amount of HFC emitted at system disposal in year t (kg)
Mt-d – residusl charge of HFC in equipment being disposed of expressed in percentage of full charge, (%)
ηrec, d – recovery efficiency at disposal, which is the ration of recovered HFC reffered to the HFC contained in the system (%)

The total amount of HFC filled into industrial refrigeration equipment in 2014 amounts to 7.07 t constituting 0.12 t manufacturing emissions. HFC in stocks amounts to 41.06 t constituting 6.57 t operating emissions. As the HFC amounts filled into refrigeration equipment are available since 1998, the decommissioning emissions according to 15 years lifetime could be estimated starting from 2013. The amount of HFCs remained in decommission is amount of refrigerant initially charged into the systems in 1999 (1.02 t) which constitutes 0.08 t disposal emissions in 2014.

- *Transport Refrigeration (CRF 2.F.1.d)*

Activity data

According to F-gases research (2004), only negligible amount of HFCs was used in railways and water transport. Small amount of HFC-23 was filled into refrigerating equipment in ships. HFC-134a and HFC-125 was filled into mobile refrigerators used in road transport. For 1995-2004 activity data for emission calculation were taken from responses to questionnaires during first F-gases research (2004).

For 2004-2005 activity data were obtained from enterprises that responded on data request letters sent by LEGMC. For 2006-2014 activity data for emission calculation from Transport Refrigeration is taken from annual reports by F-gases operators according to Regulation (EC) No. 517/2014 and national legislation No.563. 245 operators reported data of their activities

[80] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9*

with F-gases in 2014. Share of substances used in transport refrigeration was obtained according to information provided by transport refrigeration companies.

Emission factors and calculations

Tier 2a – emission-factor approach from 2006 IPCC Guidelines was used to estimate emissions from transport refrigeration. Emissions result from charging, lifetime and end-of-life of equipment and are calculated for each type of HFC separately.

According to the methodology, refrigerant emissions at a reporting year can be calculated separately for each stage of life of the equipment. These emissions come from:

- $E_{charge,\ t}$ – emissions related to the refrigerant charge: connection and disconnection of the refrigerant container and the new equipment to be charged;
- $E_{lifetime,t}$ – annual emissions from the banks of refrigerants during operation (fugitive emissions and ruptures) and servicing;
- $E_{end\text{-}of\text{-}life,}t$ – emissions at system disposal.

Equation 7.10 from 2006 IPCC Guidelines was used to sum up all the emissions occurring during the lifetime of the equipment:

$$E_{total,t} = E_{Charge,t} + E_{Lifetime,t} + E_{End\text{-}of\text{-}life,t}$$

There are no HFC-containing equipment manufacturing companies in Latvia and all appliances used in transport refrigeration are imported therefore HFC emissions are estimated from stocks and from disposal.

Emission factors and assumptions used in emission calculation from transport refrigeration are as follows:

- HFCs mainly charged in Transport Refrigeration are HFC-134a and HFC-404a;
- Average emission factor during charging of equipment is 0.6%[81];
- Country specific emission factor during operation of equipment is 30%[82];
- Average life time of transport applications 8 years[83];
- Residual charge of HFC in equipment being disposed 50%[84];
- Recovery efficiency at disposal 70%[85].

Equation from 2006 IPCC Guidelines for charging emissions estimation:

$$E_{Charged,\ t} = M_t \times k/100$$

where:
$E_{charged}$ *– emissions during system manufacture/assembly in year (kg)*
Mt – amount of HFC-134a charged into a new equipment in year (kg)
k – charging losses (%)

[81] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9 – Average value applied for transport applications.*
[82] *Confirmed by Latvian Freezing Equipment Engineers` Association*
[83] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9 – Average value applied for transport applications*
[84] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9*
[85] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9*

Equation from 2006 IPCC Guidelines for emission estimation stocks:

$$E_{lifetime,\ t} = B_t \times x / 100$$

where:
$E_{lifetime}$ – amount of emissions during equipment operation (t)
Bt – amount of F-gases held in stocks in year t (tonnes)
x – losses during operation period (%)

Equation from 2006 IPCC Guidelines for emission estimation from disposal:

$$E_{end\text{-}of\text{-}life,\ t} = M_{t\text{-}d} \times p/100 \times 1\text{-}(\eta_{rec,\ d} / 100)$$

where:
$E_{lend\text{-}of\text{-}life}$– amount of HFC emitted at system disposal in year t (kg)
Mt-d – residusl charge of HFC in equipment being disposed of expressed in percentage of full charge, (%);
ηrec, d – recovery efficiency at disposal, which is the ration of recovered HFC reffered to the HFC contained in the system (%)

The total amount of HFC filled into transport refrigeration equipment in 2014 amounts to 2.69 t constituting 0.02 t manufacturing emissions. HFC in stocks amounts to 7.51 t constituting 2.25 t operating emissions. As the HFC amounts filled into refrigeration equipment are available since 1998, the decommissioning emissions according to 8 years lifetime could be estimated 2006-2014. The amount of HFCs remained in decommission is amount of refrigerant initially charged into the systems in 2006 (3.24 t) which constitutes 0.16 t disposal emissions in 2014.

- *Mobile Air Conditioning (CRF 2.F.1.e)*

Activity data

Under 2.F.1.e HFC-134a emissions are estimated for the following road vehicle types which were assessed according to emission control system (EURO classes):

- Passenger cars
- Light Duty Vehicles <3,5t
- Heavy duty vehicles 3,5 -12 t
- Heavy duty vehicles >=12 t
- Buses <=18 t
- Buses >18 t

Average percentage of vehicles equipped with air conditioning systems according to technology used in each vehicle type was estimated taking into account the information from Lithuanian NIR 2015[86] assuming similar conditions with Lithuania`s vehicle fleet (Table 4.38).

Table 4.38 Average percentage of vehicles equipped with air conditioning systems by vehicle type and technology

Technology	Passenger cars	Light Duty Vehicles <3,5t	Heavy duty vehicles 3,5 -12 t	Heavy duty vehicles >=12 t	Buses <=18 t	Buses >18 t
Convential 1990-1993	26	0	0	30	0	0

[86] *http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8812.php*

Technology	Passenger cars	Light Duty Vehicles <3,5t	Heavy duty vehicles 3,5 -12 t	Heavy duty vehicles >=12 t	Buses <=18 t	Buses >18 t
EURO 1 1993-1997	40	1	1	40	1	1
EURO 2 1997-2001	56	9	9	53	9	9
EURO 3 2001-2006	74	38	38	82	38	38
EURO 4 2006-2011	93	77	77	98	77	77
EURO 5 2011-2014	100	94	94	100	94	94
EURO 6 Since 2014	100	94	94	100	94	94

Average amounts of HFC-134a in each vehicle type are summarized in Table 4.39.

Table 4.39 HFC-134a average amount by vehicle type

Vehicle type	Average refrigerant amount (kg)
Passenger cars	0.6
Light Duty Vehicles <3,5t	0.7
Heavy duty vehicles 3,5 -12 t	1.2
Heavy duty vehicles >=12 t	1.2
Buses <=18 t	8
Buses >18 t	13

Emission factors and calculations

Tier 2a – emission-factor approach from 2006 IPCC Guidelines for each vehicle type was used to estimate emissions from mobile air conditioniners. As most part of vehicle fleet in Latvia are second hand there are no data available on the original factory charge. HFC emissions from mobile air conditioning are estimated from stocks and disposal. According to the methodology, refrigerant emissions at a reporting year can be calculated separately for each stage of life of the equipment. HFC-134a emissions from mobile air conditioning are estimate from following stages:

- $E_{lifetime,t}$ – annual emissions from the banks of refrigerants during operation (fugitive emissions and ruptures) and servicing;
- $E_{end\text{-}of\text{-}life,}t$ – emissions at system disposal.

Equation 7.10 from 2006 IPCC Guidelines was used to sum up all the emissions occurring during the lifetime of the equipment:

$$E_{total,t} = E_{Lifetime,t} + E_{End\text{-}of\text{-}life,t}$$

Emission factors and assumptions used in emission calculation from mobile air conditioning are as follows:

- HFC used in mobile air conditioning is HFC-134a ;
- Average emission factor during operation of equipment is 15%[87];
- 8% of total MACs are disposed every year[88];
- Average life time of transport applications 13 years[89];

[87] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9 – Average value applied for mobile air conditioners*
[88] *Confirmed by Latvian Freezing Equipment Engineers` Association*

- Residual charge of HFC in equipment being disposed 100%[90];
- $\eta_{rec,\ d} = 0$[91]

Equation from 2006 IPCC Guidelines for emission estimation stocks:

$$E_{lifetime,\ t} = B_t \times x / 100$$

where:
$E_{lifetime}$ *– amount of emissions during equipment operation (t)*
Bt – amount of F-gases held in stocks in year t (tonnes)
x – losses during operation period (%)

The amount of F-gases remained in MACs after the disposal every year is estimated by multiplying amount of MACs disposed with the approximate amount of F-gases remained in one appliance. It is assumed that 100% of F-gases remained in MACs after their lifetime.

Equation from 2006 IPCC Guidelines for emission estimation from disposal of MACs:

$$E_{end\text{-}of\text{-}life,t} = M_{t\text{-}d} \times p/100 \times (1-\eta_{rec,d}/100)$$

where:
$E_{end\text{-}of\text{-}life,t}$ *– amount of emissions from system disposal (t)*
Mt-d– amount of HFCs charged into domestic refrigerators and freezers in year (t-n) (tonnes)
P – residual charge of HFC in equipment being disposed of expressed in % of full charge (%)
ηrec,d – recovery efficiency at disposal

In 2014 the total HFC-134a stock in all road vehicle types in Latvia amounts to 274.2 t. The HFC-134a emissions from stocks are 41.13 t. In 2014 the amount of HFC in disposed MACs in year was 8.78 t which according to assumption of 100% emission of disposal resulted in 8.78 t of HFC-134a (71.37 kt CO_2 eq.).

- *Stationary Air Conditioning (CRF 2.F.1.f)*

Activity data

Activity data for emission calculation from stationary air conditioning is taken from annual reports by F-gases operators according to Regulation (EC) No. 517/2014 and national legislation No.563[92]. 245 operators reported data of their activities with F-gases in 2014. Activity data for this category is derived during F-gases research (2016) when the proportion of HFCs used in stationary air conditioning were obtained directly contacting with operators who report the F-gases amounts within the legislation mentioned above.

Emission factors and calculations

Tier 2a – emission-factor approach from 2006 IPCC Guidelines was used to estimate emissions from stationary air conditioning. Emissions result from charging, lifetime and end-of-life of equipment and are calculated for each type of HFC separately.

[89] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9 – Average value applied for mobile air conditioners*
[90] *Confirmed by Latvian Freezing Equipment Engineers` Association*
[91] *Confirmed by Latvian Freezing Equipment Engineers` Association*
[92] *http://likumi.lv/ta/id/233736-noteikumi-par-ipasiem-ierobezojumiem-un-aizliegumiem-attieciba-uz-darbibam-ar-ozona-slani-noardosam-vielam-un-fluoretam-siltumn...*

According to the methodology, refrigerant emissions at a reporting year can be calculated separately for each stage of life of the equipment. These emissions come from:

- $E_{charge,\ t}$ – emissions related to the refrigerant charge: connection and disconnection of the refrigerant container and the new equipment to be charged;
- $E_{lifetime,t}$ – annual emissions from the banks of refrigerants during operation (fugitive emissions and ruptures) and servicing;
- $E_{end\text{-}of\text{-}life,}t$ – emissions at system disposal.

Equation 7.10 from 2006 IPCC Guidelines was used to sum up all the emissions occurring during the lifetime of the equipment:

$$E_{total,t} = E_{Charge,t} + E_{Lifetime,t} + E_{End\text{-}of\text{-}life,t}$$

There are no HFC-containing equipment manufacturing companies in Latvia and all appliances used in stationary air conditioning are imported.

Emission factors and assumptions used in emission calculation from stationary air conditioners are as follows:

- HFCs mainly charged in Industrial Refrigeration are HFC-407c, HFC-410a, HFC-404a, HFC-134a, HFC-422d and HFC-417a;
- Average emission factor during charging of equipment is 0.6%[93];
- Average emission factor during operation of equipment is 8%[94];
- Average life time of stationary air conditioning applications 15 years[95];
- Residual charge of HFC in equipment being disposed 80%[96];
- Recovery efficiency at disposal 90%[97].

Equation from 2006 IPCC Guidelines for charging emissions estimation:

$$E_{Charged,\ t} = M_t \times k/100$$

where:
$E_{charged}$ *– emissions during system manufacture/assembly in year (kg)*
Mt – amount of HFC-134a charged into a new equipment in year (kg)
k – charging losses (%)

Equation from 2006 IPCC Guidelines for emission estimation stocks:

$$E_{lifetime,\ t} = B_t \times x\ /\ 100$$

where:
$E_{lifetime}$ *– amount of emissions during equipment operation (t)*
Bt – amount of F-gases held in stocks in year t (tonnes)
x – losses during operation period (%)

[93] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9 – Average value applied for residental and commercial air conditioners including heat pumps*
[94] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9 – Average value applied for residental and commercial air conditioners including heat pumps*
[95] *Confirmed by Latvian Freezing Equipment Engineers` Association*
[96] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9*
[97] *2006 IPCC Guidelines, Volume 3, Chapter 7, Table 7.9*

The total amount of HFC filled into stationary air conditioners in 2014 amounts to 9.81 t constituting 0.06 t manufacturing emissions. HFC in stocks amounts to 98.15 t constituting 7.85 t operating emissions. Emissions from disposal or stationary air conditioners are not estimated due to lifetime of 15 years that has not been reached yet.

4.7.1.3 Uncertainties and time series-consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty for Refrigeration and air conditioning sector could arise to 50% according to expert judgement. Also uncertainty of emission factors for HFCs is assumed as 50%.

Time series of the estimated emissions are consistent because the same methodology, emission factors and data sources are used for sectors for all years in time series.

4.7.1.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the 2.F. sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

QA/QC check is performed according to 2006 IPCC Guidelines. All information on activity data and emission calculations are stored and archived in the common FTP folder. All findings are documented using check-lists which are archived and documented in centralized archiving system (common FTP folder).

All estimations of the emissions done in the LEGMC are checked on the logical mistakes by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogic changes in the activity data and emissions.

Quality control check list is filled for each category taking into account criteria given in QA/QC plan approved in national legislation. All findings were documented and introduced in GHG inventory.

Quality manager from LEGMC has checked the data between CRF and NIR to ensure the consistency as well as QC actions were done in CRF in purpose to double check if all sub-applications are covered.

Currently using CRF Reporter software version 5.14 it is not possible to enter NO in green and grey cells for those F-gases where emissions are not occurring in Latvia although CRF Reporter User manual says that if disaggregated data is not available for certain categories, the CRF Reporter allows users to report information in the parent category. This can be done by directly entering data in the green cells (i.e. overwriting formulas).

Under 2.F.1 Refrigeration and Air Conditioning only F-gases which are source of emissions are reported. Remaining F-gases are not added as child nodes according to CRF User manual however it is not currently possible to enter data in green cells for these F-gases therefore some information in the parent category (green cells) in corresponding CRF tables are missing. It was confirmed by CRF Reporter help desk that this is an CRF internal issue which

will be improved in the future releases of the software. But for the moment it was suggested to leave cells blank. Due to this reason completeness check in CRF Reporter shows incompleteness (orange light) which could be solved when CRF Reporter will allow to enter notation keys for F-gases directly in green and grey cells.

QA/QC procedures within CRF Reporter were carried out in order to ensure completeness and consistency of reported data.

4.7.1.5 Category-specific recalculations

Recalculations were made in all 2.F. subcategories due to implementation of F-gases research (2016) results. According to the research, activity data taken from annual reports by F-gases operators were split between the subcategories and the time series was recalculated at a level of 2006 IPCC Guidelines subcategories (Commercial, Industrial, Transport refrigeration and Stationary air conditioning). Emission factors were elaborated consulting with Latvian Freezing Equipment Engineers` Association.

Recalculation of refrigerant stocks and operating emissions for Commercial, Industrial, Transport refrigeration and Stationary air conditioning were made due to correction of methodology, based on cumulative calculation of the refrigerant amounts in operating systems over time. Recalculation made due to recommendation by TERT[98] during EU ESD[99] review in 2016.

Recalculations were made also for mobile air conditioners as more precise data regarding population of cars and distribution by vehicle types (passenger cars, LDV, HDV), age and vehicle categories according to emission control system (EURO classes) were obtained.

4.7.1.6 Category-specific planned improvements

For the next inventory it is planned to perform additional cross-checks with other data sources in order to reassess and ensure completeness of the F-gases inventory.

4.7.2 Foam Blowing Agents (CRF 2.F.2)

4.7.2.1 Category description

The category covers HFC emissions from PU foams and foaming of polyether for shoe soles. HFCs from PU foams are emitted only from the use of imported foams containing F-gases as there is no production of PU foams in Latvia.

The calculation of emissions under 2.F.2 was carried out for following gases:

- HFC-134a
- HFC-227ea
- HFC-245fa
- HFC-152a
- HFC-365mfc

[98] *Technical expert review team*
[99] *https://emrt.eea.europa.eu/*

In 2014 emissions totalled 0.96 kt CO_2 equivalent including 0.96 kt CO_2 equivalent from foaming of polyether for shoe soles and 0.001 kt CO_2 equivalent resulting from PU foam use in construction (building).

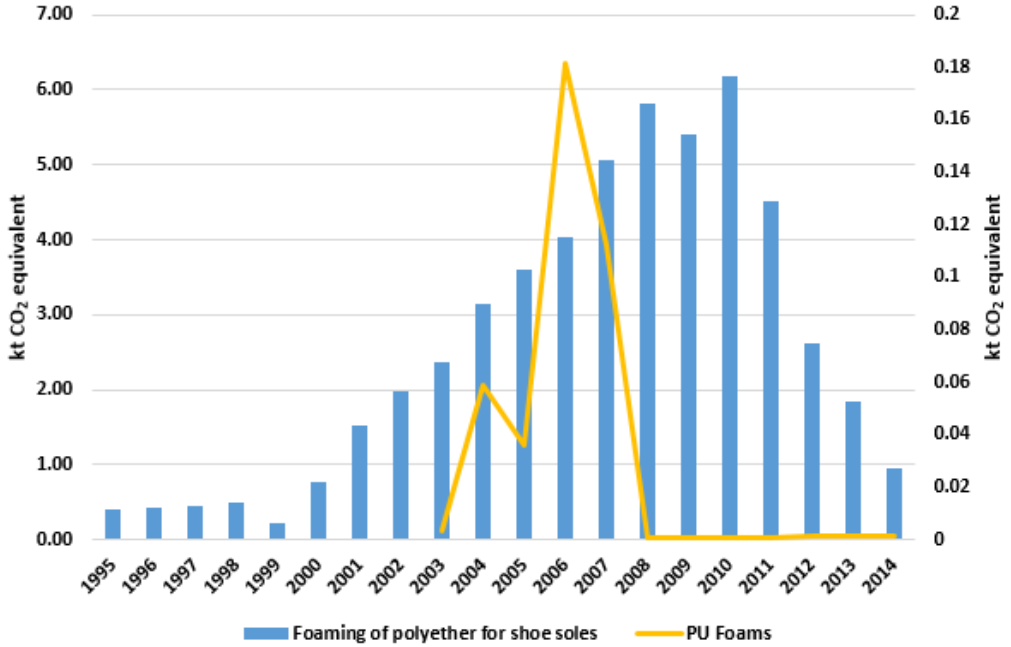

Figure 4.16 HFC emissions from 2.F.2[100] (kt CO_2 eq.)

Manufacturing of shoes (shoe soles) containing HFC-134a occurred in 1995-2002 when comparatively smaller amounts of HFC were emitted. After 2002 emissions from stocks and disposal were estimated and emissions started to increase reaching peak level in 2010. According to F-gases Regulation (EU) No 517/2014 which repeals Regulation (EC) No 842/2006 from 4 July 2006 it is prohibited to place on the EU market footwear containing F-gases. According to prohibitions described in EU regulations it was assumed that amount of shoes containing HFC-134a started to decrease since 2007 however emissions from disposal were still at previous level.

Between 2013 and 2014 the emissions decreased by 91% mostly due to decrease of emissions from HFC-134a containing footwear disposal (Figure 4.16).

Emissions from PU foams are estimated starting from 2003 when data from Chemicals Register become avalaible. Since then emissions have been increased very rapidly due to economic development and increased activity in building sector reaching the highest level in 2006. Afterwards emissions started to decrease and since 2008 rather small amounts are emitted. Fluctuations between years are mostly related to consumed foam amounts in construction.

4.7.2.2 Methodological issues

An overview of the methods used and gases reported under 2.F.2 sector is presented in Table 4.40.

[100] *PU Foams on secundary axis*

Table 4.40 Summary of emission calculation methods and gases in CFR 2.F.2

CRF Category/subcategory	Method used	Gases reported
2.F.1 Foam Blowing agents		
2.F.2.a Closed Cells	Tier 2a	HFC-134a HFC-227ea HFC-245fa HFC-152a HFC-365mfc

- *PU foams*

Activity data

The imported amount of construction foams is obtained from Chemicals Register. No export and production data is reported to the Chemicals Register therefore only imported amount can be obtained. So only emissions from use of PU foams (stocks) are calculated.

Although the activity in building sector in previous years has radically increased, emission estimations for PU foams can be done starting from 2003 due to the lack of activity data of imported and used building foams or foams used in windows manufacturing as well as lack of data on foams containing F-gases. It is assumed that all the construction foams imported are closed cells foams (used in insulation applications) according to NACE classification. The data on foams imported as well as the average percentage of F-gases in foams were obtained from Chemicals Register.

Emission factors and calculations

HFC emissions are calculated from foams in stocks. The emission calculations were done according to 2006 IPCC Guidelines Tier 2a method using activity data on imported foams and default emission factor – annual losses 4.5% of the original HFC charge/year[101].

Equation from 2006 IPCC Guidelines for emissions from closed-cell foam in year was used:

$$Emissions_t = Bank_t \times EF_{AL}$$

where:
$Emissions_t$ = emissions from closed-cell foam in year t, tonnes
$Bank_t$ = HFC charge blown into closed-cell foam manufacturing between year t and year t-n, tonnes
EF_{AL} = annual loss emission factor, fraction
t = current year

The product lifetime of foam is 20 years. As in that time Latvia was part of Soviet Union the specific data was not collected as well as it is believable that the foam blowing did not occur in country or it occur in very negligible amounts. Therefore decommissioning losses from foams are not estimated (NE).

- *Foaming of polyether (for shoe soles)*

Activity data

Activity data for emission estimation from foaming of polyether for shoe soles is taken from CSB databases about produced imported and exported amount of shoes[102]. Assumptions and

[101] *2006 IPCC Guidelines for National Greenhouse Gas Inventories: Emissions of Fluorinated Substitutes for Ozone Depleting Substances (Volume 3) Industrial Processes and Product Use, p.7.35*

default leakage factors are taken from Danish project "The Greenhouse gases: HFCs, PFCs and SF_6" [103].

The manufacturing of shoe soles containing HFC-134a occurred in Latvia in 1995-2002. The amount of produced shoes (shoe soles) is obtained by CSB. According to Danish project[103] it was assumed that 5% of all shoes with plastic, rubber and leather soles contain polyether containing 8 g of HFC-134a per shoe.

Emission factors and calculations

Total amount of HFC-134a used for manufacturing of shoe soles can be estimated by using equation:

$$HFC_{filled} = Sh_{produced} \times d_{HFC} \times HFC_{sh}$$

where:
HFC_{filled} – total amount of HFC-134a used in manufacturing of shoes (t)
$Sh_{produced}$ – amount of produced shoes (pieces)
d_{HFC} – amount of shoes containing HFC-134a (%)
HFC_{sh} – amount of HFC-134a filled in one shoe sole (t)

Danish default leakage factor for HFC-134a emitted during manufacturing is 15%.

The HFC-134a emissions from manufacturing of shoe soles can be estimated by using equation:

$$E_{production} = HFC_{filled} \times k$$

where:
$E_{production}$ – HFC-134a emissions from shoe manufacturing (t)
HFC_{filled} – total amount of HFC used in manufacturing of shoes (t)
k – leakage from shoes production (%)

The amount of imported, exported and produced shoes (shoe soles) is obtained by CSB. According to Danish project it was assumed that 5% of all shoes with plastic, rubber and leather soles contain polyether containing 8 g of HFC-134a per shoe.

Total amount of HFC-134a held in stocks in shoe soles can be estimated by using equation:

$$HFC_{stocks} = HFC_{filled} + HFC_{imported} - HFC_{exported}$$

where:
HFC_{stocks} – total amount of HFC-134 held in stocks in shoe soles and used in country in particular year (t)
HFC_{filled} – total amount of HFC-134a filled in shoes during manufacture of shoes (t)
$HFC_{imported}$ – total amount of HFC-134a imported in shoes (t)
$HFC_{exported}$ – total amount of HFC-134a exported in shoes (t)

Danish default leakage factor for HFC-134a emitted during lifetime is 4.5% (lifetime is 3 years) or 1.5% annually.

The HFC-134a emissions from stocks held in shoe soles can be estimated by using equation:

$$E_{stocks} = HFC_{stocks} \times x$$

[102] *http://data.csb.gov.lv/Selection.aspx?px_tableid=atirdz\Detaliz%C4%93ta+statistika\8+z%C4%ABmju+l%C4%ABmen%C4%AB\2012_imp_8.px&px_language=en&px_type=PX&px_db=atirdz&rxid=cdcb978c-22b0-416a-aacc-aa650d3e2ce0*
[103] *http://www2.mst.dk/common/Udgivramme/Frame.asp?http://www2.mst.dk/udgiv/publications/2009/978-87-7052-962-4/html/bred01_eng.htm*

where:
E_{stocks} – HFC-134a emissions from shoe lifetime (t)
HFC_{stocks} – total amount of HFC-134 held in stocks in shoe soles and used in country in particular year (t)
x – leakage from using of shoes during its lifetime (%)

According to above mentioned Danish project average lifetime of shoes is 3 years. It means that for HFC-134a emission estimation the amount of HFC-134a remained in shoe soles after their lifetime in year^{-3} has to be known. As CSB doesn't have so old data the approximate amount back to year 1992 is extrapolated taken into account the amount curve in 1995-2000.

Total amount of HFC-134a left in shoe soles after their lifetime ends can be estimated by using equation:

$$HFC_{remained} = HFC_{stocks} \times (1-x)$$

where:
$HFC_{remained}$ – total amount of HFC-134a remained in shoes after their lifetime in year^{-3} (t)
(1-x) – percentage amount of HFC left in shoes (%)

For the emission estimation from disposal default Danish emission factor 71.5% is used as some part of shoes are destroyed in incineration and thereby not released as emissions.

The HFC-134a emissions from disposal of shoe soles can be estimated by using equation:

$$E_{disposal} = HFC_{remained} \times Q$$

where:
$E_{disposal}$ – total amount of HFC-134a emissions from disposal
$HFC_{remained}$ – total amount of HFC-134a remained in shoes after their lifetime in year^{-3} (t)
Q – leakage from disposal (%)

4.7.2.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty for Foam Blowing sector could arise to 50% according to expert judgement. Also uncertainty of emission factors for HFCs is assumed as 50%.

Time series of the estimated emissions are consistent because the same methodology, emission factors and data sources are used for sectors for all years in time series.

4.7.2.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the 2.F. sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

More detailed description can be found under chapter 4.7.1.4.

Currently using CRF Reporter software version 5.14 it is not possible to enter NO in green and grey cells for those F-gases where emissions are not occurring in Latvia although CRF

Reporter User manual says that if disaggregated data is not available for certain categories, the CRF Reporter allows users to report information in the parent category. This can be done by directly entering data in the green cells (i.e. overwriting formulas).

Under 2.F.2 Foam blowing Agents, 2.F.2.a Closed Cells only F-gases which are source of emissions are reported. Remaining F-gases and F-gases under 2.F.2.b Open Cells are not occurring and are not added as child nodes according to CRF User manual however it is not currently possible to enter data in green cells for these F-gases therefore some information in the parent category (green cells) in corresponding CRF tables are missing. It was confirmed by CRF Reporter help desk that this is an CRF internal issue which will be improved in the future releases of the software. But for the moment it was suggested to leave cells blank. Due to this reason completeness check in CRF Reporter shows incompleteness (orange light) which could be solved when CRF Reporter will allow to enter notation keys for F-gases directly in green and grey cells.

QA/QC procedures within CRF Reporter were carried out in order to ensure completeness and consistency of reported data.

4.7.2.5 Category-specific recalculations

Foaming of polyether for shoe soles is reported under 2.F.2 Foam blowing agents according to allocation suggested by TERT during EU ESD review in 2015. Therefore HFC-134a emissions are summed up from both – PU foams and foaming of polyether for shoe soles in this submission.

4.7.2.6 Category-specific planned improvements

No planned improvements of this category.

4.7.3 Fire Protection (CRF 2.F.3)

4.7.3.1 Category description

The category covers HFC emissions from use of fire protecting equipment. In 2014 emissions totalled 0.03 kt CO_2 equivalent giving only 0,01% from total HFC emissions in 2.F (Figure 4.17). As the emissions from fire suppression systems occur when the system is discharged in case of fire or accidentally, emissions are estimated only from for operating of fire protection systems using HFC-227ea and HFC-23.

Emission time series started in 2001 when the first data regarding use of Fire protection systems containing HFCs was received during the first F-gases research (2004). Since then strong emission fluctuations have been observed. Compared to 2013 in 2014 the emissions have decreased by 124% mainly due to decrease in activity data in this sector.

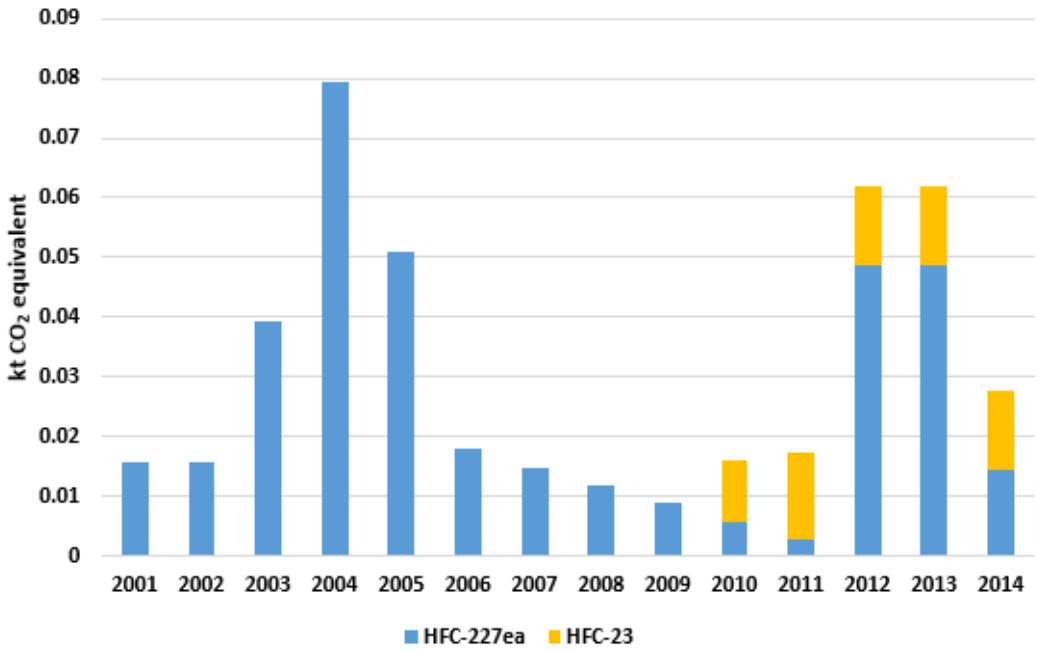

Figure 4.17 HFC emissions from 2.F.3 (kt CO_2 eq.)

Emissions from fire extinguishing are problematic to estimate due to the fact that there is only statistical information of the registered fire extinguishing equipment (pieces) in Latvia done by State Fire and Rescue Service. Type of substance used in equipment isn't registered.

According to Regulation No.563 of the Cabinet of Ministers of Latvia companies who use F gases in stationary fire protection equipment shall report amounts used to responsible institution (LEGMC) each year till 31st of March. Information from LEGMC database available since 2010. Till then historical data from basic F-gases research (2004) was used and extrapolation was done.

4.7.3.2 Methodological issues

An overview of the methods used and gases reported under 2.F.3 sector is presented in Table 4.41.

Table 4.41 Summary of emission calculation methods in CFR 2.F.3

CRF Category/subcategory	Method used	Gases reported
2.F.3 Fire Protection	Tier 2a	HFC-227ea, HFC-23

Activity data

During the F-gases research (2004) it was found out that there is no manufacturing of fire extinguishers containing F-gases. 19 enterprises were questioned including only manufacturer of fire extinguishers. According to responses received a little amount of fire extinguishers are filled with F-gases. Only 2 enterprises reported the amount of HFC-227ea in their installed equipment in particular year and amount of HFC-227ea held in stocks (containers) of fire extinguishing equipment. It was reported that no charging was done for the installed equipment. Fire extinguishers were installed already filled with F-gases and

there weren't any necessity to recharge them. Therefore only emissions from stocks were calculated.

Amount of F-gases in annually installed equipment and amount held in containers is used as activity data for emission estimations from stocks. Activity data for historical years (2001-2006) is taken from the first F gases research done in 2004. Since 2010 data is taken from annual F-gases reports, where operators annually report F-gases amounts used in their equipment.

Emission factors and calculations

It is assumed that 2% from total stocks is emitted during equipment operations annually according to 2006 IPCC Guidelines [104].

Equation from 2006 IPCC Guidelines for emission estimation from stocks:

$$E_{lifetime,\ t} = B_t \times x / 100$$

where:
$E_{lifetime}$ *– amount of emissions during equipment operation (t)*
Bt – amount of F-gases held in stocks in year t (tonnes)
x – losses during operation period (%)

The lifetime of the equipment is 20 years therefore emissions at system disposal were not estimated.

4.7.3.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty for Fire Protection sector could arise to 50% according to expert judgement. Also uncertainty of emission factors for HFCs is assumed as 50%.

Time series of the estimated emissions are consistent because the same methodology, emission factors and data sources are used for sectors for all years in time series.

4.7.3.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the 2.F. sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

More detailed description can be found under chapter 4.7.1.4.

Currently using CRF Reporter software version 5.14 it is not possible to enter NO in green and grey cells for those F-gases where emissions are not occurring in Latvia although CRF Reporter User manual says that if disaggregated data is not available for certain categories,

[104] *2006 IPCC Guidelines for National Greenhouse Gas Inventories: Emissions of Fluorinated Substitutes for Ozone Depleting Substances (Volume 3) Industrial Processes and Product Use, p.7.63*

the CRF Reporter allows users to report information in the parent category. This can be done by directly entering data in the green cells (i.e. overwriting formulas).

Under 2.F.3 Fire Protection only F-gases which are source of emissions are reported. Remaining F-gases are not occurring and are not added as child nodes according to CRF User manual however it is not currently possible to enter data in green cells for these F-gases therefore some information in the parent category (green cells) in corresponding CRF tables are missing. It was confirmed by CRF Reporter help desk that this is an CRF internal issue which will be improved in the future releases of the software. But for the moment it was suggested to leave cells blank. Due to this reason completeness check in CRF Reporter shows incompleteness (orange light) which could be solved when CRF Reporter will allow to enter notation keys for F-gases directly in green and grey cells.

QA/QC procedures within CRF Reporter were carried out in order to ensure completeness and consistency of reported data.

4.7.3.5 Category-specific recalculations

HFC-23 emissions were calculated starting from 2010 as activity data was obtained from annual reports by F-gases operators.

4.7.3.6 Category-specific planned improvements

No improvements are planned for this category.

4.7.4 Aerosols (Metered Dose Inhalers CRF 2.F.4.a)

4.7.4.1 Category description

This category covers HFC-134a emissions from metered dose inhalers. There are no other HFC containing aerosol types used in Latvia.

In 2014 emissions totalled 4.70 kt CO_2 equivalent giving 2.2% from total HFC emissions in 2.F (Figure 4.18). The 2014 emissions increased 25% compared to 2013 due to the increased amount of imported HFC-134a in products. Emissions have increased compared to the base year as well. The fluctuation in the time series is due to observed changes in consumption of HFC containing metered dose inhalers.

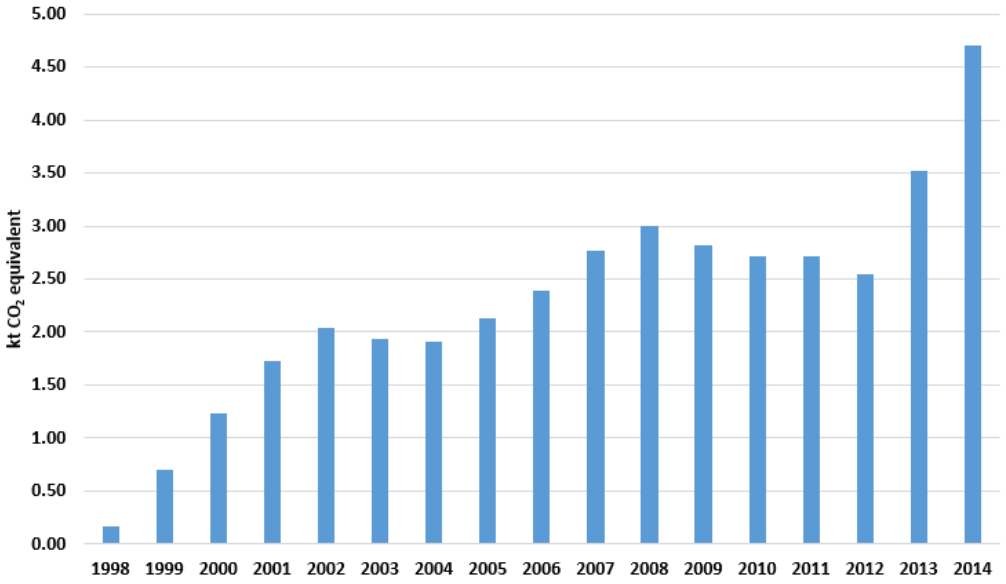

Figure 4.18 HFC emissions from 2.F.4.a (kt CO_2 eq.)

During the first F-gases research (2004) it was found out that there is no production of F-gases containing aerosols in Latvia. All aerosols used in Latvia are imported. It is very difficult to collect the data of imported aerosols as it is necessary to separate HFCs containing aerosols from others. It is almost impossible to get the information from all households and importers of industrial aerosols in Latvia as Central Custom Service registers only all imported aerosols with one custom code not dividing them by type or by substances containing. Also since Latvia is in Schengen zone only imported amount from Third Countries is registered.

Only the aerosols used in medicine for asthmatics are estimated and reported under this category. During the first F-gases investigation number of inhalers containing HFC–134a was obtained as well as average amount of HFC-134a filled in one inhaler divided by the type of medicine. All the inhalers are imported as no inhalers for asthmatics are produced in Latvia.

4.7.4.2 Methodological issues

An overview of the methods used and gases reported under 2.F.4 sector is presented in Table 4.42.

Table 4.42 Summary of emission calculation methods in CFR 2.F.4

CRF Category/subcategory	Method used	Gases reported
2.F.4 Aerosols	Tier 2a	HFC-134a

Activity data

For years 1998-2006 data of imported inhalers reported by importers of medical preparations was used as activity data for emission calculations. From 2007 till 2014 data for emission estimations annually is reported by State Agency of Medicines of Latvia. All importers of the medical preparations shall report the imported and sold amount of medicines so these data are very precise.

Total amount of HFC-134a used in metered dose inhalers in particular year can be estimated as the imported amount of inhalers containing HFC-134a and an average amount of HFC-134a filled in each type of inhalers is known.

Emission factoirs and calculations

Equation for total amount HFC-134a used as medical preparation:

$$HFC_{sold} = \Sigma MDI_{sold} \times HFC_{filled}$$

where:
HFC_{sold} – total amount of HFC sold/imported in country (t)
MDI_{sold} – amount of sold/imported particular type of metered dose inhalers containing F-gases (pieces)
HFC_{filled} – amount of HFCs filled in particular type of inhaler (t)

According to 2006 IPCC Guidelines 50%[105] leakage from metered dose inhalers sold in particular year and 50% from inhalers sold in year before particular year is assumed.

Equation from 2006 IPCC Guidelines for metered dose inhalers emissions:

$$Emissions_t = S_t \times EF + S_{t-1} \times (1-EF)$$

where:
$Emissions_t$ = emissions in year t, tonnes
St – quantity of HFC and PFC contained in aerosol products sold in year t, tonnes
S_{t-1} – quantity of HFC and PFC contained in aerosol products sold in year t-1, tonnes
EF = emission factor (=fraction of chemical emitted during the first year), fraction

4.7.4.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty for Aerosol sector could arise to 50% according to expert judgement. Also uncertainty of emission factors for HFCs is assumed as 50%.

Time series of the estimated emissions are consistent because the same methodology, emission factors and data sources are used for sectors for all years in time series.

4.7.4.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the 2.F. sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

More detailed description can be found under chapter 4.7.1.4.

Currently using CRF Reporter software version 5.14 it is not possible to enter NO in green and grey cells for those F-gases where emissions are not occurring in Latvia although CRF Reporter User manual says that if disaggregated data is not available for certain categories, the CRF Reporter allows users to report information in the parent category. This can be done

[105] *2006 IPCC Guidelines for National Greenhouse Gas Inventories: Emissions of Fluorinated Substitutes for Ozone Depleting Substances (Volume 3) Industrial Processes and Product Use, p.7.29*

by directly entering data in the green cells (i.e. overwriting formulas). Entering data in green cells is only possible when the parent node to which the grid with green cells belongs does not have any child nodes.

Under 2.F.4 Aerosols only F-gases which are source of emissions are reported. Remaining F-gases are not occurring and are not added as child nodes according to CRF User manual however it is not currently possible to enter data in green cells for these F-gases therefore some information in the parent category (green cells) in corresponding CRF tables are missing. It was confirmed by CRF Reporter help desk that this is an CRF internal issue which will be improved in the future releases of the software. But for the moment it was suggested to leave cells blank. Due to this reason completeness check in CRF Reporter shows incompleteness (orange light) which could be solved when CRF Reporter will allow to enter notation keys for F-gases directly in green and grey cells.

QA/QC procedures within CRF Reporter were carried out in order to ensure completeness and consistency of reported data.

4.7.4.5 Category-specific recalculations

No recalculations are done for this category.

4.7.4.6 Category-specific planned improvements

No improvements are planned for this category.

4.8 OTHER PRODUCT MANUFACTURE AND USE (2.G)

Under 2.G Latvia reports emissions from sulphur hexafluoride (SF_6) and nitrus oxide (N_2O), occurring in following sectors:

- Electrical equipment (CRF 2.G.1);
- N_2O from product uses (CRF 2.G.3);

SF_6 and PFCs emissions from Other product use (2.G.2) and Other (2.G.4) are not occurring in Latvia. Under 2.G only F-gases which are source of emissions are reported. Remaining F-gases are not occurring and are not added as child nodes in CRF Reporter according to CRF User manual however it is not currently possible to enter data in green cells for these F-gases therefore some information in the parent category (green cells) in corresponding CRF tables are missing.

In 2014 GHG emissions from other product manufacture and use amounted 10.59 kt CO_2 eq (0.1%) from Latvia`s total CO_2 equivalent emissions without LULUCF. In 2014 compared to 2013 emissions have increased by 1.3%, but compared to 1990 emissions have increased by 87.7%.

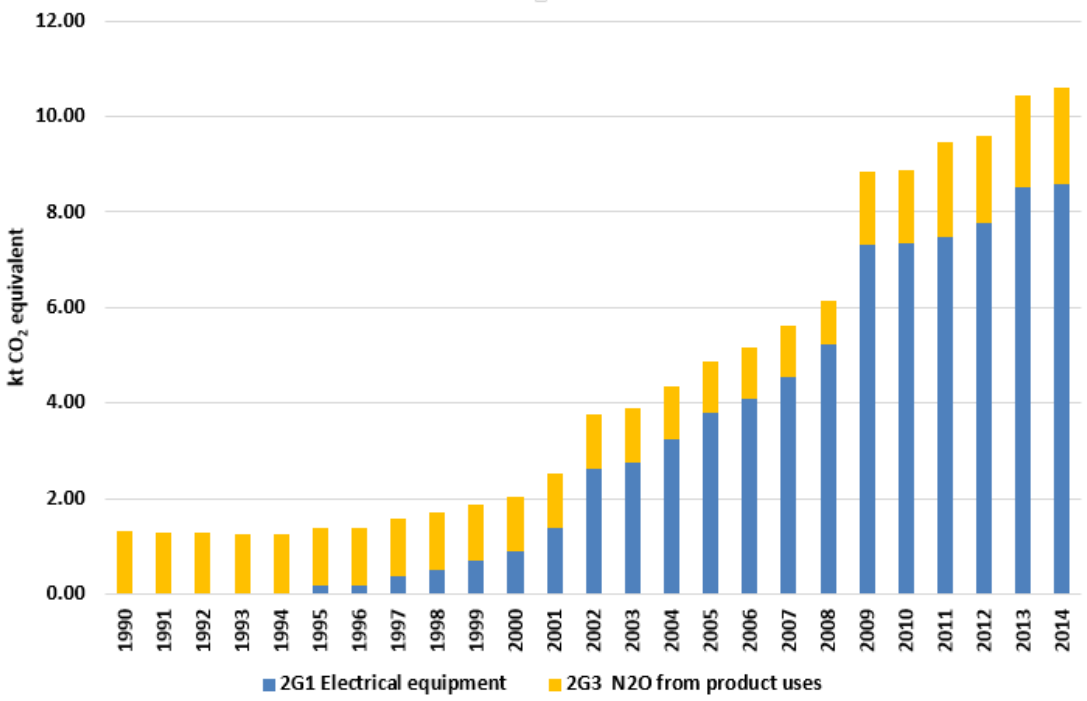

Figure 4.19 Emissions from 2.G Other product manufacture and use (kt CO_2 eq.)

The total emissions from 2.G have increased since 1990 (see Figure 4.19 and Table 4.44). Emission trend could mainly associated with increase in activity data received from companies. Emission fluctuations in the N_2O From Product Uses sector are linked with the economic situation of the country.

Reported emissions, calculation methods and type of emission factors for the 2.G Other Product Manufacture and Use in the Latvian inventory are summarized in Table 4.43.

Table 4.43 GHG emission categories, methods and gases reported from 2.G Other Product Manufacture and Use

Category	Method used	Gases reported
G. Other Product Manufacture and Use		
1. Electrical Equipment	Tier1	SF_6
3. N_2O from Product Uses (Medical Applications)	CS	N_2O

Table 4.44 Total emissions from 2.G Other Product Manufacture and Use, 1990-2014 (kt CO_2 eq.)

	2G Other Product manufacture and Use	2.G.1 Electrical Equipment	2.G.3 N_2O from Product Uses
1990	1.30	NE	1.30
1995	1.40	0.17	1.22
2000	2.05	0.88	1.16
2001	2.54	1.39	1.15
2002	3.75	2.62	1.13
2003	3.88	2.76	1.12
2004	4.36	3.25	1.11

	2G Other Product manufacture and Use	2.G.1 Electrical Equipment	2.G.3 N_2O from Product Uses
2005	4.88	3.78	1.10
2006	5.16	4.07	1.09
2007	5.63	4.55	1.08
2008	6.13	5.23	0.89
2009	8.85	7.33	1.53
2010	8.87	7.35	1.51
2011	9.45	7.47	1.98
2012	9.59	7.78	1.82
2013	10.46	8.50	1.95
2014	10.59	8.58	2.01
Share of total IPPU % in 2014	1.3%	1.0%	0.2%
2014 versus 2013	+1.3%	+0.9%	+3.0%
2014 versus 1990	+713%	+4848%	+55%

4.8.1 Electrical Equipment (CRF 2.G.1)

4.8.1.1 Category description

This category covers emissions of sulphur hexafluoride (SF_6) from electrical equipment used in high and medium voltage commutation and control installations. Equipment is not manufactured in Latvia. SF_6 emissions are estimated from charging and lifetime. There is only one enterprise where huge amount of SF_6 is filled. Installations are not produced in Latvia and the old equipment without fill of the SF_6 was dismantled at the beginning of 1990s. Only starting from 1992 new equipment was gradually installed. Since 1992, it uses small amount of SF_6 in electrical equipment, but since 1995 used amount is increasing.

In 2014 SF_6 emissions from Electrical Equipment constituted 8.58 kt CO_2 eq (81% from total 2.G emissions). Emissions have grown since 1995 by 98% and by 0.9% compared to 2013 (Figure 4.20 and Table 4.45).

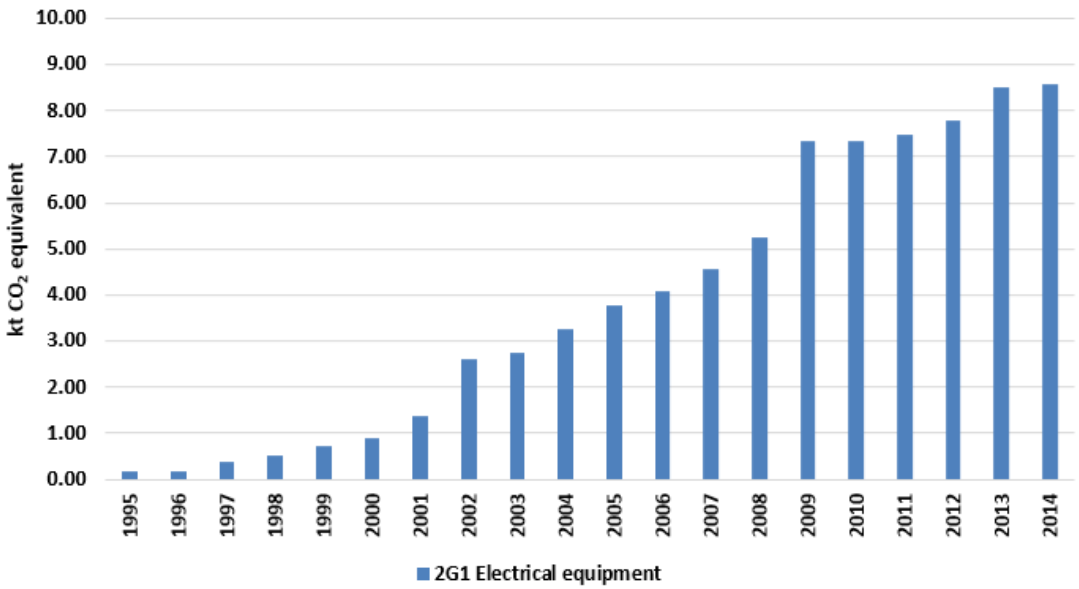

Figure 4.20 SF_6 emissons from 2.G.1 (kt CO_2 eq.)

Table 4.45 SF_6 emissions from 2.G.1 Electrical Equipment, 1995-2014 (kt CO_2 eq.)

	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electrical equipment	0.17	0.88	1.39	2.62	2.76	3.25	3.78	4.07	4.55	5.23	7.33	7.35	7.47	7.78	8.50	8.58

4.8.1.2 Methodological issues

An overview of the methods used and gases reported under 2.G.1 sector is presented in Table 4.46.

Table 4.46 Summary of emission calculation methods and gases in CFR 2.G.1

CRF Category/subcategory	Method used	Gases reported
2.F.1 Electrical Equipment	Tier1	SF_6

Activity data

Enterprise imports equipment already filled with SF_6. There is no manufacturing of the electric equipment containing SF_6 in Latvia, therefore only emissions from charging and operating were estimated using amount of SF_6 in newly installed equipment as activity data reported by the company. For years 2003-2014 enterprise reports the emergency leakage from electrical equipment which are also reported as operating emissions.

Emission factors and calculations

For emission estimations the Tier1 default emission factor method from 2006 IPCC Guidelines was used. Emissions are estimated by multiplying default regional emission factor (for Europe) by amount of SF_6 used in equipment in enterprise. The emissions are estimated by splitting data into the sealed pressure electrical equipment (MV switchgear) and closed pressure electrical equipment (HV switchgear) containing the SF_6 due to the different emission factors for each of these installations in 2006 IPCC Guidelines. For HV switchgears 2.6 %, but for MV switchgears 0.2% emission factor was used.

Equation from 2006 IPCC Guidelines for emission estimation from charging:

$$E_{charged,\ t} = M_t \times k / 100$$

where:
$E_{charged}$ – emissions during system manufacture/assembly in year (kg)
M_t – amount of HFC-134a charged into a new equipment in year (kg)
k – charging losses (%)

Equation from 2006 IPCC Guidelines for emission estimation from stocks:

$$E_{lifetime,\ t} = B_t \times x / 100$$

where:
$E_{lifetime}$ – amount of emissions during equipment operation (t)
B_t – amount of F-gases held in stocks in year t (tonnes)
x – losses during operation period (%)

Lifetime of used equipment is 30 years and no equipment was dismantled yet therefore emissions from disposal are marked "NO" in CRF Reporter.

4.8.1.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

As there is only one facility in the country which uses SF_6 in their technology and reports the data on SF_6 usage directly to LEGMC, it is assumed that data used for emission estimation under this subcategory is more precise. Uncertainty of activity data for SF_6 from electrical equipment is assumed as ±2% for AD, but EF uncertainty could arise up to 30% according to the 2006 IPCC Guidelines.

Time series of the estimated emissions are consistent because the same methodology, emission factors and data sources are used for sectors for all years in time series.

4.8.1.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the 2.G. sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

More detailed description can be found under chapter 4.7.1.4.

Currently using CRF Reporter software version 5.14 it is not possible to enter NO in green and grey cells for those F-gases where emissions are not occurring in Latvia although CRF Reporter User manual says that if disaggregated data is not available for certain categories, the CRF Reporter allows users to report information in the parent category. This can be done by directly entering data in the green cells (i.e. overwriting formulas).

Under 2.G.1 Electrical equipment only F-gases which are source of emissions are reported. Remaining F-gases are not occurring and are not added as child nodes according to CRF User manual however it is not currently possible to enter data in green cells for these F-gases therefore some information in the parent category (green cells) in corresponding CRF tables are missing. It was confirmed by CRF Reporter help desk that this is an CRF internal issue which will be improved in the future releases of the software. But for the moment it was suggested to leave cells blank. Due to this reason completeness check in CRF Reporter shows incompleteness (orange light) which could be solved when CRF Reporter will allow to enter notation keys for F-gases directly in green and grey cells.

QA/QC procedures within CRF Reporter were carried out in order to ensure completeness and consistency of reported data.

4.8.1.5 Category-specific recalculations

No recalculations were done.

4.8.1.6 Category-specific planned improvements

No improvements planned for this category.

4.8.2 N_2O From Product Uses (CRF 2.G.3)

4.8.2.1 Category description

The N_2O emissions under CRF 2.G.3 produce N_2O from product uses: Medical applications. N_2O emissions from anaesthesia formed a negligible part of total GHG emissions in Latvia. In 2014 these emissions totalled 2.01 kt CO_2 eq.

4.8.2.2 Methodological issues

N_2O emissions from medical applications were estimated taking into account the amount of N_2O sold. According to 2006 IPCC Guidelines, it was assumed that 100% of N_2O sold for anaesthesia was emitted to the air, therefore activity data is equal to estimated emissions. The data on the N_2O sales was available since 2007. Activity data was provided by the State Agency of Medicines of Latvia. The estimation of emissions is based on the assumption that all used N_2O is emitted to the atmosphere in the same year when it is produced or imported in Latvia.

To obtain a comparable data in time series for years 1990-2006 assume that base year for N_2O Emissions is year 2007, N_2O emissions for years 1990-2006 were calculated proportionally, taking into account the number of inhabitants provided by CSB.

4.8.2.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty of available activity data under CRF 2.G.3 sub-sector was ±2% in 2014. Emission factor uncertainty is assumed to be 2%. Time series consistency was ensured by using one method for all time series.

4.8.2.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the Other product manufacture and use (2.G.3) sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

All estimations of the emissions done in the LEGMC also are checked on the logical mistakes by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogic changes in the activity data and emissions.

Quality control check list is filled for each category taking into account criteria given in QA/QC plan approved in the national legislation. All findings were documented and introduced in GHG inventory. All corrections are archived in centralized archiving system (common FTP folder).

4.8.2.5 Category-specific recalculations

During quality control procedures mistakes in N_2O emission calculation were found and therefore emissions were recalculated for all time series.

4.8.2.6 Category-specific planned improvements

No improvements are planned under CRF 2.G.3.

4.9 OTHER PRODUCTION (CRF 2.H)

4.9.1 Category description

Other Production sub-sector includes indirect emissions from:

- Pulp and Paper (2.H.1);
- Food and beverages industry (2.H.2).

NMVOC emissions constitute 1.32 kt in 2014 and decreased by 2.8% comparing with 2013 and by 61.1% comparing with 1990.

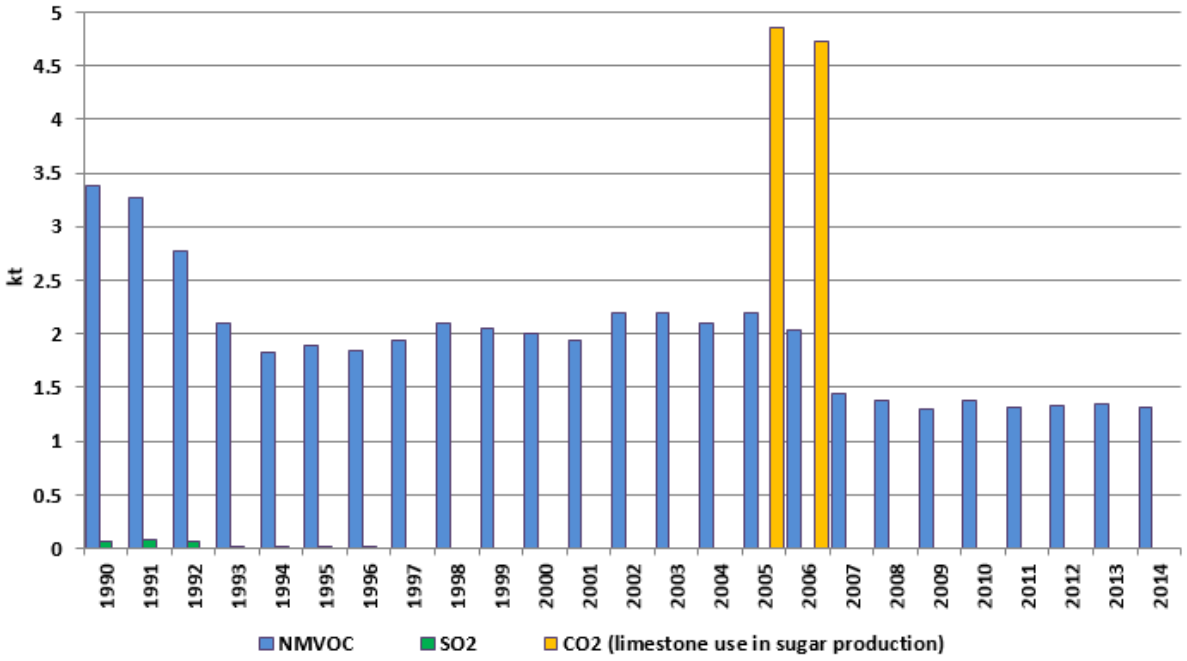

Figure 4.21 Total emissions from 2.H Other Production in 1990–2014 (kt)

Considerable fluctuations occurred in time period 1991–1993 due to changes in economic situation in country (Figure 4.21). Decrease of NMVOC emissions in time period 1999 – 2001 is explained with decresing demand of Food and beverages export to CIS countries. For the years in time period 2002–2004 NMVOC emissions were stable. NMVOC emissions decreased by 36.9% in 2005-2008 that is explained with decrease of produced spirits by 28.4% and closure of sugar production plants. Sugar is no longer produced in Latvia since 2007. For time period 2005-2006 data of used limestone in sugar production are reported. CO_2 emissions were calculated as two sugar production plants entered into ETS as operators and detailed information became available from annual GHG reports. After these two years

sugar production plants stopped their activities and were closed. Since 2007 the total amount of food and beverages industry sector decrease. That could be explained with economic crisis in 2008-2009 as well with rise in prices of national and imported production.

SO_2 emissions are reported for time period 1990–1996 when pulp and paper industry were closed due to facility closes. In latest years wood pulp and paper industry is developing again still wood pulp is imported and not produced in country so SO_2 emissions that occurred in pulp production processes are not emitted. Since 2010 situation are quite stable in food and drink industry.

4.9.2 Methodological issues

Reported emissions, calculation methods and type of emission factors for the 2.H Other in the Latvian inventory are summarized in Table 4.47.

Table 4.47 GHG emission categories, methods and gases reported from 2.H Other

Category	Method used	Gases reported
H. Other		
1.Pulp & Paper	Tier1	SO_2
2.Food and beverages industry	Tier1	NMVOC, CO_2

Methods

NMVOC emissions from the food and beverages industry as well as SO_2 emissions from pulp and paper are calculated. Emissions are calculated according to IPCC 1996.

Emission factors

SO_2 emission factor 0.03 (t/t) is taken from IPCC 1996[106].

The NMVOC emission factors (Table 4.48) are taken from the EMEP/CORINAIR 2013[107] with exception of NMVOC emission factor for spirits production. NMVOC emission factor from EMEP/CORINAIR 2007 that corresponds to other spirits was used. CSB provided aggregated statistical data where it can be seen that 95.5% of all spirits produced in Latvia is produced from grains (sheer alcohol or spirits) and no brandy and whiskey is produced in Latvia. That's why emission factor for Other Spirits 0.4 kg/hl (alcohol) is used.

Table 4.48 NMVOC emission factors for food and drink industries

Production	Emission factors
Wine	0.08 kg/hl
Beer	0.035 kg/hl
Spirits	0.4 kg/hl
Meat, fish, poultry	0.3 kg/t
Sugar	10 kg/t
Cakes, biscuits, breakfast cereals	1 kg/t
Bread	8 kg/t
Animal forage	1 kg/t

[106] http://www.ipcc-nggip.iges.or.jp/public/gl/invs5b.html *(p.2.39, Table 2-24)*
[107] http://www.eea.europa.eu/publications/emep-eea-guidebook-2013, *2.H.2 Food and beverage industry (p.14-21)*

Activity data

Activity data for calculation of the NMVOC emissions from the food and drink industry is obtained from the CSB. Activity data of pulp and paper sub-sector also were taken from CSB (Table 4.49). LEGMC has signed an agreement with CSB to get data of total production of products from sectors where data are confidential.

Still for the 2014 data for the category – wine production, was classified as confidential and not available for the LEGMC. That's why for this category 2006 year's data was used also for 2007-2014.

Table 4.49 Activity data of 2.H Other Production sector

	Pulp and Paper	Wine	Beer	Spirits	Meat, fish, poultry	Sugar	Limestone use in sugar production	Cakes, biscuits, breakfast cereals	Bread	Animal forage
	kt	1000 hl	1000 hl	1000 hl	kt	kt	kt	kt	kt	kt
1990	36.6	19.9	87.4	324.5	569.3	31.0	NO	54.8	314.0	200.0
1995	1.5	159.2	652.8	341.5	82.8	29.3	NO	24.4	145.4	214.4
2000	NO	C	945.1	C	197.3	C	NO	24.3	121.1	173.8
2005	NO	C	1293.3	C	243.8	C	11.0	53.6	116.3	248.6
2006	NO	C	1383.0	C	288.4	C	10.7	45.0	107.3	244.2
2007	NO	C	1414.3	C	286.0	NO	NO	46.5	102.3	336.8
2008	NO	C	1333.8	C	297.7	NO	NO	38.5	100.7	307.3
2009	NO	C	1292.4	C	253.5	NO	NO	33.3	95.9	299.3
2010	NO	C	1484.9	C	252.7	NO	NO	38.0	90.0	409.8
2011	NO	C	1626.6	C	261.5	NO	NO	39.7	88.6	360.9
2012	NO	C	1488.5	C	264.3	NO	NO	44.5	91.4	348.2
2013	NO	C	1513.7	C	286.2	NO	NO	56.4	88.1	380.1
2014	NO	C	967.5	C	270.7	NO	NO	50.4	84.9	379.5

4.9.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty of activity data was assumed as 2% for 1990-2006 because statistical data from CSB were used. For 2007-2008 the uncertainty is assumed higher – 10%, as no precise information is available regarding wine production. SO_2 and NMVOC emission factor uncertainty were assigned as 50% because default emission factors from IPCC 1996 were used.

Time series of the estimated emissions are consistent and complete because the same methodology, emission factors and data sources are used for sectors for all years in time series. GHG emissions from all sectors are estimated or reported as not occurring / not applicable therefore there are no "not estimated" sectors.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level. There are no such issues.

4.9.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the IPPU sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

QA/QC check is performed with Tier1 method from IPCC GPG 2000.

Activity data used in NMVOC and SO_2 emissions was reported by CSB to LEGMC within National Inventory System. CSB has the internal QA/QC procedures based on mathematical model and analysis to avoid logic mistakes. The activity data used in estimations is repeatedly verified by CSB energy experts by checking the data input in data estimation database and reported in the NIR. All estimations of the emissions done in the LEGMC also are checked on the logical mistakes by checking the time series of the activity data, emission factors and emissions consistency to display all significant and illogic changes in the activity data and emissions.

Emissions are checked using time series consistency check for the IEF estimated in CRF Reported and all IEF changes in time series are double-checked and reasonable explanation for IEF changes has to be found under each subsector source category description.

The QC form has been filled in for each category taking into account criteria given in QA/QC plan approved in national legislation. Form then is archived.

There was involved external auditor from CSB for QA/QC in 2016 mainly for comparing activity data with central statistics. No specific or significant issues were found under this sector.

4.9.5 Category-specific recalculations

No recalculations were done for this sector.

4.9.6 Category-specific planned improvements

No improvements are planned for this sector for nearest submissions.

5 AGRICULTURE (CRF 3)

5.1 OVERVIEW OF SECTOR

Greenhouse gases (GHG) emissions from agriculture sector in Latvia include:

1) methane (CH_4) emissions from enteric fermentation of domestic livestock and manure management;
2) nitrous oxide (N_2O) emissions from manure management and managed soils;
3) carbon dioxide (CO_2) emissions from lime and urea application.

Emissions from managed soils include:

-) direct nitrous oxide emissions from:

1) application of synthetic nitrogen (N) fertilizer;
2) application of animal manure, compost, sewage sludge and other organic fertilizers;
3) urine and dung N deposited by grazing animals on pasture, range and paddock;
4) N in crop residues;
5) cultivation of organic soil in croplands and grasslands;
6) N mineralisation associated with loss of soil organic matter resulting from change of land use or management of mineral soils.

-) indirect nitrous oxide emissions from atmospheric deposition and nitrogen leaching/run-off.

Rice cultivation (3 C) and savannas (3 E) are not typical for Latvia, therefore these categories are reported as "NO" in CRF tables. Legislative measures and agricultural residue management practices prohibit agricultural residues burning on fields, therefore a notation key "NO" is used in CRF tables under the category Field Burning of Agricultural Residues (3 F). The calculation of emissions is based on 2006 IPCC Guidelines methodology. Detailed information about methods is provided under each subcategory. Overview of GHG emissions sources from Agriculture sector in 2014 is shown in Figure 5.1.

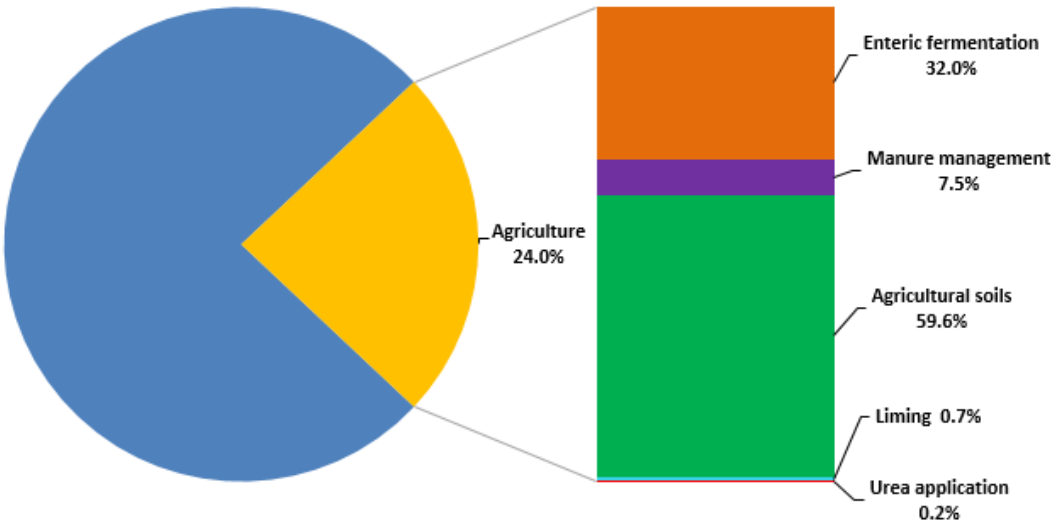

Figure 5.1 Emissions from the agriculture sector compared with the total emissions in 2014

In 2014, agriculture sector contributed 2726.4 kt CO_2 eq. which made up 24.0% of total national GHG emissions in Latvia. Agricultural soils are responsible for 59.6% of total emissions from Agriculture. Second largest emission source is Enteric fermentation contributing with 32%. Manure Management constituted 7.5% from Agicultural emissions in 2014. Liming and Urea application are less significant emission sources producing less then 1% of total Agricultural emissions in 2014 (Figure 5.1).

Nitrous oxide emissions constituted 63.4% (1729.8 kt CO_2 eq.) and methane emissions resulted in 35.7% (972.2 kt CO_2 eq.) of total GHG emissions from agricultural sector. Remaining 0.9% (24.4 kt CO_2) of total GHG emissions originated from liming and urea fertilization. 89.8% of total agriculture sector methane emissions resulted from enteric fermentation and 10.2% - from manure management. The largest part (94.0%) of total nitrous oxide emissions resulted from direct-indirect emissions of managed soils, only 6.0% of total nitrous oxide emissions related to manure management.

In 2014, GHG emissions from agriculture sector in Latvia increased by 3.3% comparing with 2013. However, annual emissions have been reduced by 50.0% since 1990 due to decrease in the number of livestock, nitrogen fertilizers etc. (Table 5.1).

Table 5.1 Greenhouse gas emissions in the agricultural sector, 1990–2014 (kt CO_2 eq.)

Year	CH_4	N_2O	CO_2	Total
1990	2411.2	2663.7	379.1	5454.0
1991	2312.4	2495.7	238.6	5046.7
1992	1912.5	2010.7	37.5	3960.7
1993	1256.1	1609.9	4.0	2870.0
1994	1102.5	1464.2	2.5	2569.1
1995	1074.5	1326.0	2.0	2402.5
1996	1028.4	1343.5	1.5	2373.4
1997	1006.3	1352.5	1.3	2360.2
1998	936.4	1315.6	3.4	2255.5
1999	807.2	1253.0	3.5	2063.6
2000	811.7	1280.1	6.2	2098.0
2001	857.7	1361.5	2.2	2221.4
2002	849.7	1333.0	20.1	2202.9
2003	849.8	1378.9	27.1	2255.8
2004	822.5	1362.2	2.5	2187.3
2005	847.6	1420.2	3.0	2270.8
2006	854.6	1421.3	2.9	2278.8
2007	894.1	1473.8	6.5	2374.4
2008	868.3	1478.0	6.0	2352.3
2009	866.0	1510.6	8.5	2385.0
2010	873.9	1550.5	6.1	2430.5
2011	883.8	1560.1	12.5	2456.4
2012	903.3	1654.5	16.1	2573.9
2013	937.4	1684.5	17.9	2639.7
2014	972.2	1729.8	24.4	2726.4
Share of total % in 2014	35.7%	63.4%	0.9%	100.0%
2014 versus 2013	+3.7%	+2.7%	+36.8%	+3.3%
2014 versus 1990	-59.7%	-35.1%	-93.6%	-50.0%

**In all tables non-rounded values are used to calculate percentage*

Several emission sources in the Agriculture sector are key categories both in level and trend assessment. Information regarding results of key category analysis for the Agriculture sector is presented in Table 5.2**.**

Table 5.2 Identified key categories for the agriculture sector

IPCC category	Gas	Identification criteria	with LULUCF	without LULUCF
3.A.1 Enteric Fermentation - Cattle	CH_4	L1, L2,T1,T2	X	X
3.B.1.1 Manure Management - Cattle	CH_4	L1,L2,T1,T2		X
3.B.2.1 Manure Management - Cattle	N_2O	L1,L2		X
3.B.5 Indirect N2O emissions from Manure Management	N_2O	L1,L2,T2	X	X
3.D.1. Direct N2O emissions from managed soils	N_2O	L1, L2,T1,T2	X	X
3.G. Liming	CO_2	T1,T2	X	X

Some interannual variation of emissions, which can be noticed from the time series, was mainly caused by fluctuation in activity data among the years due to changes in the number of animals, which had been significantly affected by economic situation in the country, as well as agricultural policy. Methane and nitrous oxide emissions from manure management were affected by the fluctuation in the number of animals and the proportion of manure managed in different manure management systems which vary depending on animal species. Nitrous oxide emissions from managed soils generally were affected by the numbers describing management of organic soils, amount of synthetic fertilizers consumption, the number of grazing livestock, sown area and crop yields, which have large variation among the years.

Emissions from agriculture noticeably decreased in the beginning of 1990s after the Soviet system and large state or collective farms collapses. However, in the recent years it is possible to observe a slight increase of sown area, consumption of synthetic N-fertilizers, non-dairy, sheep, swine and poultry numbers. State efforts to improve animal manure management systems (MMS) and expansion of anaerobic digestation in the largest farms is the main reason that reduces the increase of emissions from manure management. In the last years, dairy farming in Latvia turns to liquid slurry management system according to closing of small farms and reflection to the trend to this management system in developed countries, however liquid slurry produces more methane and results in increase of this type of emissions.

The number of cattle, sheep, swine, goats, horses, poultry, rabbits and fur-bearing animals' population, as well as data on milk production and fat content in milk are obtained from the Central Statistical Bureau (CSB) of Latvia Database[108] and statistical yearbooks[109]. The number of fur-bearing animals relates to no open access data. Similarly to the number of domestic livestock, also statistical information about amounts of synthetic fertilizer N application and crop production is obtained from the CSB database. The number of deer in

[108] *Agriculture, Forestry and Fishery. http://data.csb.gov.lv/pxweb/en/lauks/?rxid=a79839fe-11ba-4ecd-8cc3-4035692c5fc8*
[109] *Agriculture in Latvia. Collection of Statistical Data. Rīga: 2014. 64 pp*

Latvia is obtained from available information from informative reports prepared by Ministry of Agriculture[110] and Wild Animal Breeders Association[111]. The distribution of different MMS is adopted from national studies. Calculation of the distribution is done based on research results and developed methodology provided by Latvia University of Agriculture.

Statistical information about livestock number in Latvia is included in Table 5.3. The number of fur-bearing animals is not available for 1990-1992 and 1995, therefore interpolation and extrapolation is used to fill in the gaps of time series.

Table 5.3 Number of livestock, 1990–2014 (thousand heads)

Year	Dairy Cattle	Non-dairy Cattle	Sheep	Swine	Goats	Horses	Poultry	Rabbits	Fur-bearing animals	Deer
1990	535.1	904.2	164.6	1401.1	5.4	30.9	10321.1	193.9	260.2	ND
1991	531.4	851.5	183.7	1246.5	6.1	30.0	10395.1	223.3	260.2	ND
1992	481.7	662.6	164.7	866.5	6.4	28.4	5438.3	198.5	260.2	ND
1993	351.0	326.9	114.0	481.8	6.3	26.2	4123.7	162.8	260.2	ND
1994	311.9	238.9	86.3	500.7	7.4	26.8	3699.6	154.5	221.0	ND
1995	291.9	245.2	72.2	552.8	8.9	27.2	4198.3	152.5	213.5	ND
1996	274.6	234.8	55.5	459.6	8.4	25.8	3790.7	134.3	205.9	ND
1997	262.8	214.1	40.7	429.9	8.9	23.3	3550.7	93.4	88.6	ND
1998	242.1	192.3	29.4	421.1	10.5	22.0	3208.8	97.6	55.2	ND
1999	205.6	172.8	27.0	404.9	8.1	19.0	3236.9	72.3	84.0	ND
2000	204.5	162.2	28.6	393.5	10.4	19.9	3104.6	110.9	97.2	ND
2001	209.1	175.6	29.0	428.7	11.5	19.6	3621.2	150.4	117.7	ND
2002	204.6	183.5	31.5	453.2	13.2	18.5	3882.0	141.6	116.3	ND
2003	186.3	192.3	39.2	444.4	15.0	15.4	4002.6	149.2	119.4	ND
2004	186.2	184.9	38.6	435.7	14.7	15.5	4049.5	135.5	143.5	ND
2005	185.2	200.0	41.6	427.9	14.9	13.9	4092.3	97.9	141.7	ND
2006	182.4	194.7	41.3	416.8	14.3	13.6	4488.1	92.9	182.8	3.3
2007	180.4	218.3	53.9	414.4	13.0	13.0	4756.8	96.4	181.4	4.0
2008	170.4	209.8	67.1	383.7	12.9	13.1	4620.5	57.4	197.5	5.3
2009	165.5	212.7	70.7	376.5	13.2	12.6	4828.9	43.9	164.4	7.8
2010	164.1	215.4	76.8	389.7	13.5	12.0	4948.7	33.5	167.0	7.6
2011	164.1	216.5	79.7	375.0	13.4	11.5	4417.9	39.3	183.7	9.6
2012	164.6	228.5	83.6	355.2	13.3	10.9	4910.9	37.3	231.6	9.3
2013	165.0	241.5	84.8	367.5	12.6	10.7	4985.8	38.9	231.6	11.5
2014	165.9	256.1	92.5	349.4	12.3	10.1	4413.9	38.3	313.9	13.2
2014 versus 2013*	+0.5%	+6.0%	+9.1%	-4.9%	-2.4%	-5.6%	-11.5%	-1.5%	+35.5%	+14.2%
2014 versus 1990*	-69.0%	-71.7%	-43.8%	-75.1%	+127.8%	-67.3%	-57.2%	-80.2%	+20.6%	ND

Latvian livestock industry has been influenced by historical events and economical situation. Particularly significant changes in the livestock industry began in 1992 after the restoration of Latvian independence when most of big farms went into liquidation. Since the Soviet

[110] *Ministry of Agriculture. Available at: https://www.zm.gov.lv/lauksaimnieciba/statiskas-lapas/lauksaimniecibas-gada-zinojumi?nid=531#jump*

[111] *Wild Animal Breeders Association. Available at: http://www.losp.lv/sites/default/files/articles/attachments/publications/22.12.2011_-_1500/17_savvalas_dzivnieki.pdf*

Union had a planned economy, most of the output of livestock products was carried out in other Soviet republics. Reorientation of livestock product export to Western markets was more difficult in terms of market saturation. Latvian farmers were forced to reduce production levels of milk, meat and crop. Consequently, livestock numbers declined most rapidly in 1990-1994 in all sectors, except for goat farming. All the above-mentioned social and economic changes lead to also eliminating of stud-farms. The horses were sold, only the strongest stud-farms continued to work. Starting from 2004, according to Latvia's accession to the European Union (EU), the number of livestock has stabilized. The increase of production indicators was characteristic for beef cattle, sheep, goat and poultry industries. Dairy farming is one of the most important branches of agriculture in Latvia. The number of dairy cows in Latvia is relatively stable, with a tendency to a slight increase in the last years. In 2014, 165.9 thousand dairy cows were registered and an average milk yield per cow reached 5512 kg, showing the highest value since 1990. Since 2009, the number of large farms has increased, while small farms have been closed, however dairy farms in Latvia are characterized by a low herd size in comparison with other European countries.

Statistical surveys are the source of data on crop production in commercial companies, private farms and individual merchants. Fluctuations in activity data is observed due to economic situation in the country. Since 2007, two sugar factories have stopped their activity therefore no data is presented further. Agricultural statistics data fulfil criteria determined by the EU and requirements are determined in the legislative acts. The Project Documentation System (ADS) is established at CSB. It is a quality metadata system for internal and external users. There are methodological descriptions of all statistical surveys and calculations. Annual samples are made up as stratified simple samples. Holdings are selected by economic size (standard output – SO) and type of farming. SO is a standard indicator characterizing the economic activity of agricultural holding, i.e., value acquired from one hectare of agricultural crops or one livestock head (unit), estimated at prices of the corresponding region and expressed in EUR. A total standard output characterises the economic size of the holding in monetary terms. Farms with SO >= 50000 EUR are included for 100% statistical surveys; farms with 2000 EUR <SO < 50000 EUR are selected by economic size and type of farming. Sample size for annual sample (Crop and Animal survey) includes 5.1 thousand holdings. Small holdings with SO < 2000 EUR are not included in annual Crop and Animal surveys, but information for these holdings is estimated using experts' method. For this estimation CSB uses information from Agricultural Censuses and surveys of small farms, which are organized between Censuses. Crop and livestock statistics quality reports are available on CSB web page[112;113].

Total sown area in 2014 was 1150.5 thousand ha, the number of total sown area increased by 0.3% compared to 2013. Share of main crops in the total sown area is represented in Figure 5.2.

[112] *Available at: http://www.csb.gov.lv/sites/default/files/quality_report_on_annual_crop_statistics_2010_0.pdf*
[113] *Available at: http://www.csb.gov.lv/sites/default/files/quality_report_on_livestock_and_meat_statistics_2010_0.pdf*

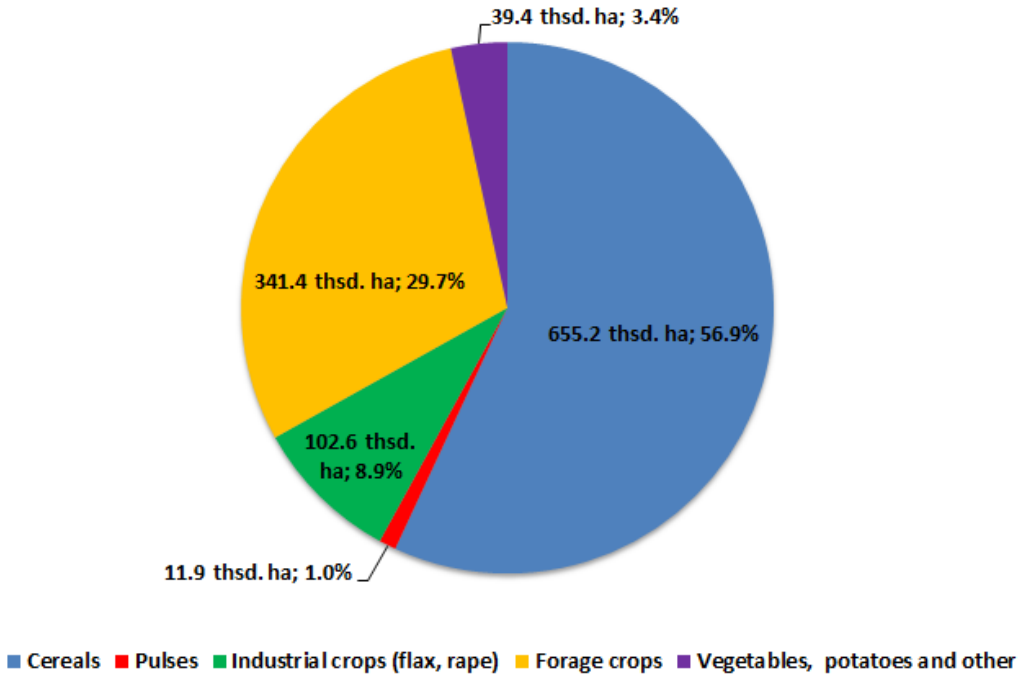

Figure 5.2 Sown area in Latvia, 2014

Statistical information about crop production in Latvia for calculation of nitrous oxide emissions is included in Table 5.4 and Table 5.5. Data about sown area of oil flax (1990-1999) are not available; therefore data for filling gaps in the time series are extrapolated from the closest numbers. Other statistical data are included in relevant subchapters.

Table 5.4 Sown area of agricultural crops, 1990–2014 (thousand ha)

Year	Wheat	Barley	Triticale	Oats	Rye	Buckwheat	Mixed cereals	Pulses
1990	141.5	306.6	1.1	82.4	130.7	0.1	12.7	10.5
1991	71.5	397.4	2.6	92.7	69.2	0.1	13.7	9.0
1992	128.6	347.0	3.3	69.4	131.4	0.1	13.5	6.7
1993	169.1	270.3	6.8	48.5	187.6	0.1	6.2	2.8
1994	94.6	264.1	3.1	54.0	62.7	0.1	5.3	2.8
1995	109.6	195.9	2.7	45.6	40.4	0.1	6.8	3.0
1996	149.2	176.4	1.7	53.6	56.4	0.1	6.8	3.6
1997	152.3	188.7	2.8	59.1	62.5	0.6	11.0	4.7
1998	150.9	165.9	5.3	59.7	57.7	1.7	13.6	6.8
1999	146.0	142.7	5.8	47.2	47.2	2.3	7.9	2.5
2000	158.1	130.6	5.9	45.5	54.8	6.2	5.3	2.1
2001	166.8	124.0	13.0	55.2	55.8	10.6	4.1	3.2
2002	153.5	132.1	15.5	47.1	42.3	10.5	3.4	2.5
2003	167.8	129.2	19.1	49.4	44.2	6.5	2.9	2.9
2004	169.9	123.5	17.1	56.7	45.1	9.7	3.3	2.6
2005	187.4	145.9	13.3	58.0	39.3	10.4	3.7	2.2
2006	215.1	149.8	11.3	62.9	42.8	14.0	4.9	1.4
2007	224.6	139.7	12.4	62.4	57.5	10.7	3.0	1.6
2008	256.6	123.9	13.8	66.2	59.0	10.4	2.7	1.6
2009	285.7	94.6	13.1	60.6	59.0	10.1	2.5	2.5
2010	307.6	91.1	12.1	63.3	34.6	8.2	3.6	2.7
2011	311.3	94.7	9.9	59.3	28.4	9.5	3.8	3.8
2012	354.7	85.2	13.3	62.0	37	11.7	3.8	4.6

Year	Wheat	Barley	Triticale	Oats	Rye	Buckwheat	Mixed cereals	Pulses
2013	371.8	82.3	14.2	62.4	29.1	10.6	1.2	7.0
2014	402.5	119.9	10.7	66.8	32.3	10.2	4.6	11.9
2014 versus 2013	+8.3%	+45.7%	-24.6%	+7.1%	+11.0%	-3.8%	+283.3%	+70.0%
2014 versus 1990	+184.5%	-60.9%	+872.7%	-18.9%	-75.3%	+10100.0%	-63.8%	+13.3%

Table 5.5 Sown area of agricultural crops, 1990–2014 (thousand ha)

Year	Sugar beet	Fodder roots	Potatoes	Maize for silage and forage	Crops for green feed and silage	Perennial grass	Fibre flax	Oil flax	Rape
1990	14.7	37.0	80.3	44.8	73.9	664.0	11.9	0.3	1.9
1991	14.6	39.4	82.2	39.5	84.9	679.6	8.8	0.3	0.7
1992	24.8	36.5	96.9	24.8	56.7	598.6	7.6	0.3	1.3
1993	12.1	29.6	87.7	9.2	31.4	536.0	0.6	0.3	1.7
1994	12.0	26.2	80.4	2.7	20.9	540.6	1.5	0.3	2.2
1995	9.5	19.8	75.3	0.6	17.8	374.7	1.4	0.3	1.1
1996	10.0	17.3	78.7	1.2	11.6	398.4	1.3	0.3	0.8
1997	10.9	14.9	69.6	0.5	13.2	389.7	1.6	0.3	0.4
1998	16.3	13.1	58.8	0.5	12.8	392.7	2.2	0.3	1.2
1999	15.5	9.1	50.1	0.7	12.0	383.1	2.0	0.3	6.5
2000	12.7	9.0	51.3	1.2	11.4	347.2	1.6	0.3	6.9
2001	14.1	9.6	55.1	1.0	8.4	304.4	1.4	0.4	8.4
2002	15.9	7.5	53.6	1.2	7.2	335.1	2.1	0.1	18.4
2003	14.4	7.1	54.6	1.7	9.9	282.9	2.1	0.1	25.9
2004	13.8	5.6	48.9	2.9	9.9	302.3	2.7	0.1	54.3
2005	13.5	3.8	45.1	2.9	8.7	360.6	2.2	0.2	71.4
2006	12.7	2.8	45.1	3.5	11.4	425.8	1.5	0.2	83.2
2007	0.3	2.3	40.3	5.1	11.1	427.1	1.4	0.1	99.2
2008	NO	0.9	37.8	5.9	8.2	413.1	0.4	0.2	82.6
2009	NO	0.7	30	9.8	7.2	413.7	0.1	0.2	93.3
2010	NO	0.9	30.1	7.1	6.3	387.3	0.0	1.1	110.6
2011	NO	0.8	29.7	11.3	5.7	370.8	0.1	1.4	121.3
2012	NO	0.6	28.2	20.6	10.6	351.4	0.6	0.3	117.5
2013	NO	0.3	27.3	20.4	7.7	356.7	0.2	0.1	128.2
2014	NO	0.2	26.8	21.7	7.3	312.4	0.1	0.5	100.1
2014 versus 2013	NO	-33.3%	-1.8%	+6.4%	-5.2%	-12.4%	-50.0%	+400.0%	-21.9%
2014 versus 1990	-100.0%	-99.5%	-66.6%	-51.6%	-90.1%	-53.0%	-99.2%	+66.7%	5168.4%

5.2 ENTERIC FERMENTATION (CRF 3.A)

5.2.1 Category description

Methane (CH_4) is emitted as a by-product of the normal livestock digestive process, in which microbes resident in the animals' digestive system ferment the feed consumed by the

animal. This fermentation process is also known as enteric fermentation[114]. Ruminant livestock (cattle, sheep and goats) are the primary source of methane emissions. The amount of enteric methane emitted is driven primarily by the number and size of domestic animals, the type of digestive system, and the type and amount of feed consumed[115]. Latvia reports emissions from cattle (including dairy cows, other mature non-dairy cattle and growing cattle according to CRF Option B), sheep, swine, goats, horses, rabbits, and fur-bearing animals (Table 5.6). Emission from poultry enteric fermentation has not been estimated. According to 2006 IPCC Guidelines, methodology for enteric fermentation calculation from poultry is not developed. Methane emission from poultry is calculated only in the manure management category.

Table 5.6 Reported emissions under the subcategory enteric fermentation

CRF	Source	Emissions reported	Level
3.A 1	Dairy Cattle / Non-dairy Cattle (other mature and growing cattle)	CH_4	Tier 2
3.A 2	Sheep	CH_4	Tier 1
3.A 3	Swine	CH_4	Tier 1
3.A 4	Other – Buffalo	NO	Tier 1
3.A 4	Other – Camels	NO	Tier 1
3.A 4	Other – Deer	CH_4	Tier 1
3.A 4	Other – Goats	CH_4	Tier 1
3.A 4	Other – Horses	CH_4	Tier 1
3.A 4	Other – Mules and asses	NO	Tier 1
3.A 4	Other – Poultry	NE	Tier 1
3.A 4	Other – Rabbits	CH_4	Tier 1
3.A 4	Other – Fur-bearing animals	CH_4	Tier 1

Cattle are the largest source of enteric fermentation methane emissions (94.9% from total enteric fermentation methane emissions) in Latvia. In 2014, dairy cattle produced 64.6% and non-dairy cattle –30.3% of methane emissions. Emissions from sheep formed 2.1%, from swine – 1.5% and from other livestock – 1.5% of the total emissions from enteric fermentation. In 2014, total methane emissions from enteric fermentation of domestic livestock increased by 1.18 kt or 3.5%, compared with 2013. This is caused by the increase of the number of cattle, sheep, fur-bearing animals and deer. Since 1990, generally due to the evident fall of the number of livestock, methane emissions decreased by 60.7% (Table 5.7).

Table 5.7 Methane emissions from enteric fermentation by livestock category, 1990–2014 (kt)

Year	Dairy cattle	Non-Dairy cattle	Sheep	Swine	Goats	Horses	Rabbits	Fur-bearing animals	Deer	Total, CH_4
1990	55.11	29.61	1.32	2.10	0.03	0.56	0.11	0.03	ND	88.86
1991	53.48	27.70	1.47	1.87	0.03	0.54	0.13	0.03	ND	85.25
1992	46.26	21.06	1.32	1.30	0.03	0.51	0.12	0.03	ND	70.62
1993	33.61	10.36	0.91	0.72	0.03	0.47	0.10	0.03	ND	46.23
1994	30.70	7.64	0.69	0.75	0.04	0.48	0.09	0.02	ND	40.42
1995	29.41	7.69	0.58	0.83	0.04	0.49	0.09	0.02	ND	39.16

[114] *IPCC GPG, 2000*
[115] *2006 IPCC Guidelines*

Year	Dairy cattle	Non-Dairy cattle	Sheep	Swine	Goats	Horses	Rabbits	Fur-bearing animals	Deer	Total, CH_4
1996	28.36	7.57	0.44	0.69	0.04	0.46	0.08	0.02	ND	37.67
1997	28.45	6.89	0.33	0.64	0.04	0.42	0.06	0.01	ND	36.83
1998	26.63	6.18	0.24	0.63	0.05	0.40	0.06	0.01	ND	34.18
1999	22.59	5.40	0.22	0.61	0.04	0.34	0.04	0.01	ND	29.24
2000	23.03	4.99	0.23	0.59	0.05	0.36	0.07	0.01	ND	29.33
2001	23.97	5.34	0.23	0.64	0.06	0.35	0.09	0.01	ND	30.69
2002	23.19	5.65	0.25	0.68	0.07	0.33	0.08	0.01	ND	30.26
2003	22.63	6.17	0.31	0.67	0.08	0.28	0.09	0.01	ND	30.24
2004	21.93	5.87	0.31	0.65	0.07	0.28	0.08	0.01	ND	29.21
2005	22.19	6.54	0.33	0.64	0.07	0.25	0.06	0.01	ND	30.11
2006	22.26	6.61	0.33	0.63	0.07	0.24	0.05	0.02	0.06	30.27
2007	22.42	7.71	0.43	0.62	0.07	0.23	0.06	0.02	0.07	31.63
2008	21.57	7.52	0.54	0.58	0.06	0.24	0.03	0.02	0.09	30.65
2009	21.13	7.81	0.57	0.56	0.07	0.23	0.03	0.02	0.13	30.53
2010	21.15	8.15	0.61	0.58	0.07	0.22	0.02	0.02	0.13	30.95
2011	21.26	8.39	0.64	0.56	0.07	0.21	0.02	0.02	0.16	31.32
2012	21.64	9.04	0.67	0.53	0.07	0.20	0.02	0.02	0.16	32.34
2013	22.12	9.87	0.68	0.55	0.06	0.19	0.02	0.02	0.20	33.72
2014	22.54	10.58	0.74	0.52	0.06	0.18	0.02	0.03	0.22	34.91
Share of total % in 2014	64.6%	30.3%	2.1%	1.5%	0.2%	0.5%	0.1%	0.1%	0.6%	100%
2014 versus 2013	+1.9%	+7.2%	+9.1%	-4.9%	-2.4%	-5.6%	-1.5%	+35.5%	+14.2%	+3.5%
2014 versus 1990	-59.1%	-64.3%	-43.8%	-75.1%	+127.8%	-67.3%	-80.2%	+20.6%	ND	-60.7%

5.2.2 Methodological issues

The Tier 1 approach relies on default emissions factors. For Tier 1 methodology countries are required to collect data on number of animals for each livestock category. The Tier 2 approach is more complex because it draws upon country-specific information on animal and feed characteristics. The Tier 2 approach is recommended to estimate methane emissions for countries with large cattle and sheep populations.

Emissions from enteric fermentation of domestic livestock in Latvia have been calculated by using the IPCC Tier 1 and Tier 2 methodologies presented in the 2006 IPCC Guidelines. Methane emissions from enteric fermentation for sheep, swine, goats, horses, rabbits, fur-bearing animals and deer have been calculated with the IPCC Tier 1 methodology by multiplying the number of the animals in each category with the IPCC default emission factor of the respective livestock category as shown in 2006 IPCC Guidelines[116]:

$$Emissions = EF_{(T)} \cdot \left(\frac{N_{(T)}}{10^6}\right)$$

where:
Emissions = methane emissions from Enteric Fermentation, kt CH_4 *yr*$^{-1}$

[116] *2006 IPCC Guidelines. Volume 4, Chapter 10, Equation 10.19, page 10.28*

$EF_{(T)}$ = emission factor for the defined livestock population, kg CH_4 head^{-1} yr^{-1}
$N_{(T)}$ = the number of head of livestock species / category T in the country
T = species/category of livestock

The default emission factors as for developed countries according to 2006 IPCC Guidelines[117] were used to calculate methane emissions from enteric fermentation for sheep, swine, goats, horses and rabbits (Table 5.8). As default IPCC and national emission factors for rabbits and fur-bearing animals are not available, other emission factors as Norwegian[118] emission factor for fur-bearing animals and Russian[119] emission factor for rabbits were used for enteric fermentation emission calculations similarly by experience of the neighbouring countries. Emission factor for deer also is adopted form Norwegian National Inventory as average value reported for deer and reindeer, because in the data base of Agricultural data centre category deer includes also the information about reindeer. For reindeer the emission factor 14.0 kg animal^{-1} year^{-1} is used and for deer 20.0 kg animal^{-1} year^{-1} in Norwegian National Inventory Report based on studies of Karlengen (2012)[120].

Table 5.8 Default methane emission factors from enteric fermentation

Livestock category	EF (kg CH_4 head^{-1} yr^{-1})
Sheep	8.00
Swine	1.50
Goats	5.00
Horses	18.00
Rabbits	0.59
Fur-bearing animals	0.10
Deer	17.0

The Tier 2 approach to estimate emissions is implemented for cattle, because emissions from cattle make up the biggest part of total agricultural sector methane emissions. With the Tier 2 methodology methane emissions have been calculated as in the Tier 1 methodology mentioned above, but the emission factors (EF) for dairy cattle and young and mature non-dairy cattle have been calculated according to 2006 IPCC Guidelines methodology represented as[121]:

$$EF = \left[\frac{GE \cdot \left(\frac{Y_m}{100}\right) \cdot 365}{55.65}\right]$$

where:
EF = emission factor, kg CH_4 head^{-1} yr^{-1}
GE = gross energy intake, MJ head^{-1} day^{-1}
Y_m = methane conversion factor, per cent of gross energy in feed converted to methane (default values in table 10.12, page 10.30 from 2006 IPCC Guidelines)
The factor 55.65 (MJ/kg CH_4) is the energy content of methane

[117] *2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.10, page 10.28*
[118] *Greenhouse gas emission in Norway 1990-2011, National inventory report, 2013, p. 238, Table 6.3*
[119] *Национальный доклад о кадастре антропогенных выбросов из источников и абсорбции поглотителями парниковых газов не регулируемых Монреальским протоколом за 1990-2011 г. Москва, 2013. Часть 1, С. 175, Таблица 6.5*
[120] *Karlengen, I. J., Svihus, B., Kjos, N. P. & Harstad, O. M. (2012): Husdyrgjødsel; oppdatering avmengder gjødsel og utskillelse av nitrogen, fosfor og kalium. Sluttrapport. (Manure; anupdate of amounts of manure and excretion of nitrogen, phosphorus and potassium. Final report). Ås: Departement of Animal and Aquacultural Sciences, Norwegian University of LifeSciences (Institutt for husdyr- og akvakulturvitenskap, NMBU-Norges miljø- ogbiovitenskapelige universitet)*
[121] *2006 IPCC Guidelines. Volume 4, Chapter 10, Equation 10.21, page 10.31*

For cattle, the gross energy intake (GE) has been calculated according to 2006 IPCC Guidelines[122]:

$$GE = \left[\frac{\left(\frac{NE_m + NE_a + NE_l + NE_{work} + NE_p}{REM} \right) + \left(\frac{NE_g}{REG} \right)}{\frac{DE\%}{100}} \right]$$

where:

GE = gross energy, MJ day^{-1}
NE_m = net energy required by the animal for maintenance, MJ day^{-1}
NE_a = net energy for animal activity, MJ day^{-1}
NE_l = net energy for lactation, MJ day^{-1}
NE_{work} = net energy for work, MJ day^{-1}
NE_p = net energy required for pregnancy, MJ day^{-1}
REM = ratio of net energy available in a diet for maintenance to digestible energy consumed
NEg = net energy needed for growth, MJ day^{-1}
REG = ratio of net energy available for growth in a diet to digestible energy consumed
DE%= digestible energy expressed as a percentage of gross energy

The equations for calculating NE_m (Equation 10.3, 2006 IPCC Guidelines), NE_a (Equation 10.4, 2006 IPCC Guidelines), NE_l (Equation 10.8, 2006 IPCC Guidelines), NE_p (Equation 10.13, 2006 IPCC Guidelines), NE_g (Equation 10.6, 2006 IPCC Guidelines), REM (Equation 10.14, 2006 IPCC Guidelines) and REG (Equation 10.15, 2006 IPCC Guidelines)[123] are:

$$NE_m = Cf_i \cdot (Weight)^{0.75}$$

$$NE_a = C_a \cdot NE_m$$

$$NE_l = Milk \cdot (1.47 + 0.40 \cdot Fat)$$

$$NE_p = C_{pregnancy} \cdot NE_m$$

$$NE_g = 22.02 \cdot \left(\frac{BW}{C \cdot MW} \right)^{0.75} \cdot WG^{1.097}$$

$$REM = \left[1.123 - (4.092 \cdot 10^{-3} \cdot DE\%) + [1.126 \cdot 10^{-5} \cdot (DE\%)^2] - \left(\frac{25.4}{DE\%} \right) \right]$$

$$REG = \left[1.164 - (5.160 \cdot 10^{-3} \cdot DE\%) + [1.308 \cdot 10^{-5} \cdot (DE\%)^2] - \left(\frac{37.4}{DE\%} \right) \right]$$

where:

Cf_i = maintenance coefficient (default values used[124])
Weight = animal weight, kg
Ca = coefficient corresponding to animals feeding situation (default values used)[125]
Milk = amount of milk produced, kg of milk day^{-1}
Fat = fat content of milk, % by weight
$C_{pregnancy}$ = Pregnancy coefficient (default values used[126])
BW = the average live body weight (BW) of the animals in the population, kg
MW = the mature live body weight of an adult female in moderate body condition, kg
WG = the average daily weight gain of the animals in the population, kg day^{-1}
C = a coefficient with a value of 0.8 for females, 1.0 for castrates and 1.2 for bulls
REM = ratio of net energy available in a diet for maintenance to digestible energy consumed
REG= ratio of net energy available for growth in a diet to digestible energy consumed
DE% = digestible energy, %

[122] *2006 IPCC Guidelines. Volume 4, Chapter 10, Equation 10.16, page 10.21*
[123] *2006 IPCC Guidelines. Volume 4, Chapter 10, Equation 10.3-10.15, page 10.15-10.21*
[124] *2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.4, page 10.16*
[125] *2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.5, page 10.17*
[126] *2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.7, page 10.20*

When using NEp to calculate GE, the NEp estimate must be weighted by the portion of the mature females that actually go through gestation in a year. According to animal breeding specialist calculations based on data of Agricultural Data Centre Republic of Latvia Register, 83% of the NEp value for dairy cattle is used in the GE equation.

Methane conversion factor (Ym) of zero is assumed for juveniles consuming only milk (2006 IPCC Guidelines, p.10.30). In Latvia, it was supposed that calves feed milk and milk substitute no longer than of age 3 months. Therefore it was assumed that methane conversion rate of young growing cattle group (under 1 year old) is 5.5% in 2014. The rate was estimated from IPCC default Ym 6.5%, based on an assumption that for calves between 0 and 3 months Ym is 0%.

Feed digestibility (DE) 65% is used in calculations according to the average value represented in Table 10.2 in the 2006 IPCC Guidelines, because detailed information on feed digestibility are not available in the country yet.

The calculation of GE for dairy cattle is strongly based on the milk production and fat content in milk. Trends about milk production and fat content in milk are presented in Table 5.9. Values of milk fat content for 1990-1997 are derived by extrapolation based on an assumption that fat content in milk was around 3.5% in 1990; all other information comes from CSB of Latvia.

Table 5.9 Average milk yield per cow and fat content

Year	Average milk yield, kg year^{-1}	Fat content, %
1990	3437	3.50
1991	3205	3.58
1992	2793	3.67
1993	2741	3.75
1994	2923	3.84
1995	3074	3.92
1996	3237	4.01
1997	3585	4.09
1998	3733	4.06
1999	3754	4.00
2000	3898	4.08
2001	4055	4.08
2002	3958	4.08
2003	4261	4.11
2004	4251	4.17
2005	4364	4.25
2006	4492	4.26
2007	4636	4.31
2008	4822	4.29
2009	4892	4.31
2010	4998	4.29
2011	5064	4.22
2012	5250	4.16
2013	5508	4.08
2014	5812	3.86
2014 versus 2013	+5.5%	-5.4%
2014 versus 1990	+69.1%	+10.3%

In Latvian inventory livestock category *Cattle* (CRF 3.A.1) is reported in three sub-categories: mature dairy cattle, other mature cattle and growing cattle. Calculations of methane emission from enteric fermentation for dairy cattle are not divided into smaller sub-groups. Estimation of methane emissions from non-dairy cattle is split in seven age and production type sub-groups according to the records in the database of CSB of Latvia. Growing cattle group is represented by young cattle under 1 year and young cattle aged from 1 to 2 years. These two growing cattle groups are segregated for dairy and beef cattle. Other mature cattle group include bulls, heifers and other cows aged over 2 years old. The numbers of non-dairy cattle by sub-categories are presented in Table 5.10.

Missing data or no available data for 1990-1995 are created by linear extrapolation. Total numbers of young cattle under 1 year and aged 1 to 2 years are provided by CSB. Data of young dairy and beef cattle are calculated by Latvia University of Agriculture experts based on CSB totals of mentioned young cattle groups. All numbers of other mature cattle over 2 years are original data obtained from CSB data base.

Table 5.10 The number of non-dairy cattle by sub-categories in Latvia, 1990-2014 (thousand heads)

Year	Growing Cattle						Other Mature Cattle		
	Young cattle under 1 year			Young cattle aged from 1 to 2 years			Mature non-dairy cattle over 2 years		
	dairy cattle calves	beef cattle calves	total	dairy cattle	beef cattle	total	bulls	heifers	other cows
1990	267.6	257.7	525.2	214.0	88.6	302.6	12.0	54.3	10.1
1991	265.7	228.9	494.6	212.6	72.4	285.0	11.3	51.2	9.6
1992	240.9	144.1	384.9	192.7	29.0	221.7	8.8	39.8	7.4
1993	140.4	49.5	189.9	87.8	21.7	109.4	4.3	19.6	3.7
1994	93.6	45.2	138.8	62.4	17.5	79.9	3.2	14.4	2.7
1995	87.6	47.2	134.8	64.2	17.8	82.0	3.2	14.7	2.8
1996	96.1	38.3	134.4	60.4	18.9	79.3	3.3	15.0	2.8
1997	92.0	31.7	123.7	52.6	18.1	70.7	2.6	13.8	3.3
1998	84.7	24.6	109.3	48.4	17.5	65.9	1.6	12.7	2.8
1999	82.2	18.4	100.6	45.2	14.3	59.5	1.1	9.5	2.1
2000	75.7	22.2	97.9	40.9	10.7	51.6	0.8	9.8	2.1
2001	83.6	28.4	112.0	37.6	11.4	49.0	1.7	10.4	2.5
2002	92.1	18.6	110.7	45.0	15.3	60.3	1.1	8.7	2.7
2003	93.2	16.0	109.1	48.4	18.3	66.7	1.5	11.2	3.8
2004	93.1	17.3	110.4	41.0	15.6	56.6	1.7	11.6	4.6
2005	92.6	26.3	118.9	42.6	17.0	59.6	1.6	11.9	8.0
2006	91.2	16.3	107.5	47.4	15.5	62.9	1.8	13.1	9.5
2007	90.2	24.7	114.9	59.5	13.0	72.5	1.2	14.6	15.2
2008	85.2	23.2	108.4	56.2	10.0	66.2	2.6	20.8	12.7
2009	82.8	24.8	107.4	54.6	12.2	66.8	3.0	19.9	15.5
2010	82.1	23.6	105.6	54.2	13.4	67.6	3.2	20.3	18.7
2011	82.1	21.9	103.9	54.2	12.5	66.7	3.1	20.9	22.0
2012	82.3	26.1	108.4	54.3	15.7	70.0	3.5	21.0	25.6
2013	82.5	26.8	109.3	54.5	20.9	75.3	4.3	23.4	29.2
2014	83.0	35.5	118.4	54.7	20.2	74.9	4.4	24.3	34.2
2014 versus 2013	-	-	+8.3%	-	-	-0.5%	+2.3%	+3.8%	+17.1%
2014 versus 1990	-	-	-77.5%	-	-	-75.2%	-63.3%	-55.2%	+238.6%

Results of gross energy intake (GE) calculation for dairy and non-dairy cattle from enteric fermentation are summarized in Table 5.11.

Table 5.11 Average gross energy (GE) intake (MJ day^{-1}) and methane emission factors (EF) from Enteric Fermentation (kg CH_4 head^{-1} year^{-1}) and cattle weight (kg head^{-1} year^{-1}), 1990-2014

Year	Dairy cows			Growing Cattle			Other Mature Cattle		
	Weight	GE	EF	Weight	GE	EF	Weight	GE	EF
1990	550.0	241.6	103.0	272.0	80.4	29.8	581.3	152.9	65.2
1991	550.0	236.1	100.6	270.9	79.7	29.5	581.2	152.9	65.2
1992	550.0	225.2	96.0	267.5	77.6	28.7	581.3	152.9	65.2
1993	550.0	224.6	95.8	267.3	77.0	28.6	580.8	152.9	65.2
1994	550.0	230.9	98.4	268.5	77.9	28.9	581.6	153.0	65.2
1995	550.0	236.3	100.8	271.7	78.6	29.3	580.4	152.9	65.2
1996	550.0	242.3	103.3	269.6	77.9	29.0	581.0	152.9	65.2
1997	550.0	253.9	108.3	267.9	77.5	28.8	572.8	153.9	65.6
1998	550.0	258.0	110.0	270.5	77.7	29.0	555.2	150.1	64.0
1999	550.0	257.7	109.9	268.5	76.8	28.6	552.2	149.7	63.8
2000	555.0	264.2	112.6	262.5	76.0	28.1	541.6	147.6	62.9
2001	555.0	268.9	114.6	254.0	74.8	27.3	566.1	152.9	65.2
2002	555.0	265.9	113.3	264.2	76.1	28.2	556.9	154.4	65.8
2003	555.0	285.0	121.5	270.5	77.2	28.9	559.3	155.9	66.5
2004	555.0	276.3	117.8	261.3	75.6	27.9	563.3	158.7	67.7
2005	555.0	281.1	119.8	261.2	76.1	28.0	563.3	167.3	71.3
2006	560.0	286.2	122.0	267.7	76.4	28.5	564.3	168.8	72.0
2007	560.0	291.5	124.3	271.2	77.1	28.8	556.6	174.8	74.5
2008	560.0	296.9	126.6	268.9	76.5	28.5	560.6	165.2	70.4
2009	560.0	299.4	127.7	270.6	77.1	28.8	567.4	170.5	72.7
2010	560.0	302.3	128.9	272.5	77.5	29.0	569.6	173.8	74.1
2011	565.0	303.9	129.6	272.3	77.2	28.9	568.6	176.2	75.1
2012	565.0	308.3	131.5	273.6	77.9	29.2	572.3	179.4	76.5
2013	565.0	314.5	134.1	278.3	79.1	29.8	575.1	180.1	76.8
2014	565.0	318.7	135.9	274.1	78.7	29.4	575.0	182.4	77.8

Results of gross energy intake and emission factors calculation for non-dairy cattle from enteric fermentation are summarized in Table 5.12.

Table 5.12 Gross energy (GE) intake (MJ day^{-1}) and methane emission factors (EF) from Enteric Fermentation for Non-dairy Cattle sub-groups (kg CH_4 head^{-1} year^{-1}), 2014

Non-dairy Cattle sub-groups		GE	EF
Young cattle under 1 year	dairy cattle calves	58.2	18.6
	beef cattle calves	74.8	23.9
Young cattle aged from 1 to 2 years	dairy cattle	96.0	40.9
	beef cattle	123.2	52.5
Mature non-dairy cattle over 2 years	bulls	215.3	91.8
	heifers	127.1	54.2
	other cows	217.4	92.7
IPCC default			57

5.2.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6. The uncertainty associated with livestock population varies widely depending on the source, but according to 2006 IPCC Guidelines should be known within +20%. However, according to received information from CSB of Latvia, uncertainty of activity data describing numbers of livestock could be 2-3%. Generally, the uncertainty of activity data provided by CSB of Latvia is set as 2%. 2006 IPCC Guidelines declare that emission factors estimated using the Tier 1 method are unlikely to be known more accurately than +30% and may be uncertain to +50%. Tier 2 method is likely to be in the order of +20%[127].

According to the assumptions above, emission factors estimated using the Tier 1 method is set to be uncertain of 40%, but uncertainty of emission factors estimated by the Tier 2 is set as 20%.

5.2.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the agriculture sector in order to achieve these quality objectives. Quality control meetings are held annually between experts.

Activity data check. Livestock data were checked by an inventory compiler and CSB specialist. Livestock age sub-groups data that were collected by extrapolating methods are compared with statistical data of CSB to achieve correct total numbers. Data collection methods are documented in agriculture sector inventory compilers data base for GHG inventory purposes.

Review of emission factors. Country-specific emission factors derived with Tier 2 method are cross-checked against the IPCC defaults. Results of comparison of emission factors for methane emission from enteric fermentation of dairy cows and non-dairy cattle are shown below (Table 5.13):

Table 5.13 Review of emission factors for enteric fermentation methane emissions

Category	Source	EF (kg CH_4 $head^{-1}year^{-1}$)
Dairy cows	Latvia, Tier 2, 2014	135.9
	2006 IPCC Guidelines (Western Europe)[128]	117.0
Non-dairy cattle	Latvia, Tier 2, 2014 (average)	53.5
	2006 IPCC Guidelines (Western Europe)[58]	57.0

Latvia uses higher emission factor for dairy cows based on a different feeding situation that is not totally characterized as stall fed (set for Tier 1). Also digestibility used for calculations of emission coefficient is lower (65% against 70% for Tier 1). In average enteric fermentation

[127] *2006 IPCC Guidelines. Volume 4, Chapter 10, page 10.33*
[128] *2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.11, page 10.29*

methane emission factor for non-dairy cattle is slightly lower than IPCC default, caused mainly by different feeding situation in Latvia.

5.2.5 Category-specific recalculations

For 2016 submission the main recalculations of methane emissions for the period 1900-2014 are done based on the implementation of new reporting categories for non-dairy cattle; implementation of new methodology to determine manure management and feeding situation distribution for all livestock; updating information of cattle weights based on latest expert judgements and adjusting amount of milk production per day to lactation period. Also new livestock category as *deer* is included in the inventory.

5.2.6 Category-specific planned improvements

Updating of digestible energy as percent of gross energy for cattle, according to feeding situation research is planned for the next inventory.

5.3 MANURE MANAGEMENT (CRF 3.B)

5.3.1 Category description

The emission sources cover management of manure from domestic livestock. Latvia reports methane (CH_4) and nitrous oxide (N_2O) emissions from cattle (including groups represented in the chapter 1.2), sheep, swine (including mature swine as breeding sows and boars, piglets under 50 kg of weight, young breeding sows and fattening pigs), horses, goats and poultry (including layers, broilers, turkeys, ducks, geese and other poultry), as well as rabbits, fur-bearing animals and deer (Table 5.14).

When organic matter in livestock manure decomposes in anaerobic environment, methanogenic bacteria produce methane. The amount of methane produced from manure depends on livestock type and diet, special feeding and digestibility of food, as well as waste management system. The nitrous oxide estimated in this section is the nitrous oxide produced during the storage and treatment of manure before it is applied to land. Production of nitrous oxide during storage and treatment of animal waste occurs via combined nitrification-denitrification of nitrogen in animal waste.

Table 5.14 Reported emissions under the subcategory manure management

CRF	Source	Emissions reported	Level
3.B 1	Dairy Cattle / Non-dairy Cattle (other mature and growing cattle)	CH_4, N_2O	Tier 2, Tier 2
3.B 2	Sheep	CH_4, N_2O	Tier 1, Tier 2
3.B 3	Swine	CH_4, N_2O	Tier 2, Tier 2
3.B 4	Other – Buffalo	NO	NA
3.B 4	Other – Camels	NO	NA
3.B 4	Other – Deer	CH_4, N_2O	Tier 1, Tier 2
3.B 4	Other – Goats	CH_4, N_2O	Tier 1, Tier 2
3.B 4	Other – Horses	CH_4, N_2O	Tier 1, Tier 2
3.B 4	Other – Mules and asses	NO	NA
3.B 4	Other – Poultry	CH_4, N_2O	Tier 1, Tier 2
3.B 4	Other – Rabbits	N_2O	Tier 1, Tier 1
3.B 4	Other – Fur-bearing animals	N_2O	Tier 1, Tier 1

Methane emissions from manure management have decreased by 47.5% over the time period of 1990-2014 (Table 5.15). In 2014, methane emissions from manure management of domestic livestock increased by 0.21 kt or 5.5% compared with 2013. In 2014, total nitrous oxide emissions (including direct and indirect emissions) reached 0.35 kt. Direct nitrous oxide emissions decreased by 66.5% over the time period of 1990-2014 (Table 5.16).

Table 5.15 Methane emissions from manure management by livestock category, 1990-2014 (kt)

Year	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Poultry	Rabbits	Fur-bearing animals	Deer	Total CH_4
1990	3.42	1.02	0.03	2.62	0.001	0.05	0.26	0.016	0.18	ND	7.58
1991	3.38	0.97	0.03	2.36	0.001	0.05	0.26	0.018	0.18	ND	7.24
1992	2.98	0.77	0.03	1.73	0.001	0.04	0.14	0.016	0.18	ND	5.88
1993	2.20	0.38	0.02	1.07	0.001	0.04	0.11	0.013	0.18	ND	4.01
1994	2.04	0.28	0.02	1.04	0.001	0.04	0.09	0.012	0.15	ND	3.68
1995	2.00	0.28	0.01	1.23	0.001	0.04	0.10	0.012	0.15	ND	3.82
1996	1.98	0.27	0.01	0.91	0.001	0.04	0.10	0.011	0.14	ND	3.47
1997	2.05	0.25	0.01	0.92	0.001	0.04	0.09	0.007	0.06	ND	3.42
1998	1.97	0.22	0.01	0.91	0.001	0.03	0.08	0.008	0.04	ND	3.28
1999	1.73	0.20	0.01	0.94	0.001	0.03	0.09	0.006	0.06	ND	3.05
2000	1.82	0.19	0.01	0.93	0.001	0.03	0.08	0.009	0.07	ND	3.13
2001	2.13	0.20	0.01	1.07	0.001	0.03	0.09	0.012	0.08	ND	3.62
2002	2.10	0.21	0.01	1.19	0.002	0.03	0.10	0.011	0.08	ND	3.72
2003	2.08	0.23	0.01	1.22	0.002	0.02	0.10	0.012	0.08	ND	3.75
2004	2.06	0.22	0.01	1.17	0.002	0.02	0.10	0.011	0.10	ND	3.69
2005	2.11	0.23	0.01	1.21	0.002	0.02	0.10	0.008	0.10	ND	3.80
2006	2.18	0.24	0.01	1.22	0.002	0.02	0.11	0.007	0.12	0.001	3.92
2007	2.31	0.27	0.01	1.27	0.002	0.02	0.12	0.008	0.12	0.001	4.14
2008	2.34	0.26	0.01	1.20	0.002	0.02	0.11	0.005	0.13	0.002	4.09
2009	2.39	0.27	0.01	1.18	0.002	0.02	0.12	0.004	0.11	0.002	4.10
2010	2.31	0.28	0.01	1.15	0.002	0.02	0.12	0.003	0.11	0.002	4.01
2011	2.39	0.28	0.02	1.09	0.002	0.02	0.10	0.003	0.12	0.003	4.03
2012	2.28	0.30	0.02	0.91	0.002	0.02	0.10	0.003	0.16	0.003	3.79
2013	2.28	0.32	0.02	0.88	0.002	0.02	0.10	0.003	0.16	0.003	3.77
2014	2.49	0.34	0.02	0.83	0.002	0.02	0.08	0.003	0.21	0.004	3.98
Share of total % in 2014	62.4%	8.5%	0.4%	20.7%	0.0%	0.4%	1.9%	0.1%	5.4%	0.1%	100.0%
2014 versus 2013	+9.2%	+6.1%	+9.1%	-6.3%	-2.4%	-5.6%	-23.6%	-1.5%	+35.5%	+14.2%	+5.5%
2014 versus 1990	-27.3%	-66.9%	-43.8%	-68.4%	+127.8%	-67.3%	-70.6%	-80.2%	+20.6%	ND	-47.5%

In 2014, direct emissions from manure management increased by 0.01 kt or 2.4% compared to 2013. The fluctuation of emissions is related to the variation of animal numbers, as well as changes in the distribution of livestock MMS. Similarly indirect nitrous oxide emissions

decreased by 69.5% over the time period of 1990-2014, showing the tendency to increase by 2.2% in the last inventory year compared to 2013 (Table 5.16).

Table 5.16 Nitrous oxide emissions from manure management by livestock category, 1990-2014* (kt)

Year	Dairy cattle	Non-dairy cattle	Sheep	Swine	Goats	Horses	Poultry	Rabbits	Fur-bearing animals	Deer	Total direct, N_2O	Total indirect, N_2O
1990	0.32	0.09	0.006	0.137	0.000	0.010	0.038	0.012	0.017	ND	0.62	0.46
1991	0.31	0.08	0.007	0.120	0.000	0.010	0.039	0.014	0.017	ND	0.60	0.44
1992	0.28	0.07	0.006	0.087	0.000	0.009	0.021	0.013	0.017	ND	0.50	0.35
1993	0.20	0.04	0.004	0.053	0.000	0.008	0.016	0.010	0.017	ND	0.35	0.23
1994	0.18	0.03	0.003	0.049	0.000	0.009	0.014	0.010	0.014	ND	0.31	0.21
1995	0.17	0.03	0.003	0.058	0.000	0.009	0.016	0.010	0.014	ND	0.31	0.21
1996	0.18	0.03	0.002	0.040	0.000	0.008	0.015	0.009	0.013	ND	0.29	0.19
1997	0.18	0.02	0.002	0.040	0.000	0.007	0.014	0.006	0.006	ND	0.28	0.18
1998	0.17	0.02	0.001	0.038	0.000	0.007	0.013	0.006	0.004	ND	0.26	0.17
1999	0.14	0.02	0.001	0.037	0.000	0.006	0.013	0.005	0.006	ND	0.23	0.15
2000	0.14	0.02	0.001	0.036	0.000	0.006	0.013	0.007	0.006	ND	0.23	0.15
2001	0.15	0.02	0.001	0.039	0.000	0.006	0.015	0.010	0.008	ND	0.25	0.16
2002	0.14	0.02	0.001	0.041	0.001	0.006	0.016	0.009	0.008	ND	0.25	0.16
2003	0.14	0.02	0.001	0.040	0.001	0.005	0.015	0.009	0.008	ND	0.24	0.16
2004	0.14	0.02	0.001	0.037	0.001	0.005	0.016	0.009	0.009	ND	0.23	0.16
2005	0.14	0.02	0.003	0.037	0.001	0.005	0.016	0.006	0.009	ND	0.24	0.15
2006	0.14	0.02	0.003	0.036	0.001	0.004	0.017	0.006	0.012	0.000	0.24	0.15
2007	0.14	0.03	0.004	0.037	0.001	0.004	0.018	0.006	0.012	0.000	0.24	0.15
2008	0.13	0.02	0.005	0.034	0.001	0.004	0.017	0.004	0.013	0.000	0.23	0.15
2009	0.13	0.02	0.006	0.032	0.001	0.004	0.018	0.003	0.011	0.000	0.23	0.14
2010	0.12	0.02	0.006	0.031	0.001	0.004	0.018	0.002	0.011	0.000	0.22	0.14
2011	0.12	0.02	0.006	0.028	0.001	0.004	0.015	0.003	0.012	0.000	0.22	0.14
2012	0.12	0.02	0.007	0.023	0.001	0.004	0.015	0.002	0.015	0.000	0.21	0.14
2013	0.11	0.02	0.007	0.021	0.001	0.004	0.015	0.002	0.015	0.000	0.20	0.14
2014	0.12	0.03	0.007	0.019	0.001	0.003	0.011	0.002	0.021	0.000	0.21	0.14
Share of total % in 2014	56.6%	12.3%	3.6%	9.1%	0.5%	1.6%	5.4%	1.2%	9.8%	0.0%	100.0%	
2014 versus 2013	+3.3%	+4.8%	+9.1%	-10.4%	-2.4%	-5.6%	-24.0%	-1.5%	+35.5%	0.0%	+2.4%	+2.2%
2014 versus 1990	-62.9%	-70.1%	+21.8%	-86.1%	+393.5%	-66.6%	-70.1%	-80.2%	+20.6%	ND	-66.5%	-69.5%

***emissions from pasture not included, they are reported under 3.D Managed soils*

5.3.2 Methodological issues

The 2006 IPCC Guidelines include two tiers to estimate emissions from livestock manure. The Tier 1 approach requires livestock population data by animal species/category and climate region in order to estimate emissions. The Tier 2 approach requires detailed information on

animal characteristics and the manner in which manure is managed; it is encouraged to be used for countries where a particular livestock species/category represents a significant share of emissions. The process of developing Tier 2 emission factors involves determining the mass of volatile solids excreted by the animals (VS, in kg) along with the maximum methane producing capacity for the manure (Bo, in m^3 kg of VS). In addition, a methane conversion factor (MCF) that accounts for the influence of climate on methane production must be obtained for each manure management system.

Methane emissions from manure management for sheep, goats, horses, poultry (divided as layers broilers, turkeys, ducks, geese and others), rabbits, fur-bearing animals and deer were calculated by using Tier 1 methodology by multiplying the number of the animals with the default emission factor for each animal category according to the 2006 IPCC Guidelines[129]:

$$CH_4\ manure = \sum_{(T)} \frac{\left(EF_{(T)} \cdot N_{(T)}\right)}{10^6}$$

where:
$CH_{4\ Manure}$ = CH_4 emissions from manure management, for a defined population, kt CH_4 yr^{-1}
$EF_{(T)}$ = emission factor for the defined livestock population, kg CH_4 $head^{-1}$ yr^{-1}
$N_{(T)}$ = the number of head of livestock species / category T in the country
T = species/category of livestock

Emission factors for Tier 1 methodology calculations were chosen as for *cool* climate region and are represented in Table 5.17. The original source of default emission factors is 2006 IPCC Guidelines[130]. Emission factor for deer is derived based on studies of Karlengen (2012)[131].

Table 5.17 Methane emission factors from manure management

Animal category	Emission factor (kg $head^{-1}$ $year^{-1}$)
Sheep	0.19
Goats	0.13
Horses	1.56
Layers	0.03
Broilers and others	0.02
Turkeys	0.09
Ducks	0.02
Geese	0.02
Rabbits	0.08
Fur-bearing animals	0.68
Deer	0.29

For dairy cattle, non-dairy cattle and swine the Tier 2 approach was used for estimating methane emissions from manure management systems as dairy cattle and swine represent a significant share of total emissions from agriculture sector. This method requires detailed information on animal characteristics and the manner in which manure is managed.

[129] *2006 IPCC Guidelines. Volume 4, Chapter 10, Equation 10.22, page 10.37*
[130] *2006 IPCC Guidelines. Volume 4, Chapter 10, Tables 10.15 and 10.16, page 10.40-10.41*
[131] *Karlengen, I. J., Svihus, B., Kjos, N. P. & Harstad, O. M. (2012): Husdyrgjødsel; oppdatering avmengder gjødsel og utskillelse av nitrogen, fosfor og kalium. Sluttrapport. (Manure; anupdate of amounts of manure and excretion of nitrogen, phosphorus and potassium. Final report). Ås: Departement of Animal and Aquacultural Sciences, Norwegian University of LifeSciences (Institutt for husdyr- og akvakulturvitenskap, NMBU-Norges miljø- ogbiovitenskapelige universitet)*

Methane emission factors for cattle and swine were derived from the 2006 IPCC Guidelines[132]:

$$EF_T = (VS_T \cdot 365) \cdot \left[B_{O(T)} \cdot 0.67 \frac{kg}{m^3} \cdot \sum_{S,k} \frac{MCF_{S,k}}{100} \cdot MS_{T,S,k} \right]$$

where:

$EF_{(T)}$ = annual CH_4 emission factor for livestock category T, kg CH_4 animal^{-1} yr^{-1}

$VS_{(T)}$ = daily volatile solid excreted for livestock category T, kg dry matter animal^{-1} day^{-1}

$Bo_{(T)}$ = maximum methane producing capacity for manure produced by livestock category T, m^3 CH_4 kg^{-1}of VS excreted

$MCF_{(S,k)}$ = methane conversion factors for each manure management system by climate region k, % (Solid Storage – 2%, Liquid Storage (with crust) – 10%, Pasture/Range/Paddock – 1%;Anaerobic Digester – 2% as represented in table 10.17, page 10.44, 2006 IPCC)

$MS_{(T,S,k)}$ = fraction of livestock category manure handled using manure management system in climate region k, dimensionless

0.67 = conversion factor of m^3 CH_4 to kilograms CH_4

365 = basis for calculating annual VS production, days yr^{-1}

Default methane conversion factor[133] MCF values for manure management systems: solid storage – 2%, liquid storage (with crust) – 10%, pasture/range/paddock – 1%; as well as methane producing capacities[134] B_0 (0.24 for dairy cows, 0.17 for other cattle and 0.45 for swine) are used in Latvia's National Greenhouse Gas Inventory 2016. In response to question raised by Technical expert review team (TERT) during European Union Effort sharing decision (EU ESD) voluntary review in 2015, the estimation of methane emissions from anaerobic digesters now consider MCF value 2%. For anaerobic digester 2006 IPCC Guidelines recommends MCF in the range from 0 to 100%. Based on available information and expert judgement from Latvian Biogas Association, it is assumed that anaerobic digestation completely is referred to energy production and storage of manure for a given period before transfer to the digester is not typical for Latvia. While national study will proceed, that is required from TERT, methane leakage around 2% from biogas production will be implemented in the national inventory based on Swedish experience[135].

In 2014, significant part of laying hens manure is used for biogas production. According to information provided above, methane emissions form laying hens estimated by Tier 1 are corrected by fallowing assumption:

$$CH_{4\ layer\ manure} = \\ = N_{(L)} \bullet EF_{(L)} \bullet \left(1 - MMS(anaerobic\ digester)\right) + N_{(L)} \bullet EF_{(L)} \bullet \\ \bullet MMS(anaerobic\ digester) \bullet 2\%$$

where:

CH_4 layer manure = CH_4 emissions from manure management, for laying hens, kt CH_4 yr^{-1}

$N_{(L)}$ = the number of laying hens

$EF_{(L)}$ = emission factor for the laying hens population, kg CH_4 head^{-1} yr^{-1}, Table 5.17

MMS (anaerobic digester) = share of manure digested

[132] *2006 IPCC Guidelines. Volume 4, Chapter 10, Equation 10.23, page 10.41*

[133] *2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.17, page 10.44*

[134] *2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10A-4, 10A-5, 10A-7, page 10.77-10.80*

[135] *Jonerholm K., Lundborg H. (2012) Methane losses in the biogas system. Available at http://www.balticbiogasbus.eu/web/Upload/Supply_of_biogas/Act_4_6/Annex/Methane%20losses.pdf*

Daily volatile solid (VS) excretion rate (per day on a dry-matter weight basis) was estimated as represented in the 2006 IPCC Guidelines[136]:

$$VS = \left[GE \cdot \left(1 - \frac{DE\%}{100}\right) + (UE \cdot GE)\right] \cdot \left[\left(\frac{1 - ASH}{18.45}\right)\right]$$

where:
VS = volatile solid excretion per day on a dry-organic matter basis, kg VS day^{-1}
GE = gross energy intake, MJ day^{-1}
DE% = digestibility of the feed in percent (65% for cattle, 80% for breeding swine and fattening pigs, 85% for piglets under 50 kg)
(UE • GE) = urinary energy expressed as fraction of GE (0.04•GE are considered as urinary energy)
ASH = the ash content of manure calculated as a fraction of the dry matter feed intake (0.08 for cattle and 0.02 for swine)
18.45 = conversion factor for dietary GE per kg of dry matter (MJ kg^{-1})

Results of calculation of the country specific methane emissions factors from manure management are included in Table 5.18.

Table 5.18 Daily volatile solid (VS) values and methane emission factors (EF) of manure management for cattle, 1990-2014

Year	Dairy cows		Growing Cattle		Other Mature Cattle	
	VS (kg day^{-1})	EF (kg CH_4 head^{-1} year^{-1})	VS (kg day^{-1})	EF (kg CH_4 head^{-1} year^{-1})	VS (kg day^{-1})	EF (kg CH_4 head^{-1} year^{-1})
1990	4.70	6.39	1.56	1.09	2.97	1.59
1991	4.59	6.35	1.55	1.09	2.97	1.59
1992	4.38	6.19	1.51	1.12	2.97	1.59
1993	4.37	6.27	1.50	1.12	2.97	1.59
1994	4.49	6.55	1.52	1.11	2.98	1.59
1995	4.60	6.84	1.53	1.12	2.97	1.59
1996	4.71	7.21	1.51	1.12	2.97	1.59
1997	4.94	7.80	1.51	1.12	2.99	1.60
1998	5.02	8.14	1.51	1.13	2.92	1.56
1999	5.01	8.39	1.49	1.13	2.91	1.55
2000	5.14	8.90	1.48	1.11	2.87	1.53
2001	5.23	10.18	1.46	1.09	2.97	1.59
2002	5.17	10.26	1.48	1.12	3.00	1.60
2003	5.54	11.18	1.50	1.14	3.03	1.62
2004	5.37	11.04	1.47	1.11	3.09	1.65
2005	5.47	11.42	1.48	1.10	3.25	1.74
2006	5.57	11.95	1.49	1.14	3.28	1.75
2007	5.67	12.82	1.50	1.15	3.40	1.82
2008	5.77	13.72	1.49	1.15	3.21	1.72
2009	5.82	14.44	1.50	1.15	3.31	1.77
2010	5.88	14.09	1.51	1.15	3.38	1.80
2011	5.91	14.54	1.50	1.15	3.43	1.83
2012	6.00	13.86	1.52	1.15	3.49	1.86
2013	6.12	13.80	1.54	1.15	3.50	1.87
2014	6.20	14.98	1.53	1.13	3.55	1.89

[136] *2006 IPCC Guidelines. Volume 4, Chapter 10, Equation 20.24, page 10.42*

Country specific methane emissions factors for non-dairy cattle groups are lower than IPCC default emission factor, because the amount of manure stored in liquid/ slurry based systems for non-dairy cattle in Latvia is assumed to be zero, that is lower than IPCC default share (Table 5.18, Table 5.19).

Table 5.19 Daily volatile solid (VS) values and methane emission factors (EF) of manure management for non-dairy cattle sub-groups, 2014

Non-dairy cattle sub-groups		VS (kg day^{-1})	EF (kg CH_4 head^{-1} year^{-1})
Young cattle under 1 year	dairy cattle calves	1.13	0.96
	beef cattle calves	1.46	0.78
Young cattle aged from 1 to 2 years	dairy cattle	1.87	1.58
	beef cattle	2.40	1.28
Mature non-dairy cattle over 2 years	bulls	4.19	2.24
	heifers	2.47	1.32
	other cows	4.23	2.26
IPCC default[137]			6

As Tier 2 methodology to estimate methane emissions from manure management requires information of gross energy intake by swine, but enteric fermentation emission for swine was derived by Tier 1 methodology, the Estonian inventory[138] approach to calculate gross energy intake based on swine live weight and digestible energy was adopted:

$$GE = \frac{ME}{DE\%}$$

where:
GE = gross energy intake, MJ day^{-1}
DE% = digestible energy as percentage of gross energy, %
ME =2.0 x W = energy intake for maintenance and growth MJ day^{-1}
W = live weight of swine, kg

Feed digestibility data for swine are taken from 2006 IPCC Guidelines: 80% for breeding sows, boars, young breeding sows and fattening pigs (IPCC suggested range 70-80% for confinement mature swine) and 85% for piglets (IPCC suggested range 80-90% for confinement growing swine[139]).

Results of the calculation of methane emission from manure management for swine are presented in Table 5.20.

Table 5.20 Estimation parameters and emission factors (EF) of methane emission from manure management for swine, 1990-2014

Year	Weight (head^{-1} year^{-1})	GE (MJ day^{-1})	VS (kg day^{-1})	EF(kg CH_4 head^{-1} year^{-1})
1990	74.6	35.4	0.40	1.87
1991	73.6	35.1	0.39	1.89
1992	76.8	36.0	0.40	2.00
1993	85.7	38.6	0.44	2.22
1994	75.1	35.5	0.40	2.08
1995	80.2	36.8	0.41	2.23

[137] *2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.14, page 10.38*
[138] *Estonian NIR (2015). Available at: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8812.php*
[139] *2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.2, page 10.14*

Year	Weight (head^{-1} year^{-1})	GE (MJ day^{-1})	VS (kg day^{-1})	EF(kg CH_4 head^{-1} year^{-1})
1996	66.6	32.5	0.35	1.99
1997	70.6	33.5	0.37	2.13
1998	68.9	32.9	0.36	2.16
1999	70.1	33.7	0.37	2.32
2000	69.0	33.5	0.37	2.37
2001	68.6	33.2	0.37	2.49
2002	67.9	33.1	0.37	2.61
2003	67.9	33.1	0.36	2.74
2004	64.3	31.7	0.34	2.69
2005	65.0	31.9	0.35	2.83
2006	65.8	32.2	0.35	2.94
2007	66.9	32.5	0.36	3.06
2008	66.3	32.4	0.35	3.13
2009	65.0	31.8	0.35	3.13
2010	65.4	32.0	0.35	2.95
2011	64.5	31.6	0.34	2.91
2012	62.9	31.2	0.34	2.56
2013	62.5	31.1	0.34	2.40
2014	64.3	31.8	0.35	2.36

Table 5.21 shows main methane emission calculation results for all swine sub-groups and default manure management methane emission coefficients recommended by IPCC for Western Europe. Estimated emission coefficients are lower than IPCC default mainly explained by different distribution of manure management systems.

Table 5.21 Typical animal weight, average gross energy (GE) intake, volatile solid (VS) values and emission factors (EF) for estimation of methane emission from manure management for swine sub-groups, 2014

Swine sub-groups	Number, (thousand heads)	Weight, (head^{-1} year^{-1})	GE, (MJ day^{-1})	VS, (kg day^{-1})	EF, (kg CH_4 head^{-1} year^{-1})
Piglets under 50 kg of weight (under 4 months)	169.9	27.5	19.0	0.17	1.16
Young breeding sows and fattening pigs	151.7	75.0	38.0	0.44	3.02
Mature breeding sows and boars	27.7	232	77.3	0.90	6.14
IPCC default[140]					6-9

2006 IPCC Guidelines methodology was used for estimating nitrous oxide emission from manure management by multiplying the total amount of N excretion (from all animal species/categories) in each type of manure management system by an emission factor for that type of manure management system. Emissions are then summed over all manure management systems. Direct nitrous oxide emissions (kg N_2O yr^{-1}) from manure management have been calculated by using 2006 IPCC Guidelines[141]:

$$N_2O_{D(mm)} = \left[\sum_S \left[\sum_T \left(N_{(T)} \cdot Nex_{(T)} \cdot MS_{(T,S)}\right)\right] \cdot EF_{3(S)}\right] \cdot \frac{44}{28}$$

[140] *2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.14, page 10.38 (Western Europe)*
[141] *2006 IPCC Guidelines. Volume 4, Chapter 10, Equation 20.25, page 10.54*

where:
$N_2O_{D(mm)}$ = direct N_2O emissions from Manure Management in the country, kg N_2O yr^{-1}
$N_{(T)}$ = number of head of livestock species/category T in the country
$Nex_{(T)}$ = annual average N excretion per head of species/category T in the country, kg N $animal^{-1}$ yr^{-1}
$MS_{(T,S)}$ = fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system in the country, dimensionless
$EF_{3(S)}$ = emission factor for direct N_2O emissions from manure management system S in the country, kg N_2O-N kg^{-1} N in manure management system
S = manure management system
T = species/category of livestock

The amount of nitrogen excreted annually per animal has been divided among different manure management systems and multiplied with the IPCC default emission factor for each manure management system. The manure management systems (S) reported in the inventory are:

- liquid system;
- solid storage;
- pasture/range/paddock;
- anaerobic digester.

Following emission factors for direct nitrous oxide emissions from manure management were implemented: EF_3 = 0.005 for liquid manure/slurry with natural crust cover; EF_3 = 0.005 for solid storage; EF_3 = 0 for pasture/range/paddock; EF_3 = 0 for digester (2006 IPCC Guidelines[142]). Data about the distribution of MMS according to the national studies are available in Annex A.3.7 Agriculture. Nitrous oxide emissions from pasture are calculated under manure management, but are reported under category *Urine and dung deposited by grazing animals* in CRF 3.D.

Data of N excretion during the year per each livestock category used for the inventory are country specific and are obtained from national studies[143] or calculated fallowing by 2006 IPCC Guidelines. IPCC default annual average nitrogen excretion rate was used for rabbits and fur-bearing animals[144]. EMEP/EEA recommended N excretion values are used for poultry, except layers[145]. N excretion rate for deer is adopted from Norwegian inventory[146] as average value represented for deer and reindeer. All N excretion values used in the inventory are represented in Table 5.22.

Table 5.22 Average N excretions per head of animal (N, kg $year^{-1}$)

Livestock category	1990-2004	2005-2014	Source
Sheep	6	13	National studies
Goats	6	13	National studies
Horses	46	47	National studies
Layers	0.6	0.6	National studies
Broilers and others	0.36	0.36	EMEP/EEA 2013
Turkeys	1.64	1.64	EMEP/EEA 2013

[142] 2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.21, page 10.62
[143] Fertiliser Recommendations for Agricultural Crops (2013) Ed.A. Karklins and A.Ruza. Jelgava: LLU, 55 p.
[144] 2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.19, page 10.59
[145] EMEP/EEA Air pollutant emission inventory guidebook (2013) 3.B Manure management. European Environment Agency. Table 3.7, page 27
[146] Norwegian NIR (2015) Available at:
http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8812.php

Livestock category	1990-2004	2005-2014	Source
Ducks	1.26	1.26	EMEP/EEA 2013
Geese	0.55	0.55	EMEP/EEA 2013
Rabbit	8.1	8.1	IPCC default
Fur – bearing animals	8.34	8.34	IPCC default
Deer	9	9	Norwegian NIR

Values about annual N excretion ($Nex_{(T)}$) per animal for dairy cattle and non-dairy cattle were calculated according to *IPCC* Tier 2 methodology[147]:

$$Nex_{(T)} = N_{intake} \cdot (1 - N_{retention})$$

where:
$Nex_{(T)}$ = annual N excretion rates, kg N animal^{-1} yr^{-1}
$N_{intake\ (T)}$ = the annual N intake per head of animal of species/category T, kg N animal^{-1} yr^{-1}
$N_{retention\ (T)}$ = fraction of annual N intake that is retained by animal of species/category T, dimensionless

The daily N intake per head of each cattle category is calculated as[148]:

$$N_{intake\ (T)} = \frac{GE}{18.45} \cdot \left(\frac{\frac{CP\%}{100}}{6.25} \right)$$

where:
$N_{intake\ (T)}$ = daily N consumed per animal of category T, kg N animal^{-1} day^{-1}
GE = gross energy intake of the animal, MJ animal^{-1} day^{1}
18.45 = conversion factor for dietary GE per kg of dry matter, MJ kg^{-1}
CP% = percent crude protein in diet, input
6.25 = conversion from kg of dietary protein to kg of dietary N, kg feed protein (kg N^{-1})

The daily N retention per animal head of species/category is estimated as[149]:

$$N_{retention\ (T)} = \left[\frac{Milk \cdot \frac{(Milk\ PR\%)}{100}}{6.38} \right] + \left[\frac{WG \cdot \left[268 - \left(\frac{7.03\ NE_g}{WG} \right) \right]}{\frac{1000}{6.25}} \right]$$

where:
N retention(T) = daily N retained per animal of category T, kg N animal^{-1} day^{-1}
Milk = milk production, kg animal^{-1} day^{-1} (dairy cows only)
Milk PR% = percent of protein in milk, calculated as [1.9 + 0.4 · %Fat]
6.38 = conversion from milk protein to milk N, kg Protein (kg N)$^{-1}$
WG = weight gain, input for each livestock category, kg day^{-1}
268 and 7.03 = constants
Neg = net energy for growth, MJ day^{-1}
6.25 = conversion from kg dietary protein to kg dietary N, kgProtein (kg N)$^{-1}$

Crude protein (CP) values are adopted from national studies regarding to feeding requirements for cattle[150] Based on milk yield and milk fat content data, CP=14% (1990-1995) and CP=15% is set for dairy cows. For other cattle CP values ranging from 9% to 14%.

[147] *2006 IPCC Guidelines. Volume 4, Chapter 10, Equation 10.31, page 10.58*
[148] *2006 IPCC Guidelines. Volume 4, Chapter 10, Equation 10.32, page 10.58*
[149] *2006 IPCC Guidelines. Volume 4, Chapter 10, Equation 10.33, page 10.60*
[150] *Latvietis J. (1994) Govju ēdināšanas normas. Jelgava: LLU, p.102*

Annual N excretion rate for swine is derived by IPCC methodology[151] by using typical animal mass (TAM) data:

$$Nex_{(T)} = N_{rate} \cdot \frac{TAM}{1000} \cdot 365$$

where:
$N_{ex\,(T)}$ = annual N excretion rates, kg N animal^{-1} yr^{-1}
$N_{rate\,(T)}$ = default N excretion rate, kg N (1000 kg mass) $^{-1}$ day^{-1}(Market swine=0.52, Breeding swine=0.42[152])
TAM = typical anima mass, kg livestock^{-1}

Calculated values of N excretion ($N_{ex(T)}$) per animal for dairy cattle, non-dairy cattle and swine for reporting in CRF are represented in Table 5.23.

Table 5.23 N excretion rates for dairy, non-dairy cattle and swine, 1990-2014 (kg N animal^{-1} yr^{-1})

Year	Dairy Cattle	Growing Cattle	Other Mature Cattle	Swine
1990	85.8	20.1	58.6	12.4
1991	84.6	20.1	58.6	12.3
1992	82.2	19.9	58.6	12.8
1993	82.1	19.7	58.6	14.1
1994	83.5	19.8	58.6	12.5
1995	84.7	20.0	58.5	13.3
1996	93.8	19.8	58.6	11.2
1997	96.8	19.7	58.1	11.7
1998	97.8	19.8	56.3	11.5
1999	97.7	19.6	56.0	11.7
2000	99.6	19.5	55.0	11.6
2001	100.8	19.2	57.4	11.5
2002	100.0	19.5	56.9	11.4
2003	105.2	19.7	57.3	11.4
2004	102.7	19.3	57.9	10.8
2005	104.0	19.4	58.9	10.9
2006	105.5	19.5	59.1	11.0
2007	106.9	19.8	59.2	11.2
2008	108.3	19.7	58.4	11.1
2009	108.9	19.7	59.6	10.9
2010	109.6	19.8	60.1	11.0
2011	110.2	19.7	60.3	10.8
2012	111.3	19.8	61.0	10.6
2013	112.8	20.0	61.3	10.5
2014	113.8	19.9	61.5	10.8

Detailed information on estimation results for swine subgroups is available in Table 5.24. Swine weight data are based on the judgement of Latvia University of Agriculture and Latvian pig breeding association experts.

[151] *2006 IPCC Guidelines. Volume 4, Chapter 10, Equation 10.30, page 10.57*
[152] *2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.19, page 10.59*

Table 5.24 Typical animal weight, average gross energy (GE) intake, volatile solid (VS) and emission factors (EF) for estimation of methane emission from manure management for swine sub-groups, including the number of swine, 2014

Swine sub-groups	Number (thousand heads)	Weight (kg head^{-1})	GE (MJ day^{-1})	VS (kg day^{-1})	EF (kg CH_4 head^{-1} year^{-1})
Piglets under 50 kg of weight (under 4 months)	169.9	27.5	19.0	0.17	1.16
Young breeding sows and fattening pigs	151.7	232	38.0	0.44	3.02
Mature breeding sows and boars	27.7	75.0	77.3	0.90	6.14

Latvia used country-specific data for nitrogen excretion from sheep, swine, horses, goats and poultry. In the last submission, calculations of N excretion for cattle have been based on IPCC methodology due to lack of national data for defined cattle sub-groups. After the European Union Effort sharing decision voluntary review in 2015, TERT considered possible underestimation of N excretion for swine and broilers. According TERT recommendations, Latvia changed the approach to report N excretion data for swine and poultry of estimations. Detailed information of estimated N excretion for cattle and swine sub-groups by IPCC methodology is represented in Table 5.25. During 2014-2016 Latvia makes efforts to update country-specific N excretion values based on national research data in the next inventory.

Table 5.25 N excretion rates (Nex) for nitrous oxide emissions estimation of non-dairy cattle and swine subgroups, 2014

Non-dairy cattle sub-groups		**Nex** (kg N animal^{-1} yr^{-1})
Young cattle under 1 year	dairy cattle calves	15.7
	beef cattle calves	18.5
Young cattle aged from 1 to 2 years	dairy cattle	24.7
	beef cattle	26.4
Mature non-dairy cattle over 2 years	bulls	93.9
	heifers	49.4
	other cows	65.9
Swine sub-groups		
Piglets under 50 kg of weight (under 4 months)		5.0
Young breeding sows and fattening pigs		13.0
Mature breeding sows and boars		36.0

The total quantity of excreted N by livestock among MMS implemented in Latvia and estimation results of managed manure N available for application to managed soils is summarized in Table 5.26.

Table 5.26 N excretion rates (Nex) per manure management system (MMS) and manure N available for application to managed soils (kg N animal^{-1} yr^{-1})

Year	Solid storage	Liquid systems	Pasture range and paddock	Anaerobic digester	Toal Nex per MMS	N_{MMS_Avb}
1990	72083512	7453168	16052837	NO	95589518	51212483
1991	69386461	7223344	14992170	NO	91601975	49665605
1992	57427766	6020188	11238671	NO	74686625	41871815
1993	39773585	4236245	6560358	NO	50570188	29343556

Year	Solid storage	Liquid systems	Pasture range and paddock	Anaerobic digester	Toal Nex per MMS	N $_{MMS_Avb}$
1994	34871568	4106517	5565753	NO	44543839	25896200
1995	34289070	4653114	5419438	NO	44361621	25596053
1996	32938641	4298093	5394751	NO	42631485	24597545
1997	30439812	4609528	5085023	NO	40134363	22818112
1998	27869971	4672334	4555195	NO	37097500	21109540
1999	24448036	4573689	3744870	NO	32766595	18751402
2000	24475347	4863909	3707678	NO	33046933	19047225
2001	24973043	6297529	3862869	NO	35133441	20263741
2002	24570666	6688075	3657265	NO	34916005	20190294
2003	23707518	6804851	3774626	NO	34286994	19666060
2004	22864638	6832109	3720662	NO	33417409	19215881
2005	22799788	7139076	4126192	NO	34065056	19347707
2006	22966652	7440917	4078219	NO	34485788	19669116
2007	23045353	8061401	4454149	NO	35560903	20088348
2008	21613718	8135214	4468507	NO	34217438	19225511
2009	20563609	8391709	4619252	20687	33595256	18606693
2010	20055630	7929003	4777726	1340483	34102842	17997611
2011	19550816	8031840	4883737	1661835	34128227	17836274
2012	19580180	6905556	5195731	3430828	35112295	17316215
2013	19314328	6634924	5651406	4568674	36169332	16998389
2014	19433878	7149125	6054822	4800176	37438000	16820900
Share of total % in 2014	51.9%	19.1%	16.2%	12.8%	100.0%	-
2014 versus 2013	+0.6%	+7.7%	+7.1%	+5.1%	+3.5%	-1.0%
2014 versus 1990	-73.0%	-4.1%	-62.3%	NA	-60.8%	-67.2%

As explained in 2006 IPCC Guidelines, nitrous oxide emissions calculation should be referred to Tier 2 methodology; if country specific data is included in the estimation (country specific N excretion rates constitute Tier 2 methodology)[153].

The indirect nitrous oxide emissions from volatilisation of N in forms of NH_3 and Nox from manure management are estimated as:

$$N_2O_{G(mm)} = (N_{volatilization-MMS} \bullet EF_4)$$

where:

$N_2O_{G(mm)}$ = indirect N_2O emissions due to volatilization of N from Manure Management in the country, kg N_2O yr^{-1}

$N_{volatilization-MMS}$ = amount of manure nitrogen that is lost due to volatilisation of NH_3 and Nox, kg N yr^{-1}

EF_4 = emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N_2O-N (kg NH_3-N + Nox-N volatilised)$^{-1}$; default value 0.01 kg N_2O-N (kg NH_3-N +Nox-N volatilised)$^{-1}$ is used

The indirect nitrous emissions from leaching and runoff of N from manure management systems are estimated as:

$$N_2O_{L(mm)} = (N_{leaching-MMS} \bullet EF_5)$$

where:

$N_2O_{L(mm)}$ = indirect $_{N2O}$ emissions due to leaching and runoff from Manure Management in the country, kg N_2O yr^{-1}

[153] *2006 IPCC Guidelines. Volume 4, Chapter 10, page 10.53*

$N_{leaching-MMS}$ = amount of manure nitrogen that leached from manure management systems, kg N yr^{-1}
EF_5 = emission factor for N_2O emissions from nitrogen leaching and runoff, kg N_2O-N/kg N leached and runoff (default value 0.0075 kg N_2O-N (kg N leaching/runoff)$^{-1}$

The amount of manure nitrogen that is lost due to volatilisation of NH_3 and Nox is assigned to Tier 2 approach, according to TERT suggestion after European Union Effort sharing decision voluntary review in 2015. Tier 2 methodology to calculate N that is lost due to volatilisation of NH_3 and Nox from the livestock buildings and manure storage facilities is adopted from EMEP/EEA 2013[154].

Risks related to the agricultural point source pollution of surface waters by N leaching and run-off from manure storages can be consider as significant, because the number of farms with high livestock number (more than 250 animal units), especially from pig-breeding and poultry farming branches, increasing in last years; besides many of them are located in the Nitrate Vulnerable Zone with short distance to the water bodies of national importance. Results of long-term agricultural runoff monitoring show that in the catchment basin where the large livestock farms as potential point source pollution are located, the concentrations of nitrogenous compounds are characterized by large dispersion and high maximum concentrations. Based on the measures taken at the national level in order to reduce the pollution of surface waters caused by agricultural production, the long-term agricultural point source pollution monitoring observations indicate that concentrations of pollutants show negative trends, but are still should be taken into account[155]. Values of $Frac_{Leach}$ is based on expert judgment who are involved in national agricultural point source monitoring activities under Agricultural Runoff programme. In 1990-2004, $Frac_{Leach}$ is set to 10% by reducing the value to 1% for slurry storages and 5% to solid storages till 2014. The amount of manure N that is leached from manure management systems is derived from 2006 IPCC Guidelin*es*, Equation 10.28[156].

5.3.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6. The uncertainty of the manure management system usage data depends on the characteristics of each country's livestock industry and how information on manure management is collected. 2006 IPCC Guidelines show that for one type of management system, the uncertainty associated with management system usage data can be 10% or less. However, for countries where there is a wide variety of management systems, the uncertainty range in management system usage data can be much higher, in the range of 25% to 50%, depending on the availability of reliable and representative survey data that differentiates animal populations by system usage[157]. For Latvia uncertainty of 25% is set. The uncertainty range for the default emission factors is estimated to be +30%. Improvements achieved by Tier 2 methodologies are evaluated to

[154] *EMEP/EEA Air pollutant emission inventory guidebook. (2013) 3.B Manure management. European Environment Agency, page 18*
[155] *Berzina L. (2014) Analysis of Point Source Pollution from Agricultural Production Influence on Surface Water Quality in Highly Vulnerable Zones. Summary of the Thesis for Doctoral Degree in Engineering Sciences, Environmental Science branch, Environmental Engineering subbranch. 91 p.*
[156] *2006 IPCC Guidelines. Volume 4, Chapter 10, Equation 10.28, page, 10.56*
[157] *2006 IPCC Guidelines. Volume 4, Chapter 10, page 10.50*

reduce uncertainty ranges in the emission factors to +20%. IPCC expert judgment shows that uncertainty ranges for the default N excretion rates are estimated at about +50%[158]. Latvia uses country specific values, therefore uncertainty for N excretion rates are reduced to 25%.

5.3.4 Category-specific QA/QC and verification

Activity data check. The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. General QC procedures including quality checks related to calculations, data processing, completeness, and documentation were used during the inventory. Defined manure management systems in the inventory is consistent with definitions that are presented in 2006 IPCC Guidelines Table 10.18[159]. Latvia uses country specific methodology to determine distribution of manure management systems that is available in scientific literature[160].

Review of emission factors. Country-specific emission factors were compared with IPCC defaults. Emission factors were chosen as for cool climate region by average annual temperature ≤10°C. Review results are presented in the chapter above.

Latvia uses country specific nitrogen excretion rates[161], according to the latest research results. Calculated and measured nitrogen excretion rates are compared with other countries inventory data and default factors. No significant differences were found for rates used for inventory that are within the range of values reported in other EU countries.

5.3.5 Category-specific recalculations

For 2016 submission, recalculations of emissions from manure management for period 1900-2014 are done based on implementation of new approach to calculate manure management system distribution. Nitrogen excretion values are changed for poultry and swine. Emissions from swine are calculated within three age subcategories, comparing to the previous submission, manure management emissions also is split down for poultry subgroups. MCF value 2 for anaerobic digester is implemented in the inventory, according to TERT review results. Also a new animal category as deer is included in the inventory.

Recalculations of MMS are done according to outcomes of pre-defined project "Development of the National System for Greenhouse Gas Inventory and Reporting on Policies, Measures and Projections" under 2009 – 2014 EEA Grants Programme National Climate Policy. Main differences caused by implementation of new methodology to determine MMS should be tended to liquid manure system, which was found as no typical for cattle in Latvia. Significantly, the share of pasture, range and paddock was reduced for all livestock groups, except beef cattle. Most of the large livestock farms refuse grazing to keep high productivity of animals and arrange resources in economically feasible way.

[158] *2006 IPCC Guidelines.Volume 4, Chapter 10, page 10.66*
[159] *2006 IPCC Guidelines. Volume 4, Chapter 10, Table 10.18, page 10.49*
[160] *Priekulis J., Āboltiņš A. (2015) Calculation Methodology for Cattle Manure Management Systems Based on the 2006 IPCC Guidelines. Proceedings of the 25th NJF Congress Nordic View to Sustainable Rural Development. Riga, pp.274-280*
[161] *Fertiliser Recommendations for Agricultural Crops (2013) Ed.A. Karklins and A.Ruza. Jelgava:LLU, 55 p.*

5.3.6 Category-specific planned improvements

Implementation of country specific nitrogen excretion values for all livestock groups based on latest research activities. Revision of MCF value for anaerobic digester.

5.4 AGRICULTURAL SOILS (CRF 3.D)

5.4.1 Category description

In the 2006 IPCC Guidelines, direct and indirect emissions of nitrous oxide from managed soils are estimated separately. The following N sources are included in the inventory for estimating direct nitrous oxide emissions from managed soils:

- synthetic N fertilizers (F_{SN});
- organic N fertilizers (e.g., animal manure, compost, sewage sludge, digestate) (F_{ON});
- urine and dung N deposited on pasture, range and paddock by grazing animals (F_{PRP});
- N in crop residues (above-ground and below-ground), including from N-fixing crops and from forages during pasture renewal (F_{CR});
- drainage/management of organic soils (F_{OS}).

Indirect nitrous oxide emissions from managed soils are determined for volatilization and leaching processes. Indirect nitrous oxide emissions included in the inventory are reported in Table 5.27.

Table 5.27 Reported emissions under the subcategory Agricultural Soils

CRF	Source	Emissions reported	Level
3.D 1.1	Inorganic N fertilizers	N_2O	Tier 1
3.D 1.2.a	Animal manure applied to soils	N_2O	Tier 1
3.D 1.2.b	Sewage sludge applied to soils	N_2O	Tier 1
3.D 1.2.c	Other organic fertilizer applied to soils	N_2O	Tier 1
3.D 1.3	Urine and dun deposited on soils	N_2O	Tier 1
3.D 1.4	Crop residues	N_2O	Tier 1
3.D 1.5	Mineralization/immobilization associated with loss/gain of soil organic matter	NO	NA
3.D 1.6	Cultivation of organic soils	N_2O	Tier 1
3.D 1.7	Other	NO	NA
3.D 2.1	Atmospheric deposition	N_2O	Tier 1
3.D 2.2	Nitrogen leaching and run-off	N_2O	Tier 1

Nitrous oxide emission from managed soils was 5.45 kt in 2014; which is 2.7% more than in 2013. In general, emission has decreased in 2014 by 30.5% comparing with 1990. The main reason for that was decreasing of all livestock numbers that affected the amount of nitrogen excreted annually to soil and low consumption of fertilizers. However, in 2014 nitrous oxide emission increased by 0.14 kt or 2.7% compared with 2013 (Table 5.28). The main reason of the increase of emission absolute number is the growing demand of synthetic fertilizers in the latest years.

In 2014, total nitrous oxide emission from managed soils originated as 87.9% from direct sources. Indirect nitrous oxide emission from volatilization formed 3.5% and from leaching – 8.6% of the nitrous oxide total emission (Table 5.28).

Table 5.28 Nitrous oxide emissions from Managed Soils, 1990-2014 (kt)

Year	N_2O direct emission	N_2O indirect emission from atmospheric deposition	N_2O indirect emission from leaching and run-off	Total
1990	6.59	0.42	0.85	7.85
1991	6.19	0.38	0.76	7.33
1992	5.10	0.27	0.53	5.90
1993	4.29	0.18	0.36	4.83
1994	3.96	0.14	0.29	4.40
1995	3.60	0.12	0.21	3.93
1996	3.67	0.12	0.23	4.02
1997	3.72	0.12	0.25	4.08
1998	3.64	0.11	0.23	3.99
1999	3.51	0.10	0.21	3.82
2000	3.58	0.11	0.23	3.91
2001	3.76	0.13	0.27	4.16
2002	3.69	0.12	0.25	4.06
2003	3.81	0.13	0.28	4.23
2004	3.78	0.13	0.28	4.18
2005	3.92	0.14	0.31	4.38
2006	3.92	0.14	0.31	4.38
2007	4.05	0.15	0.34	4.55
2008	4.08	0.15	0.35	4.58
2009	4.18	0.16	0.37	4.70
2010	4.29	0.17	0.38	4.84
2011	4.33	0.17	0.38	4.88
2012	4.60	0.18	0.44	5.21
2013	4.68	0.18	0.45	5.31
2014	4.80	0.19	0.47	5.45
Share of total % in 2014	87.9%	3.5%	8.6%	100.0%
2014 versus 2013	+2.5%	+3.3%	+4.8%	+2.7%
2014 versus 1990	-27.2%	-54.6%	-44.8%	-30.5%

In 2014, managed organic soils formed the major part of total direct emissions (54.8%), following by emission from synthetic fertilizers (23.9%), crop residues (11.6%), animal manure applied to soils (5.5%), urine and dung deposited on pasture (3.8%), and other organic N additions applied to soils (Table 5.29). Overall, nitrous oxide emissions from application of other organic fertilizer (except manure), pastures, crop residues and synthetic N fertilizer increasing most rapidly in last years. This could be explained by the fact of increased number of beef cattle grazing on pastures and expanding of sown area. During last two inventory years the production of beef increased by 5.8%. The significant growth in harvested production was mainly affected by increase of the cereal crop area. According to CSB information, in 2014 the area of cereal cropland increase by 12.2% compared to 2013. Use of mineral fertilizer N per one ha of sown area continued to grow from 61 kg in 2013 to 63 kg in 2014 and comprised in 49.7% of straight nitrogen mineral fertilizer amount applied to soils[162]. Increasing use of other organic fertilizers could be linked to expansion of anaerobic digestion of biomass and applying digestate to soil.

[162] *Agriculture in Latvia. Collection of statistical data. Central Statistical Bureau of Latvia, 2015*

Table 5.29 Nitrous oxide emissions from N inputs to managed soils, 1990-2014 (kt)

Year	F_{SN}	F_{ON} (animal manure)	F_{ON} (sludge)	F_{ON} (other)	F_{PRP}	F_{CR}	F_{OS}
1990	2.06	0.80	NO	NO	0.50	0.64	2.57
1991	1.77	0.78	NO	NO	0.47	0.61	2.58
1992	1.04	0.66	NO	NO	0.35	0.48	2.58
1993	0.62	0.46	NO	NO	0.20	0.43	2.57
1994	0.46	0.41	NO	NO	0.17	0.35	2.57
1995	0.18	0.40	NO	NO	0.17	0.28	2.57
1996	0.23	0.39	NO	NO	0.17	0.33	2.56
1997	0.30	0.36	NO	NO	0.16	0.34	2.55
1998	0.31	0.33	NO	NO	0.14	0.32	2.54
1999	0.30	0.29	NO	NO	0.12	0.27	2.53
2000	0.36	0.30	NO	NO	0.11	0.28	2.52
2001	0.50	0.32	0.024	NO	0.12	0.29	2.51
2002	0.43	0.32	0.018	NO	0.11	0.30	2.50
2003	0.59	0.31	0.007	NO	0.12	0.29	2.50
2004	0.55	0.30	0.006	NO	0.11	0.31	2.49
2005	0.64	0.30	0.005	NO	0.13	0.37	2.48
2006	0.67	0.31	0.007	NO	0.12	0.34	2.47
2007	0.72	0.32	0.006	NO	0.14	0.41	2.46
2008	0.75	0.30	0.004	NO	0.14	0.44	2.45
2009	0.82	0.29	0.005	NO	0.14	0.44	2.49
2010	0.94	0.28	0.007	0.008	0.14	0.39	2.52
2011	0.94	0.28	0.007	0.003	0.15	0.40	2.55
2012	1.02	0.27	0.006	0.007	0.16	0.54	2.58
2013	1.10	0.27	0.006	0.009	0.17	0.52	2.62
2014	1.15	0.26	0.005	0.011	0.18	0.56	2.63
Share of total % in 2014	23.9%	5.5%	0.1%	0.2%	3.8%	11.6%	54.8%
2014 versus 2013	+4.6%	-1.0%	-8.3%	+24.2%	+7.1%	+7.9%	+0.6%
2014 versus 1990	-44.5%	-67.2%	NA	NA	-63.2%	-13.7%	+2.2%

F_{SN} = synthetic N fertilizer, F_{ON} = organic N additions, F_{PRP} = urine and dang N deposited on pasture, F_{CR} = N in crop residues, F_{OS} = managed organic soil in grassland and cropland.

5.4.2 Methodological issues

For estimation of nitrous oxide emissions from managed soils the Tier 1 methodology was used. Direct nitrous oxide emissions from agricultural soils have been calculated using the following equation according to 2006 IPCC Guidelines[163] :

$$N_2O_{Direct} - N = N_2O - N_{N\,inputs} + N_2O - N_{OS} + N_2O - N_{PRP}$$

where:

$$N_2O - N_{N\,inputs} = (F_{SN} + F_{ON} + F_{CR} + F_{SOM}) \cdot EF_1$$

$$N_2O - N_{OS} = \left(F_{OS,CG,Temp} \cdot EF_{2G,Temp}\right)$$

$$N_2O - N_{PRP} = \left[\left(F_{PRP,CPP} \cdot EF_{3PRP,CPP}\right) + \left(F_{PRP,SO} \cdot EF_{3PRP,SO}\right)\right]$$

[163] *2006 IPCC Guidelines. Volume 4, Chapter 11, Equation 11.1, page 11.7*

where:
N_2O_{Direct} –N = annual direct N_2O–N emissions produced from managed soils, kg N_2O–N yr^{-1}
N_2O–$N_{N\ inputs}$ = annual direct N_2O–N emissions from N inputs to managed soils, kg N_2O–N yr^{-1}
N_2O–N_{OS} = annual direct N_2O–N emissions from managed organic soils, kg N_2O–N yr^{-1}
N_2O–N_{PRP} = annual direct N_2O–N emissions from urine and dung inputs to grazed soils, kg N_2O–N yr^{-1}
F_{SN} = annual amount of synthetic fertiliser N applied to soils, kg N yr^{-1}
F_{ON} = annual amount of animal manure, compost, sewage sludge and other organic N additions applied to soils, kg N yr^{-1}
F_{CR} = annual amount of N in crop residues (above-ground and below-ground), including N-fixing crops, and from forage/pasture renewal, returned to soils, kg N yr^{-1}
F_{SOM} = annual amount of N in mineral soils that is mineralised, in association with loss of soils C from soils organic matter as a result of changes to land use or management, kg N yr^{-1}
F_{OS} = annual area of managed/drained organic soils in grasslands and croplands, ha
F_{PRP} = annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock, kg N yr^{-1}
EF_1 = emission factor for N_2O emissions from N inputs, kg N_2O–N kg^{-1} N input
EF_2 = emission factor for N_2O emissions from drained/managed organic soils, kg N_2O–N ha^{-1} yr^{-1}
EF_{3PRP} = emission factor for N_2O emissions from urine and dung N deposited on pasture, range and paddock by grazing animals, kg N_2O–N/kg N input

Inorganic N fertilizers: CRF 3.D 1.1

Annual amount of the synthetic fertilizer N is one of the parameters to estimate direct nitrous oxide emission from N inputs to managed soils. Data of inorganic fertiliser N applied to soils are provided by CSB of Latvia. Input values for direct nitrous oxide emission calculation from inorganic N fertilizers are represented in Table 5.35.

Organic N fertilizers: CRF 3.D 1.2

Amount of the organic N fertiliser (F_{ON}) applied to soils is calculated using methodology represented in 2006 IPCC Guidelines[164]. This includes applied to soils animal manure, sewage, compost, as well as other organic amendments of regional importance to agriculture:

$$F_{ON} = F_{AM} + F_{SEW} + F_{COMP} + F_{OOA}$$

where:
F_{ON} = total annual amount of organic N fertiliser applied to soils other than by grazing animals, kg N yr^{-1}
F_{AM} = annual amount of animal manure N applied to soils, kg N yr^{-1}
F_{SEW} = annual amount of total sewage N that is applied to soils, kg N yr^{-1}
F_{COMP} = annual amount of total compost N applied to soils, kg N yr^{-1}
F_{OOA} = annual amount of other organic amendments used as fertiliser, kg N yr^{-1}

Data on the amount of sewage sludge applied to managed soils are provided by LEGMC, other data of organic N fertiliser applied to soils are obtained from CSB. Application of sewage sludge as fertilizer is relatively small in Latvia. Amounts of sewage composts are not included in the calculations. Other organic amendments used as fertiliser mainly refer to digestate. Amount of nitrogen in sewage sludge, digestate and composts are calculated based on agriculture research results done by Latvia University of Agriculture scientists,[165] other research projects [166] and Latvia University of Agriculture expert judgement. Statistics

[164] *2006 IPCC Guidelines. Volume 4, Chapter 11, Equation 11.3, page 11.12*
[165] *Gemste I., Vucāns A. (2010) Notekūdeņu dūņas. Jelgava, LLU, 276 lpp.*
[166] *Litiņa I. (2013) Digestāta kā mēslošanas līdzekļa efektivitātes novērtējums kukurūzas sējumā. Zinātniski praktiskā konference LAUKSAIMNIECĪBAS ZINĀTNE VEIKSMĪGAI SAIMNIEKOŠANAI. Jelgava, LLU, 206-209 lpp.*

of different types of organic N fertilisers applied to soils are limited in Latvia. Available data are represented in Table 5.30.

Table 5.30 Statistics of organic N fertilisers applied to soils, 2001-2014

Year	Sewage sludge applied to managed soils, t dry matter	Composts applied to managed soils, thousand t	Other organic N (digestate) applied to managed soils thousand t
2001	30946.7	NO	NO
2002	22513.9	NO	NO
2003	9230.89	NO	NO
2004	7683.7	NO	NO
2005	6545.5	NO	NO
2006	8936.4	NO	NO
2007	8131.6	NO	NO
2008	5255.2	NO	NO
2009	6686.9	NO	NO
2010	9306.5	95.5	3.7
2011	8759.5	39.9	6.1
2012	7472.6	62.2	82.5
2013	7479.2	40.4	289.9
2014	6861.2	36.2	413.9
2014 versus 2013	-8.3%	-10.4%	+42.8%

Animal manure N (F_{AM}) emits from agricultural soil through manure application to fields as an organic fertilizer. Calculation of emissions from nitrogen input through application of animal manure is done according to 2006 IPCC Guidelines[167]:

$$F_{AM} = N_{MMS\,Avb} \cdot [1 - (Frac_{FEED} + Frac_{FUEL} + Frac_{CNST})]$$

where:
F_{AM} = annual amount of animal manure N applied to soils, kg N yr^{-1}
$N_{MMS\,Avb}$ = amount of managed manure N available for soil application, feed, fuel or construction, kg Nyr^{-1}
$Frac_{FEED}$ = fraction of managed manure used for feed
$Frac_{FUEL}$ = fraction of managed manure used for fuel
$Frac_{CNST}$ = fraction of managed manure used for construction

Total annual amount of the managed manure N available for soil application (F_{MMS_Avb}) is determined by 2006 IPCC Guidelines (Chapter 10.5.4) according to the directions of estimation of N lost from manure management systems to final application on managed soils. Calculation of F_{MMS_Avb} is done by fully adopted IPCC methodology (2006 IPCC Guidelines, Volume 4, Chapter 10, Equation 10.34, p.10.65; fallowing by default values for total N loss from manure management represented in Table 10.23, p.10.67). There is no data available on the fraction of manure being used as feed, fuel or material of construction therefore F_{AM} is considered to be equal to $N_{MMS\ Abv.}$ Total annual amount of managed manure N available for soil application is determined under CRF category 3B Manure management and is represented in Table 5.26.

Urine and Dung Deposited by Grazing Animals: CRF 3.D 1.3

The term F_{PRP} refers to the annual amount of N deposited on pasture, range and paddock soils by grazing animals. F_{PRP} is estimated using 2006 IPCC Guidelines from the number of

[167] *2006 IPCC Guidelines. Volume 4, Chapter 11, Equation 11.4, page 11.13*

animals in each livestock species/category T($N_{(T)}$), the annual average amount of N excreted by each livestock species/category T ($Nex_{(T)}$), and the fraction of this N deposited on pasture, range and paddock soils by each livestock species/category T ($MS_{(T,PRP)}$)[168]:

$$F_{PRP} = \sum_{T} \left[\left(N_{(T)} \cdot Nex_{(T)} \right) \cdot MS_{(T,PRP)} \right]$$

Total annual amount of N deposited on pasture, range and paddock soils by grazing animals is determined under CRF category 3B Manure management and is represented in Table 5.26.

Total annual amount of N deposited on pasture, range and paddock soils separately for two groups: $F_{PRP, CPP}$ (cattle, poultry and swine) and $F_{PRP, SO}$ (other livestock), according to directions of nitrous oxide emissions estimation by IPCC is summarized in Table 5.35.

Crop residues: CRF 3.D 1.4

The annual production of the amount of crop residue N (F_{CR}) is estimated based on 2006 IPCC Guidelines Tier 1 methodology[169]:

$$F_{CR} = \sum_{T} \left\{ \left[\left(Area_{(T)} - Area\ burnt_{(T)} \cdot C_f \right) \cdot R_{AG(T)} \cdot N_{AG(T)} \cdot \left(1 - Frac_{Remove(T)} \right) + Area_{(T)} \cdot R_{BG(T)} \cdot N_{BG(T)} \right] \right\} \cdot Crop_{(T)} \cdot Frac_{Renew(T)}$$

where:
F_{CR} = annual amount of N in crop residues (above and below ground), including N-fixing crops, and from forage/pasture renewal, returned to soils annually, kg N yr^{-1}
$Crop_{(T)}$ = harvested annual dry matter yield for crop T, kg d.m. ha^{-1}
$Area_{(T)}$ = total annual area harvested of crop T, ha yr^{-1}
Area burnt $_{(T)}$ = annual area of crop T burnt, ha yr^{-1}
C_f = combustion factor
$Frac_{Renew(T)}$ = fraction of total area under crop T
$R_{AG(T)}$ = ratio of above-ground residues dry matter to harvested yield for crop T
$N_{AG(T)}$ = N content of above-ground residues for crop T, kg N (kg d.m.)$^{-1}$
$Frac_{Remove(T)}$ = fraction of above-ground residues of crop T removed annually for purposes such as feed, bedding and construction, kg N (kg crop-N)$^{-1}$
$R_{BG(T)}$ = ratio of below-ground residues to harvested yield for crop T, kg d.m. (kg d.m.)$^{-1}$
$N_{BG(T)}$ = N content of below-ground residues for crop T, kg N (kg d.m.)$^{-1}$
T = crop or forage type.

Correction factor to estimate dry matter yields ($Crop_{(T)}$) is determined as[170]:

$$Crop_{(T)} = Yield\ Fresh_{(T)} \cdot DRY$$

where:
$Crop_{(T)}$ = harvested dry matter yield for crop T, kg d.m. ha^{-1}
$Yield\ Fresh_{(T)}$ = harvested fresh yield for crop T, kg fresh weight ha^{-1}
DRY = dry matter fraction of harvested crop T, kg d.m. (kg fresh weight)$^{-1}$

Mainly default and international input data were used to estimate N that is returned to soils by crop residues, except data of crop production (area and yield) that originates from CSB Database. Dry matter fractions of harvested crop are collected as combination of IPCC default and national values, corrected by expert judgement (Table 5.31).

[168] *2006 IPCC Guidelines. Volume 4, Chapter 11, Equation 11.5, page 11.13*
[169] *2006 IPCC Guidelines. Volume 4, Chapter 11, Equation 11.6, page 11.14*
[170] *2006 IPCC Guidelines. Volume 4, Chapter 11, Equation 11.7, page 11.15*

Table 5.31 Dry matter fraction (DRY) of harvested crop (kg fresh weight^{-1})

Crop	DRY
Wheat	0.86
Barley,	0.86
Triticale	0.86
Oats	0.86
Rye	0.86
Buckwheat	0.86
Pulses	0.91
Fodder roots	0.20
Potatoes	0.22
Vegetable	0.22
Maize for silage and forage	0.30
Crops for green feed and silage	0.17
Perennial grass	0.90
Rape	0.91
Flax	0.91

Calculations on annual amount of N in crop residues are done based on default factors represented in 2006 IPCC Guidelines[171].All data sources to calculate N that is returned to soil by crop residues are represented in Table 5.32.

Table 5.32 Data sources for estimation of N in crop residues

Input parameter	Data source
Crop harvested yield	Central Statistical Bureau
Crop harvested area	Central Statistical Bureau
Burnt crop area	NO
Frac $_{Renew}$	Expert judgement, IPCC default
Frac $_{Remove}$	Expert judgement, IPCC default
AG_{DM}	2006 IPCC, Table 11.2
N_{AG}	2006 IPCC, Table 11.2
R_{BG-BIO}	2006 IPCC, Table 11.2
N_{BG}	2006 IPCC, Table 11.2
R_{AG}	2006 IPCC, Page 11.4
R_{GB}	2006 IPCC, Page 11.4

There is no field burning of agricultural residues observed in Latvia and area burnt is set to zero. It is estimated by Latvia University of Agriculture expert that approximately 20% of above-ground residues of all main crops (wheat, outs, barley and rye) and 80% of rape are removed annually for purposes such as feeding, bedding and construction (Frac $_{Remove}$). No other data to estimate the fraction of above-ground residues of crop removed for purposes such as feed, bedding and construction is available. According to expert judgment, perennial grass is renewed on average every 4 years. For annual crops Frac $_{Renew}$ 1 was set, as also proposed in the 2006 IPCC Guidelines. Final results of estimation of annual amount of N in crop residues are available in Table 5.35.

[171] *2006 IPCC Guidelines. Volume 4, Chapter 11, Table 11.2, page 11.17*

Mineralization/immobilization associated with loss/gain of soil organic matter: CRF 3.D 1.5

Average annual loss of soils carbon due to land use or management systems change was obtained from LULUCF sector. The net annual amount of N mineralised in mineral soils as a result of loss soil carbon stock change due land use change is accounted under LULUCF sector and reported under activities listed in paragraph 3.3 of the Kyoto protocol (deforestation). The net annual amount of N mineralised in mineral soils as a result of loss soil carbon stock change due to management activities, including conversion of cropland to grassland, is assumed to be NO, because of the net removals of CO_2 in soil in cropland and grassland due to management activities.

Cultivation of organic soils: CRF 3.D 1.6

Data on annual area of managed organic soils are adopted from LULUCF sector and prepared by Latvian State Forest Research Institute *Silava.* Nitrous oxide emissions from cultivated organic soils have been calculated with the IPCC methodology by dividing the area into grassland and cropland and using emission factors from IPCC Wetlands Supplement[172] to reach consistent reporting of emissions with LULUCF sector. Tier 1 methodology[173] for calculations is used and emission coefficients are summarized in Table 5.34. The area of cultivated organic soils is shown in (Table 5.33).

Table 5.33 Area of cultivated organic soil, 1990-2014 (ha)

Year	Organic soil in cropland	Organic soil in grassland	Total
1990	95759.1	41348.7	137107.8
1991	95833.3	41350.0	137183.3
1992	95993.8	41141.7	137135.6
1993	96063.6	40947.5	137011.1
1994	96113.5	40877.8	136991.3
1995	96151.9	40591.2	136743.1
1996	95903.3	40274.9	136178.1
1997	95658.1	40020.5	135678.6
1998	95495.8	39639.5	135135.2
1999	95220.8	39446.7	134667.5
2000	95011.0	39100.9	134111.9
2001	94658.9	38778.7	133437.6
2002	94438.0	38452.3	132890.3
2003	94193.1	38300.5	132493.5
2004	93880.0	38016.1	131896.2
2005	93553.4	37856.4	131409.8
2006	93213.3	37870.3	131083.6
2007	92859.6	37907.8	130767.4
2008	92492.4	37846.0	130338.4
2009	92571.1	39905.0	132476.1
2010	92649.9	41968.5	134618.4
2011	92718.6	44036.5	136755.1
2012	92787.4	46109.1	138896.5

[172] *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. Chapter 2, Table 2.5, page 2.33*

[173] *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. Chapter 2, , page 2.31*

Year	Organic soil in cropland	Organic soil in grassland	Total
2013	92846.1	48186.4	141032.5
2014	92938.1	49038.1	141976.2
Share of total % in 2014	65.5%	34.5%	100.0%
2014 versus 2013	+0.1%	+1.8%	+0.7%
2014 versus 1990	-2.9%	+18.6%	+3.6%

Atmospheric deposition: CRF 3.D 2.1

The nitrous oxide emission from atmospheric deposition of N volatilised from managed soil is estimated using 2006 IPCC Guidelines[174]:

$$N_2O_{(ATD)} - N = \left[(F_{SN} \cdot Frac_{GASF}) + \left((F_{ON} + F_{PRP}) \cdot Frac_{GASM}\right)\right] \cdot EF_4$$

where:

$N_2O_{(ATD)}$-N = annual amount of N_2O–N produced from atmospheric deposition of N volatilised from managed soils, kg N_2O–N yr^{-1}

F_{SN} = annual amount of synthetic fertiliser N applied to soils, kg N yr^{-1}

$Frac_{GASF}$ = fraction of synthetic fertiliser N that volatilises as NH_3 and Nox, kg N volatilised (kg of N applied)$^{-1}$

F_{ON} = annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils, kg N yr^{-1}

F_{PRP} = annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock, kg N yr^{-1}

$Frac_{GASM}$ = fraction of applied organic N fertiliser materials (F_{ON}) and of urine and dung N deposited by grazing animals (F_{PRP}) that volatilises as NH_3 and Nox, kg N volatilised (kg of N applied or deposited)$^{-1}$

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 Nox-N emitted

Results of estimation are available in Table 5.28.

Nitrogen leaching and run-off: CRF 3.D 2.2

The nitrous oxide emission from nitrogen loss from agricultural soils through leaching and runoff is estimated as shown in 2006 IPCC Guidelines[175]:

$$N_2O_{(L)} - N = (F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM}) \cdot Frac_{LEACH-(H)} \cdot EF_5$$

where:

$N_2O_{(L)}$–N = annual amount of N_2O–N produced from leaching and runoff, kg N_2O–N yr^{-1}

F_{CR} = amount of N in crop residues (above- and below-ground), including N-fixing crops, and from forage/pasture renewal, kg N yr^{-1}

F_{SOM} = annual amount of N mineralised in mineral soils, kg N yr^{-1}

$Frac_{LEACH-(H)}$ = Fraction of N input that is lost through leaching and runoff, kg N (kg of N additions)$^{-1}$

EF_5 = emission factor for N_2O emissions from N leaching and runoff, kg N_2O–N (kg N leached and runoff)$^{-1}$

The results of estimation of nitrous oxide emission from nitrogen loss from agricultural soils through leaching and runoff are available in Table 5.28. All emission coefficients and fractions for direct and indirect emissions estimation from managed soils are summarized in Table 5.34.

[174] *2006 IPCC Guidelines. Volume 4, Chapter 11, Equation 11.9, page 11.21*

[175] *2006 IPCC Guidelines. Volume 4, Chapter 11, Equation 11.10, page 11.2*

Table 5.34 Default emission, volatilization and leaching factors for direct and indirect nitrous oxide emissions calculation

Factor	Value	Uncertainty range
EF_1 for N additions from mineral fertilizers, organic amendments and crop residues [kg N_2O–N (kg N)$^{-1}$]	0.01	0.003 – 0.03
$EF_{2\ C}$, for boreal and temperate drained organic cropland soil (kgN_2O–N ha^{-1}) $EF_{2\ G}$, for boreal drained organic grassland soils (kgN_2O–N ha^{-1})	13 9.5	8.2 – 18 4.6 – 14
$EF_{3PRP,\ CPP}$ for cattle (dairy, non dairy), poultry and pigs [kg N_2O–N (kg N) $^{-1}$]	0.02	0.007 – 0.06
$EF_{3PRP,\ SO}$ for cattle (dairy, non dairy), poultry and pigs [kg N_2O–N (kg N) $^{-1}$]	0.01	0.003 – 0.03
EF_4 [N volatilization and re-deposition], kg N_2O–N [kg NH_3–N + NO_X–volatilized]	0.010	0.002 – 0.05
EF_5 (leaching/runoff), kg N_2O–N [kg N leaching/runoff]	0.0075	0.0005 -0.025
$Frac_{GASF}$ (Volatilization from synthetic fertilizer), (kg NH_3–N + Nox–N) [kg N applied] $^{-1}$	0.10	0.03 – 0.3
$Frac_{GASM}$ (Volatilization from all organic N fertilizers applied , and dung and urine deposited by grazing animals), [kg NH_3–N + Nox–N] [kg N applied or deposited] $^{-1}$	0.20	0.05 – 0.5
$Frac_{LEACH-(H),}$N losses by leaching/runoff [kg N]	0.30	0.1 – 0.8

Summary of input variables for direct nitrous oxide emission estimation according to methodology explained above are provided in Table 5.35.

Table 5.35 Input values for direct nitrous oxide emission calculations from managed soils, 1990-2014

Year	F_{SN}	F_{OM}	$F_{PRP,\ CPP}$	$F_{PRP,\ SO}$	F_{CR}
1990	131400.0	51212.5	15683.2	369.6	41024.0
1991	112400.0	49665.6	14602.5	389.6	38510.1
1992	66000.0	41871.8	10881.1	357.6	30690.2
1993	39700.0	29343.6	6278.2	282.1	27195.5
1994	29000.0	25896.2	5315.0	250.8	22555.7
1995	11500.0	25596.1	5183.5	235.9	18069.3
1996	14500.0	24597.5	5187.4	207.3	21096.6
1997	19400.0	22818.1	4908.9	176.2	21915.9
1998	19600.0	21109.5	4399.0	156.2	20411.1
1999	19000.0	18751.4	3608.5	136.3	17247.4
2000	23000.0	19047.2	3563.2	144.4	17812.2
2001	31600.0	21811.1	3718.8	144.1	18485.6
2002	27600.0	21316.0	3514.5	142.7	19238.8
2003	37500.0	20127.6	3636.8	137.8	18613.5
2004	35200.0	19600.1	3583.3	137.4	19999.9
2005	40900.0	19675.0	3919.0	207.2	23492.1
2006	42700.0	20115.9	3844.2	234.1	21517.9
2007	46100.0	20494.9	4184.9	269.2	25881.5
2008	47500.0	19488.3	4150.5	318.0	27759.5
2009	51900.0	18941.0	4271.3	347.9	27966.1
2010	59500.0	18945.2	4417.4	360.3	25107.4
2011	59800.0	18481.7	4500.3	383.5	25494.0
2012	65200.0	18108.1	4807.3	388.5	34674.3

Year	F_{SN}	F_{OM}	$F_{PRP, CPP}$	$F_{PRP, SO}$	F_{CR}
2013	69700.0	17951.2	5241.9	409.5	32828.0
2014	72900.0	17883.0	5613.1	441.7	35405.2
2014 versus 2013	+4.6%	-0.4%	+7.1%	+7.9%	+7.9%
2014 versus 1990	-44.5%	-65.1%	-64.2%	+19.5%	-13.7%

F_{SN} = annual amount of synthetic fertiliser N applied to soils, t N yr^{-1}
F_{OM} = annual amount of animal manure N applied to soils, t N yr^{-1}
$F_{PRP\ CPP}$ = annual amount of urine and dung N deposited by grazing cattle, swine and poultry on pasture, t N yr^{-1}
$F_{PRP\ SO}$ = annual amount of urine and dung N deposited by grazing other animals on pasture, t N yr^{-1}
F_{CR} = annual amount of N in crop residues (above and below ground), including N-fixing crops, t N yr^{-1}

5.4.3 Uncertainties and time-series consistency

The uncertainty of activity data is set to 2%. The uncertainty of the default emission factors reaches +50%.

5.4.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the agriculture sector in order to achieve quality objectives. Quality meetings are held annually between experts. A complete coverage of the direct and indirect nitrous oxide emissions from managed land requires estimation of emissions for all anthropogenic inputs and activities (F_{SN}, F_{ON}, F_{CR}, F_{PRP}, F_{SOM} and F_{OS}), that is done in the inventory. N excretion data are consistent with those used for the manure management systems source category. National crop production and synthetic fertilizer consumption statistics is compared to FAO. CSB of Latvia shows efforts to reduce differences between national statistics and FAO data. All calculations mostly are done according to Tier 1. Fluctuations in time series should be explained by fluctuations of statistical data, showing that agricultural production numbers in Latvia are highly variable. As production levels are strongly associated with support of famers from state, situation on agriculture products market, agricultural products price changes, local demand of agricultural products and other.

5.4.5 Category-specific recalculations

Recalculations are done due to the implementation of new emission coefficient for nitrous oxide emission estimation from organic soils and including updated information about organic soil areas (2009-2014) in the inventory. Dry matter fraction values and grassland area was updated for emission calculations from crop residue, based on the revision of current estimation and suggested technical corrections. Recalculations also are affected by implementation of new methodology to determine the share of grazing animals.

5.4.6 Category-specific planned improvements

Future development of the country specific value for $Frac_{LEACH}$-(H) and $FRAC_{GASM}$ is planned to estimate N losses by leaching/runoff and volatilization.

5.5 FIELD BURNING OF AGRICULTURAL RESIDUES (CRF 3.F)

Notation key – NO is used for reporting field burning of agricultural residues in Latvia. Legislative measures and agricultural residue management practices prohibit field burning of agricultural residues. This is explained by Latvian Administrative Violations Code Section 179 Violation of Fire Safety Regulations.

5.6 LIMING (CRF 3.G)

Liming is used to reduce soil acidity and improve plant growth in managed systems, particularly agricultural lands and managed forests. Adding carbonates to soils in the form of lime (e.g., calcic limestone ($CaCO_3$), or dolomite (CA $Mg(CO_3)_2$) leads to CO_2 emissions as the carbonate limes dissolve and release bicarbonate ($2HCO_3^-$), which evolves into CO_2 and water (H_2O). CO_2 emission from additions of carbonate limes to soils are estimated using Tier 1 methodology with the formula from 2006 IPCC Guidelines[176]:

$$CO_2 - C\ Emission = (M_{Limestone} \cdot EF_{Limestone}) + (M_{Dolomite} \cdot EF_{Dolomite})$$

where:
CO_2–C Emission = annual C emissions from lime application, tonnes C yr^{-1}
M = annual amount of calcic limestone ($CaCO_3$) or dolomite (CA $Mg(CO_3)_2$), tonnes yr^{-1}
EF = emission factor, tonne of C (tonne of limestone or dolomite) $^{-1}$

IPCC default emission factors are EF=0.12 for limestone and EF=0.13 for dolomite. The uncertainty of them is 50%. Statistical data in Latvia provides information on overall consumption of liming material. Therefore EF 0.13 is implemented for determination of CO_2 emissions from liming. Activity data and calculated emissions are represented in Table 5.36.

Table 5.36 Consumed lime and calculated CO_2 emissions, 1990-2014

Year	Annual amount of consumed liming material (t $year^{-1}$)	CO_2 emissions (kt)
1990	779200	371.42
1991	486700	231.99
1992	70600	33.65
1993	3500	1.67
1994	1600	0.76
1995	2700	1.29
1996	1400	0.67
1997	400	0.19
1998	4700	2.24
1999	4900	2.34
2000	10200	4.86
2001	700	0.33
2002	32900	15.68
2003	53800	25.64
2004	2200	1.05
2005	3300	1.57
2006	3000	1.43
2007	10700	5.10
2008	6000	2.86
2009	8700	4.15
2010	4300	2.05

[176] *2006 IPCC Guidelines. Volume 4, Chapter 11, Equation 11.12, page 11.27*

Year	Annual amount of consumed liming material (t year^{-1})	CO_2 emissions (kt)
2011	17400	8.29
2012	21600	10.30
2013	28900	13.78
2014	41300	19.69
2014 versus 2013	+42.9%	+42.9%
2014 versus 1990	-94.7%	-94.7%

Latvian agricultural land has a tendency to acidification of soil**.** According to information provided by State Plant Protection Service, 53.5% of agricultural land required for liming to neutralize the acidity in 2014. Since 1992, soil liming has to be characterized as insufficient. However, liming activities rapidly increase in the last 5 years.

5.7 UREA APPLICATION (CRF 3.H)

CO_2 emission from urea fertilisation is estimated with the following equation from 2006 IPCC Guidelines[177]:

$$CO_2 - C\ Emission = M \cdot EF$$

where:
CO_2–C Emission = annual C emissions from urea application, tonnes C yr^{-1}
M = annual amount of urea fertilisation, tonnes urea yr^{-1}
EF = emission factor, tonne of C (tonnes of urea)$^{-1}$

Emission factor (EF) of 0.20 for urea application emissions is used for calculations. The default 50% of uncertainty is applied, activity data uncertainty is evaluated as 2%. CSB of Latvia data of urea application is available from 2007. FAO data for 2002 and 2003 is also available. Data for all other years are derived by extrapolation of available statistical values. Table 5.37 represents activity data and estimated CO_2 emissions from urea fertilisation.

Table 5.37 Urea oundwoodion statistics and calculated CO_2 emissions, 1990-2014

Year	Annual amount of urea fertilization (tonnes yr^{-1})	CO_2 emissions (kt)
1990	10512	7.71
1991	8992	6.59
1992	5280	3.87
1993	3176	2.33
1994	2320	1.70
1995	920	0.67
1996	1160	0.85
1997	1552	1.14
1998	1568	1.15
1999	1520	1.11
2000	1840	1.35
2001	2528	1.85
2002	6078	4.46
2003	1942	1.42
2004	1943	1.42
2005	1944	1.43
2006	1945	1.43

[177] *2006 IPCC Guidelines. Volume 4, Chapter 11, Equation 11.13, page 11.32*

Year	Annual amount of urea fertilization (tonnes yr^{-1})	CO_2 emissions (kt)
2007	1946	1.43
2008	4323	3.17
2009	5930	4.35
2010	5459	4.00
2011	5798	4.25
2012	7901	5.79
2013	5558	4.08
2014	6445	4.73
2014 versus 2013	+16.0%	+16.0%
2014 versus 1990	-38.7%	-38.7%

5.8 OTHER CARBON-CONTAINING FERTILIZERS (CRF 3.I)

There is no data on other carbon-containing fertilizers use in Latvia. Notation key – NO is used.

5.9 OTHER (CRF 3J)

There is no information on other sources in Latvia. Notation key – NO is used.

6 LAND-USE, LAND-USE CHANGE AND FORESTRY (CRF 4)

6.1 OVERVIEW OF SECTOR

Total emissions of aggregated GHG (CO_2, CH_4 and N_2O) in Land Use, Land Use Change and Forestry (LULUCF) sector in 2014 were 4220.14 kt CO_2 equivalent (Figure 6.1, Table 6.1, Table 6.2). Aggregated net removals of the GHG reduced by 150 % in 2014 compared to 1990.

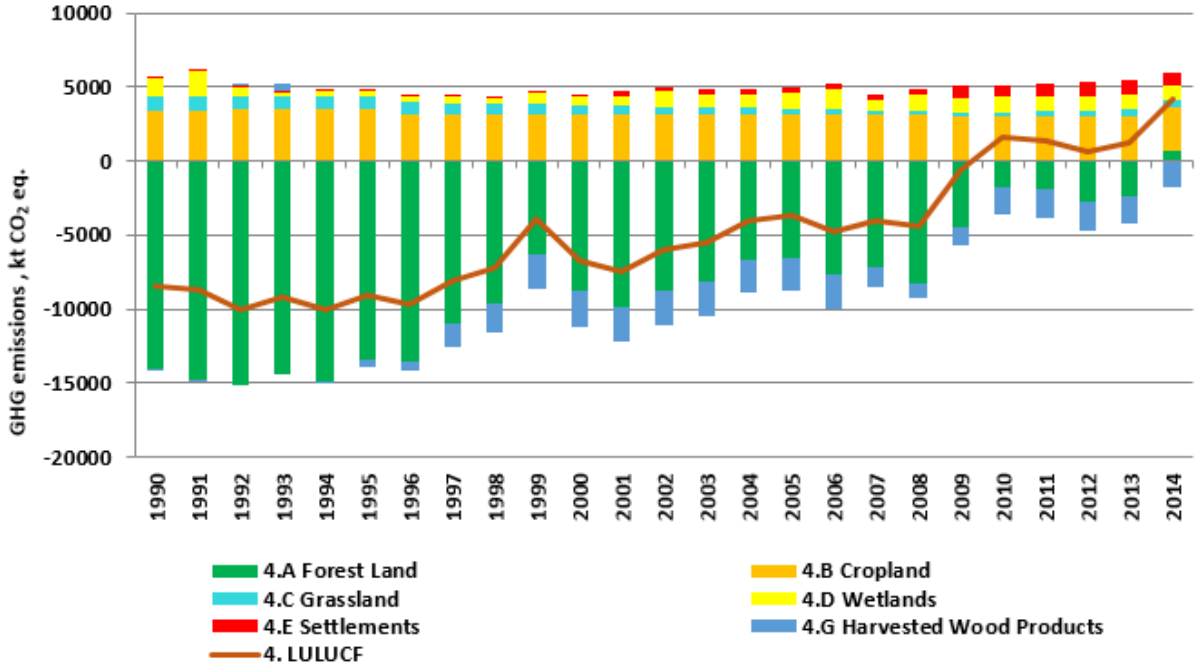

Figure 6.1 Summary of net emissions (positive sign) and removals (negative sign) in the LULUCF sector by land-use category and harvested wood products (kt CO_2 eq.)

According to the 2006 IPCC Guidelines land area is divided into six land-use categories (Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land). In Latvia, LULUCF sector comprises emissions and removals arising from Forest Land, Cropland, Grassland, Wetlands and Settlements divided into the subcategories "lands remaining in the same land-use category for the last 20 years" and "lands converted to present land use during the past 20 years". Other land is considered as unmanaged land and does not contain considerable amount of organic carbon and the emissions and removals are not reported. Emissions and removals from harvested wood products (HWP) are included in the LULUCF estimates.

Summary of net emissions and removals in the LULUCF sector by land-use category and harvested wood products is shown in Table 6.1. Decrease of CO_2 removals in living biomass in forest land and cropland is associated with increase of the harvesting rate, increase of mortality and reduction of increment as well as implementation of floating NFI cycle included in the calculations in 2014.

Table 6.1 Summary of net emissions and removals in the LULUCF sector by land-use category and harvested wood products (positive figures indicate emissions, negative removals) (kt CO_2 eq.)

Category	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
4. LULUCF	**-8421.63**	**-9037.92**	**-6695.77**	**-3728.88**	**-4716.73**	**-4051.43**	**-4429.32**	**-640.40**	**1574.79**	**1365.10**	**659.16**	**1208.75**	**4220.14**
4.A Forest Land	**-14006.83**	**-13497.13**	**-8816.64**	**-6531.41**	**-7693.70**	**-7176.14**	**-8222.21**	**-4484.39**	**-1773.97**	**-1854.24**	**-2783.46**	**-2392.13**	**745.83**
living biomass	-19117.40	-17072.79	-10849.36	-8319.10	-10855.17	-10235.38	-12224.82	-7812.51	-4095.37	-4633.81	-6070.17	-4031.74	-870.27
dead wood	75.70	-1554.22	-3368.18	-3074.65	-1722.62	-1779.24	-819.79	-1645.05	-2740.66	-2410.63	-2038.20	-3816.75	-3876.24
litter	-1.38	-15.78	-36.01	-56.07	-58.85	-61.58	-64.95	-66.10	-67.25	-68.40	-69.55	-70.70	-71.84
organic soils	4749.10	4747.47	4772.36	4775.73	4777.39	4775.02	4777.04	4907.85	5038.67	5169.48	5300.30	5431.12	5455.25
biomass burning	287.16	398.19	664.53	142.69	165.55	125.04	110.31	131.41	90.64	89.11	94.16	95.94	108.93
4.B Cropland	**3419.36**	**3535.54**	**3196.05**	**3150.32**	**3145.60**	**3137.98**	**3133.06**	**3030.88**	**3030.20**	**3027.46**	**3026.68**	**3025.11**	**2890.39**
living biomass	367.23	429.56	191.89	179.06	180.98	180.97	183.73	105.59	106.08	104.83	105.54	106.44	12.89
dead organic matter	145.69	152.04	70.11	68.59	69.70	70.25	71.14	42.04	42.93	43.75	44.56	44.64	7.40
mineral soils	6.94	41.61	55.91	68.35	70.84	73.33	75.82	78.36	73.97	69.62	65.27	60.97	54.06
organic soils	2898.92	2908.78	2873.38	2828.50	2818.05	2807.19	2795.92	2798.22	2800.92	2803.33	2805.75	2807.87	2811.15
4(III) N mineralization	0.59	3.54	4.76	5.82	6.03	6.24	6.46	6.67	6.30	5.93	5.56	5.19	4.88
4.C Grassland	**971.46**	**812.71**	**614.31**	**406.34**	**371.66**	**291.94**	**248.70**	**274.83**	**299.99**	**353.73**	**407.91**	**460.60**	**486.87**
living biomass	-19.18	-20.69	-22.19	-21.74	-21.74	-50.31	-50.31	-49.50	-49.50	-49.50	-44.06	-41.72	-42.88
dead organic matter	-4.28	-3.62	-2.78	-1.78	-1.48	-8.65	-7.96	-8.15	-7.64	-7.12	-5.08	-8.71	-8.56
mineral soils	0.00	-139.67	-301.88	-481.31	-521.06	-561.89	-603.80	-603.80	-603.80	-575.52	-554.10	-525.47	-495.26
organic soils	994.82	976.60	940.74	910.80	911.13	912.03	910.55	935.45	960.46	985.58	1010.81	1036.15	1032.29
biomass burning	0.10	0.10	0.42	0.38	4.82	0.76	0.22	0.83	0.47	0.30	0.35	0.35	1.27
4.D Wetlands	**1247.34**	**427.19**	**584.93**	**1120.34**	**1365.20**	**722.18**	**1106.28**	**981.13**	**1021.62**	**1023.40**	**991.10**	**1035.55**	**1014.57**
living biomass	-65.31	-91.56	-99.60	-97.94	-97.98	-184.50	-184.50	-181.69	-181.69	-181.69	-170.06	-161.43	-165.23
dead organic matter	-13.81	-15.69	-12.34	-8.12	-6.86	-26.89	-24.50	-25.18	-23.35	-21.62	-16.88	-29.96	-29.47
organic soils	1326.46	534.45	696.88	1226.41	1470.05	933.57	1315.27	1187.99	1226.66	1226.71	1178.04	1226.94	1209.27
4.E Settlements	**113.24**	**156.79**	**157.4**	**372.07**	**385.59**	**335.50**	**350.19**	**781.14**	**822.27**	**854.48**	**905.25**	**940.73**	**897.08**
living biomass	67.62	78.44	57.50	177.83	180.31	127.14	130.69	418.43	420.73	414.88	426.67	429.85	372.73
dead organic matter	39.54	41.90	38.20	86.17	87.95	81.75	83.62	191.23	195.70	199.86	205.15	204.00	186.88
mineral soils	1.40	8.40	13.90	24.32	26.40	28.49	30.57	45.20	58.46	71.79	85.14	98.52	107.29
organic soils	3.77	22.59	38.53	67.49	73.29	79.08	84.87	102.43	119.84	136.64	153.16	169.38	185.61
4(III) N mineralization	0.91	5.46	9.28	16.25	17.65	19.04	20.44	23.84	27.53	31.30	35.14	38.98	44.56
4.G Harvested Wood Products	**-166.36**	**-473.98**	**-2433.15**	**-2248.32**	**-2292.96**	**-1364.85**	**-1047.38**	**-1226.35**	**-1827.85**	**-2042.44**	**-1891.20**	**-1864.16**	**-1817.58**

Table 6.2 Summary of net emissions and removals in the LULUCF sector by different gases (positive figures indicate emissions, negative removals)

Emissions, unit	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total emissions, kt CO_2 eq.	-8421.63	-9037.92	-6695.77	-3728.88	-4716.73	-4051.43	-4429.32	-640.40	1574.79	1365.10	659.16	1208.75	4220.14
CO_2, kt	-9305.34	-9941.32	-7639.92	-4610.85	-5650.38	-4936.29	-5314.74	-1567.49	621.75	380.13	-360.99	151.51	3133.48
CH_4, kt	12,30	12.70	13.84	11.27	12.98	11.25	11.21	12.14	12.54	13.15	13.87	14.67	15.56
N_2O, kt	1,93	1.97	2.01	2.01	2.04	2.03	2.03	2.09	2.15	2.20	2.26	2.32	2.34
NO_x, kt	0.20	0.30	0.54	0.11	0.55	0.13	0.11	0.17	0.10	0.08	0.08	0.09	0.17
CO, kt	14.24	20.84	37.77	7.40	30.82	7.77	7.42	10.54	6.41	4.99	5.04	5.96	9.87

The definitions of carbon pools are as follows:

- Living biomass consist of above-ground biomass (all biomass of living vegetation, both woody and herbaceous, above the soil including stems, stumps, branches, bark, seeds, and foliage and below-ground biomass (all biomass of live roots and stump, fine roots of less than 2 mm diameter are excluded because these often cannot be distinguished empirically from soil organic matter or litter). Forest understory is a relatively small component of the above-ground biomass carbon pool and it is excluded from calculation in the inventory time series.
- Dead wood consists of all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots down to a diameter of 2 mm, and stumps. Litter includes all non-living biomass with a size greater than the limit for soil organic matter (2 mm) and less than the minimum diameter chosen for dead wood (bottom diameter above 6 cm), lying dead, in various states of decomposition above or within the mineral or organic soil. This includes the litter layer as usually defined in soil typologies. Live fine roots above the mineral or organic soil (wit diameter less than 2 mm) are included in litter where they cannot be distinguished from it empirically.
- Soil carbon is organic carbon in mineral and organic soils (including peat) to a 30 cm depth. Live fine roots of less than 2 mm are included with soil organic matter.

The LULUCF sector is important in Latvia's GHG balance due to the fact that more than half of the country area is covered with forests and due to long history of sustainable forest management which secured continuous increase of growing stock in forests since beginning of 20th century (from 101 m^3 ha^{-1} in 1935 to 172 m^3 ha^{-1} in 2010)[178]. According to data provided by National statistical forest inventory (NFI) total forest area (including afforested lands) in 2014 was 3 299.38 kha (51 % of total country area). Total area of land converted to forest from 1990 to 2014 is 202.06 kha. Twenty years transition period is considered for land use changes, therefore area of historical forest lands is increasing during recent years, but area of lands converted to forest is decreasing, because area converted to forest until 1993 (including) is now accounted as forest land remaining forest. The same approach is applied to conversion of cropland to grassland. Conversion of forest land to other land use categories in 2014 is calculated using the extrapolation method, assuming that conversion of forest land to cropland and to settlements, as well as conversion of other land use categories follows to a linear regression based on data from 1990 to 2009.

Overview of calculation methods and types of emission factors for the LULUCF sector is shown in Table 6.3. In the forest land category removals and emissions associated with living biomass and soil were estimated using mixed approach of Tier 1 and Tier 2 and country specific activity data, like increment and harvesting figures, mortality rate in forests, wood density values, biomass expansion factors (BEFs), carbon stock in biomass, as well as the land use information. Calculations were done by Latvian State Forest Research Institute "Silava" (LSFRI Silava) with support of Ministry of Agriculture of Republic of Latvia (MoA).

Emissions from organic soils (cropland, grassland, forest land), controlled burning (forest land) and wildfires (forest land and grassland) were estimated using Tier 1 and Tier 2 methods and country specific activity data.

[178] *https://www.zm.gov.lv/public/ck/files/ZM/mezhi/buklets/MN_20_EN.pdf*

Estimation of conversion of land use from cropland to grassland was introduced in 2011 to represent land use changes associated with reduction of area of cropland. Carbon stock changes are accounted using research data demonstrating difference of carbon stock in cropland and grassland[179].

Table 6.3 Overview of methods and emission factors used in calculations of GHG emissions from the LULUCF sector

CRF	Source	CO_2		CH_4		N_2O	
		Methods	EF	Methods	EF	Methods	EF
4.A	**Forest land**						
4.A.1	Forest Land Remaining Forest Land	Tier 1, Tier 2	CS, D	Tier 1, Tier 2	D	Tier 1, Tier 2	D
4.A.2	Land Converted to Forest Land	Tier 2	CS	-	-	-	-
4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	Tier 1	D	Tier 1	D	Tier 1	D
4.B	**Cropland**						
4.B.1	Cropland Remaining Cropland	Tier 1, Tier 2	CS, D	-	-	-	-
4.B.2	Land Converted to Cropland	Tier 2	CS	-	-	Tier 1	D
4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	-	-	Tier 1	D	-	-
4.C	**Grassland**						
4.C.1	Grassland Remaining Grassland	Tier 2	CS	Tier 1	D	Tier 1	D
4.C.2	Land Converted to Grassland	Tier 1, Tier 2	CS, D	-	-	-	-
4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	-	-	Tier 1	D	-	-
4.D	**Wetland**						
4.D.1	Wetlands Remaining Wetlands	Tier 1, Tier 2	CS, D	-	-	-	-
4.D.2	4.D.2 Land Converted to Wetlands	-	-	-	-	-	-
4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	Tier 2	CS	Tier 1	D	Tier 1	D
4.E	**Settlements**						
4.E.1	Settlements Remaining Settlements	Tier 2	CS	-	-	Tier 1	D
4.E.2	Land Converted to Settlements	Tier 2	CS	-	-	Tier 1	D
4.G	**Harvested Wood Products**	Tier 2	CS	-	-	-	-

Emissions of GHG due to forest fires in LULUCF sector are calculated using data about areas of forest fires provided by the State forest service (SFS).

This is the third year when Latvia reported HWP pool using data which were obtained during elaboration of the Forest management reference level (FMRL).

Emissions from drained organic and mineral soils are calculated using default emission factors and national activity data. Information about area of drained mineral and organic soils in forest land is taken from the NFI (total area of forest types on drained soils).

Knowledge about dynamics of dead wood in forest lands is insufficient, both in terms of mortality factors and decay periods, because forest management principles were

[179] *Lazdiņš, Atbalsts Klimata Pētījumu Programmai, starpziņojums Par 2012. Gada Darba Uzdevumu Izpildi (Climate research program, middle-term report, 2012).*

significantly changed since 1990, for instance, in the 80^{ths} it was a common practice to debark stumps and to incinerate harvesting residues to reduce risk of distribution of pests. Nowadays this practice is not used any more in state forests and in very limited amount – in private forests. Instead of that collection of residues for biofuel production becomes more common. Comparison of different sources of information about dead wood (NFI and reports to the Timber Committee) demonstrates constant increase of dead wood stock in forests during the last decade; however, it could be result of several extreme weather events. Mortality factors excluding extreme events were elaborated in 2012 on the base of the NFI data (sample plots measured in 2006 and 2012) for the FMRL calculations[180].

Estimates of emissions from drained forest soils are supplemented with calculation of N_2O emissions from organic soils. Emissions of CO_2 from drained organic soils are calculated using default emission factors of the IPCC Wetlands Supplement (2.6 tonnes C ha^{-1} annually in forest land, 7.9 tonnes C ha^{-1} in cropland, 6.1 tonnes C ha^{-1} in grassland and 2.8 tonnes C ha^{-1} in peatlands).

The key categories in LULUCF sector in 2014 in Latvia are summarised in Table 6.4. The most significant key category according to the level assessment (Approach 1) and trend assessment (Approach 1) is Forest land remaining forest land. HWP included into the inventory in 2013 are also a key category by level of net emissions.

Table 6.4 LULUCF key categories

Key categories of emissions and removals	GHG	Identification criteria
4.A.1 Forest Land remaining Forest Land – Carbon stock change, dead wood	CO_2	L1, L2, T1,T2
4.A.1 Forest Land remaining Forest Land – Carbon stock change, living biomass	CO_2	L1,T1,T2
4.A.1 Forest land remaining forest land – Controlled burning	CO_2	L1, L2,T1,T2
4.A.1 Forest Land remaining Forest Land – Drained organic soil	CO_2	L1, L2,T1,T2
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	L2
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	N_2O	L1,L2,T1,T2
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	L1, L2,T1,T2
4.A.2 Land converted to Forest Land – Carbon stock change, grassland converted to forest land	CO_2	L1, L2,T1,T2
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, dead wood	CO_2	L1
4.B. Cropland remaining cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	L1, L2
4.B.1 Cropland remaining Cropland – Drained organic soil	CO_2	L1, L2,T1,T2
4.B.1 Cropland remaining Cropland – Carbon stock change – living biomass	CO_2	L2
4.B.1 Land converted to Cropland – Carbon stock change – dead organic matter	CO_2	T1,T2

[180] *Lazdiņš, Donis, and Strūve, Latvijas Meža Apsaimniekošanas Radītās Ogļskābās Gāzes (CO_2) Piesaistes Un Siltumnīcefekta Gāzu (SEG) Emisiju References Līmeņa Aprēķina Modeļa Izstrāde (Elaboration of model for estimation of GHG emissions and CO_2 removals due to forest management).*

Key categories of emissions and removals	GHG	Identification criteria
4.B.2 Land converted to Cropland – Drained organic soil	CO_2	L1, L2,T2
4.B.2 Land converted to Cropland – Carbon stock change, forest land converted to cropland	CO_2	T1,T2
4.B.2 Land converted to Cropland –Mineral soil	CO_2	T2
4.C.1 Grassland remaining Grassland – Drained organic soil	CO_2	L1, L2,T1,T2
4.C.2 Land converted to Grassland – Drained organic soil	CO_2	L1, L2,T1,T2
4.C.2 Land converted to Grassland –Mineral soil	CO_2	L1, L2,T1,T2
4.D.1 Wetlands remaining Wetlands – Carbon stock change – living biomass	CO_2	L1, L2,T1,T2
4.D.1 Wetlands remaining Wetlands – Carbon stock change –organic soils	CO_2	L1, L2
4.D.1. Wetlands, Peat extraction from lands, organic soils	CO_2	L1, L2
4.E.1 Settlements remaining Settlements – Carbon stock change – living biomass	CO_2	L1, L2,T2
4.E.2 Land converted to Settlements – Carbon stock change – dead organic matter	CO_2	L1,T1
4.E.2 Land converted to Settlements – Carbon stock change – living biomass	CO_2	L1, L2,T1,T2
4.E.2 Land converted to Settlements – Mineral soils	CO_2	L1, L2,T1,T2
4.E.2 Land converted to Settlements – Organic soils	CO_2	L1, L2,T1,T2
4. G. Harvested wood products	CO_2	L1, L2, T1,T2

The sector reporting was considerably updated during previous inventory due to development of national GHG accounting and projection tool for LULUCF sector and implementation of results of several scientific studies. The most important improvements in this report are implementation of country specific wood density values, carbon stock in different fractions of biomass, BEFs, as well as recalculation of losses due to commercial harvesting and natural mortality in forests.

6.2 LAND-USE DEFINITIONS AND THE CLASSIFICATION SYSTEMS USED AND THEIR CORRESPONDENCE TO THE LULUCF CATEGORIES

For the GHG inventory, land area and inland water bodies are classified according to the 2006 IPCC Guidelines. Connection between the IPCC land-use categories and national land classification is shown in Table 6.5.

Table 6.5 National application of IPCC land-use categories

IPCC category	National land use categories and definitions fits to IPCC categories
Forest land	Land of a minimum area of 0.1 ha with potential tree crown cover of more than 20 % and with the potential of trees to reach a minimum height of 5 m at maturity. Young natural stands and all plantations established for the forestry purposes, which have to reach a crown density of 20 % or tree height of 5 m. Areas normally forming part of the forest area, which are temporarily unstocked as a result of human intervention or natural causes, but which are expected to revert to forest. For linear formations, a minimum width of 20 m is applied.
Cropland	Arable land, including orchards and extensively managed arable lands (ploughed at least once per 20 years). Animal feeding glades (periodically ploughed areas if forest used for wild animal feeding), which according to national land use classification belong to forest land.
Grassland	Pastures, glades and bush-land which do not fit to forest definition. Vegetated

IPCC category	National land use categories and definitions fits to IPCC categories
	areas on non-forest lands complying to forest definition where land use type can be easily returned to grassland by cutting grass and small trees without legal requirement of transformation of the land use, but except grassland used in forage production and extensively managed cropland reported under cropland. Non-forest lands with average diameter of trees at the breast height less than 2 cm are reported under grassland's category.
Wetlands	All inland water bodies (rivers, ponds, lakes), swamps (constantly wet areas where height of trees cannot reach more than 5 m and ground vegetation consists mostly of sphagnum and different sword grasses), flood-lands (usually small areas suffering from exceeding water periodically); alluvial lands (larger glades and bush-lands suffering from exceeding water).
Settlements	Land under buildings including yards and gardens as well as land necessary to maintain and to access those buildings, land under roads including buffer zones, forest infrastructure including ditches and their management bands, as well as seed orchards, forest nurseries and fire-breaks, drainage systems in cropland and grassland, other infrastructure – buffer zones of industrial networks, quarries etc., but excluding peat extraction sites.
Other land	Dunes not covered by woody vegetation.

The information about area of all land use categories since 2009 comes from the NFI. Information about grassland, cropland, wetlands and other lands provided by the State land service (SLS) and Central statistical bureau (CSB) are used for reference – to estimate potential errors in the NFI data as well as to estimate the area of cropland and grassland in 1990. Conversion of cropland to grassland is estimated using remote sensing method comparing vegetation index in the NFI sample plots listed as cropland or grassland[181].

The decision support tree was elaborated in 2013 to simplify identification of land use changes in cropland, grassland and forest land using the NFI data analysis (Table 6.6). The identification of land use changes according to this approach takes 10 years. Considering that there are still some unsolved issues, like interpretation of merged sectors of the NFI plots with different initial land use and distribution of biomass located on converted sites, it is proposed to combine automated evaluation and following manual quality assurance.

Table 6.6 Decision support table to estimate conversion of grassland, cropland and forest land

First NFI 2004-2008	Second NFI 2009-2013	Third NFI 2014-2019	Fifth NFI 2020-2024
Initial land use – *grassland*	Whole plot or sector is ploughed – *no land use change marked*	Whole plot or sector is ploughed – *ploughed area is marked as cropland since second NFI*	Whole plot or sector is ploughed – *the area remains cropland*
			No signs of ploughing – *the area remains cropland*
		No signs of ploughing – *the area remains grassland*	Whole plot or sector is ploughed – *the area remains grassland*
			No signs of ploughing – *the area remains grassland*
	No signs of ploughing – *the area remains grassland*	Whole plot or sector is ploughed – *the area remains grassland*	Whole plot or sector is ploughed – *ploughed area is marked as cropland since third NFI*
			No signs of ploughing – *the*

[181] *Lazdiņš and Zariņš, Vēsturiskās (1990. Gada) Apsaimniekoto Aramzemju Platības Noteikšana Un Līdz 2009. Gadam Notikušo Aramzemju Platības Izmaiņu Novērtēšana (Estimation of area of managed croplands and change of cropland's area until 2009).*

First NFI 2004-2008	Second NFI 2009-2013	Third NFI 2014-2019	Fifth NFI 2020-2024
			area remains grassland
		No signs of ploughing – *the area remains grassland*	Whole plot or sector is ploughed – *the area remains grassland*
			No signs of ploughing – *the area remains grassland*

The areas of IPCC land-use categories and Latvia's official land area are given in Table 6.7. Slight changes are applied to the whole cycle due to harmonization of the country area.

Table 6.7 Areas of IPCC land-use classes in 1990-2014, 1000 ha[182]

Year	Total country area	Forest land	Cropland	Grassland	Settlements	Wetland	Other land
1990	6 457.30	3 124.22	1 842.24	798.24	238.82	448.35	5.44
1991	6 457.30	3 128.56	1 837.27	798.26	239.41	448.35	5.44
1992	6 457.30	3 135.28	1 833.98	794.24	240.01	448.35	5.44
1993	6 457.30	3 143.49	1 828.93	790.49	240.60	448.35	5.44
1994	6 457.30	3 149.67	1 823.50	789.15	241.19	448.35	5.44
1995	6 457.30	3 160.27	1 817.85	783.61	241.78	448.35	5.44
1996	6 457.30	3 173.39	1 810.36	777.51	242.26	448.35	5.44
1997	6 457.30	3 185.24	1 802.95	772.60	242.73	448.35	5.44
1998	6 457.30	3 197.95	1 797.12	765.24	243.20	448.35	5.44
1999	6 457.30	3 209.19	1 789.13	761.52	243.67	448.35	5.44
2000	6 457.30	3 222.13	1 782.39	754.84	244.15	448.35	5.44
2001	6 457.30	3 236.66	1 773.20	748.62	245.04	448.35	5.44
2002	6 457.30	3 248.73	1 766.53	742.32	245.92	448.35	5.44
2003	6 457.30	3 257.90	1 759.41	739.39	246.81	448.35	5.44
2004	6 457.30	3 270.95	1 750.97	733.90	247.70	448.35	5.44
2005	6 457.30	3 281.85	1 742.26	730.82	248.59	448.35	5.44
2006	6 457.30	3 289.65	1 733.30	731.09	249.48	448.35	5.44
2007	6 457.30	3 297.27	1 724.07	731.81	250.36	448.35	5.44
2008	6 457.30	3 307.06	1 714.58	730.62	251.25	448.35	5.44
2009	6 457.30	3 305.78	1 714.80	731.72	251.66	447.90	5.44
2010	6 457.30	3 304.50	1 715.02	732.82	252.08	447.44	5.44
2011	6 457.30	3 303.22	1 715.24	733.93	252.49	446.99	5.44
2012	6 457.30	3 301.94	1 715.45	735.03	252.90	446.54	5.44
2013	6 457.30	3 300.66	1 715.67	736.13	253.32	446.09	5.44
2014	6 457.30	3 299.38	1 715.89	737.23	253.73	445.63	5.44

Area of organic soils in croplands and grasslands is updated according to the inventory of historical data about farmlands implemented in 2009[183]. Area of cropland and grassland in LULUCF reporting is synchronized with Agriculture reporting, including recalculation of cultivated organic soils. It is considered that all forest land, grassland, cropland and settlements are managed. Detailed land use change matrices are provided in Table 6.9; summary – in Table 6.8.

[182] *Based on the NFI data.*

[183] *L.U. Consulting, "Augšņu un reljefa izejas datu sagatavošana un Eiropas Komisijas izstrādāto augsnes un reljefa kritēriju mazāk labvēlīgo apvidu noteikšanai piemērošanas simulācija (Projekta kopsavilkuma ziņojums)" (Elaboration of soil and terrain data and simulation of application of the criteria elaborated by the European Commission for identification of less valuable regions (Summary of the project report)), Latvijas Republikas Zemkopības Ministrija, 2010.*

Table 6.8 Summary of land use change matrix (1000 ha)

Changes	To Forest land	To Cropland	To Grassland	To Settlements	To Wetland	To Other land
1990	**3124.22**	**1842.24**	**798.24**	**238.82**	**448.35**	**5.44**
From Forest land		21.43	7.73	23.78	9.41	0.00
From Cropland	1.75		146.65	2.11	0.00	0.00
From Grassland	214.27	0.00		13.82	6.13	0.00
From Settlements	9.11	2.60	12.70		1.51	0.00
From Wetland	12.38	0.13	6.14	1.12		0.00
From Other land	0.00	0.00	0.00	0.00	0.00	
2014	**3299.38**	**1715.89**	**737.23**	**253.73**	**445.63**	**5.44**

Table 6.9 Land use change matrix (1000 ha)

Changes	To Forest land	To Cropland	To Grassland	To Settlements	To Wetland	To Other land
Land use change 1989-1990						
1989	3 122.06	1 840.33	802.90	238.23	448.35	5.43
From Forest land	1 840.33	1.91		0.59		
From Cropland	802.90		0.00			
From Grassland	238.23					
From Settlements	448.35					
From Wetland	4.32					
From Other land						
Land use change 1990-1991						
1990	3 124.22	1 842.24	798.24	238.82	448.35	5.44
From Forest land		1.91		0.59		
From Cropland			6.87			
From Grassland	6.85					
From Settlements						
From Wetland						
From Other land						
Land use change 1991-1992						
1991	3 128.56	1 837.27	798.26	239.41	448.35	5.44
From Forest land		1.91		0.59		
From Cropland			5.20			
From Grassland	9.22					
From Settlements						
From Wetland						
From Other land						
Land use change 1992-1993						
1992	3 135.28	1 833.98	794.24	240.01	448.35	5.44
From Forest land		1.91		0.59		
From Cropland			6.95			
From Grassland	10.70					

Changes	To Forest land	To Cropland	To Grassland	To Settlements	To Wetland	To Other land
From Settlements						
From Wetland						
From Other land						
Land use change 1993-1994						
1993	3 143.49	1 828.93	790.49	240.60	448.35	5.44
From Forest land		1.91		0.59		
From Cropland			7.34			
From Grassland	8.68					
From Settlements						
From Wetland						
From Other land						
Land use change 1994-1995						
1994	3 149.67	1 823.50	789.15	241.19	448.35	5.44
From Forest land		1.91		0.59		
From Cropland			7.56			
From Grassland	13.09					
From Settlements						
From Wetland						
From Other land						
Land use change 1995-1996						
1995	3 160.27	1 817.85	783.61	241.78	448.35	5.44
From Forest land		0.79		0.47		
From Cropland			8.27			
From Grassland	14.38					
From Settlements						
From Wetland						
From Other land						
Land use change 1996-1997						
1996	3 173.39	1 810.36	777.51	242.26	448.35	5.44
From Forest land		0.79		0.47		
From Cropland			8.21			
From Grassland	13.12					
From Settlements						
From Wetland						
From Other land						
Land use change 1997-1998						
1997	3 185.24	1 802.95	772.60	242.73	448.35	5.44
From Forest land		0.79		0.47		
From Cropland			6.61			
From Grassland	13.96					
From Settlements						

Changes	To Forest land	To Cropland	To Grassland	To Settlements	To Wetland	To Other land
From Wetland						
From Other land						
Land use change 1998-1999						
1998	3 197.95	1 797.12	765.24	243.20	448.35	5.44
From Forest land		0.79		0.47		
From Cropland			8.78			
From Grassland	12.50					
From Settlements						
From Wetland						
From Other land						
Land use change 1999-2000						
1999	3 209.19	1 789.13	761.52	243.67	448.35	5.44
From Forest land		0.79		0.47		
From Cropland			7.53			
From Grassland	14.20					
From Settlements						
From Wetland						
From Other land						
Land use change 2000-2001						
2000	3 222.13	1 782.39	754.84	244.15	448.35	5.44
From Forest land		0.69		0.89		
From Cropland			9.89			
From Grassland	16.11					
From Settlements						
From Wetland						
From Other land						
Land use change 2001-2002						
2001	3 236.66	1 773.20	748.62	245.04	448.35	5.44
From Forest land		0.69		0.89		
From Cropland			7.35			
From Grassland	13.66					
From Settlements						
From Wetland						
From Other land						
Land use change 2002-2003						
2002	3 248.73	1 766.53	742.32	245.92	448.35	5.44
From Forest land		0.69		0.89		
From Cropland			7.82			
From Grassland	10.74					
From Settlements						
From Wetland						
From Other land						

Changes	To Forest land	To Cropland	To Grassland	To Settlements	To Wetland	To Other land
Land use change 2003-2004						
2003	3 257.90	1 759.41	739.39	246.81	448.35	5.44
From Forest land		0.69		0.89		
From Cropland			9.13			
From Grassland	14.62					
From Settlements						
From Wetland						
From Other land						
Land use change 2004-2005						
2004	3 270.95	1 750.97	733.90	247.70	448.35	5.44
From Forest land		0.69		0.89		
From Cropland			9.39			
From Grassland	12.48					
From Settlements						
From Wetland						
From Other land						
Land use change 2005-2006						
2005	3 281.85	1 742.26	730.82	248.59	448.35	5.44
From Forest land		0.69		0.89		
From Cropland			9.65			
From Grassland	9.39					
From Settlements						
From Wetland						
From Other land						
Land use change 2006-2007						
2006	3 289.65	1 733.30	731.09	249.48	448.35	5.44
From Forest land		0.69		0.89		
From Cropland			9.92			
From Grassland	9.19					
From Settlements						
From Wetland						
From Other land						
Land use change 2007-2008						
2007	3 297.27	1 724.07	731.81	250.36	448.35	5.44
From Forest land		0.69		0.89		
From Cropland			10.18			
From Grassland	11.37					
From Settlements						
From Wetland						
From Other land						
Land use change 2008-2009						
2008	3 307.06	1 714.58	730.62	251.25	448.35	5.44

Changes	To Forest land	To Cropland	To Grassland	To Settlements	To Wetland	To Other land
From Forest land		0.41	1.29	1.89	1.57	
From Cropland	0.29			0.35		
From Grassland				2.30	1.02	
From Settlements	1.52	0.43	2.12		0.25	
From Wetland	2.06	0.02	1.02	0.19		
From Other land						
Land use change 2009-2010						
2009	3 305.78	1 714.80	731.72	251.66	447.90	5.44
From Forest land		0.41	1.29	1.89	1.57	
From Cropland	0.29			0.35		
From Grassland				2.30	1.02	
From Settlements	1.52	0.43	2.12		0.25	
From Wetland	2.06	0.02	1.02	0.19		
From Other land						
Land use change 2010-2011						
2010	3 304.50	1 715.02	732.82	252.08	447.44	5.44
From Forest land		0.41	1.29	1.89	1.57	
From Cropland	0.29			0.35		
From Grassland				2.30	1.02	
From Settlements	1.52	0.43	2.12		0.25	
From Wetland	2.06	0.02	1.02	0.19		
From Other land						
Land use change 2011-2012						
2011	3 303.22	1 715.24	733.93	252.49	446.99	5.44
From Forest land		0.41	1.29	1.89	1.57	
From Cropland	0.29			0.35		
From Grassland				2.30	1.02	
From Settlements	1.52	0.43	2.12		0.25	
From Wetland	2.06	0.02	1.02	0.19		
From Other land						
Land use change 2012-2013						
2012	3 301.94	1 715.45	735.03	252.90	446.54	5.44
From Forest land		0.41	1.29	1.89	1.57	
From Cropland	0.29			0.35		
From Grassland				2.30	1.02	
From Settlements	1.52	0.43	2.12		0.25	
From Wetland	2.06	0.02	1.02	0.19		
From Other land						
Land use change 2013-2014						
2013	3 300.66	1 715.67	736.13	253.32	446.09	5.44
From Forest land		0.41	1.29	1.89	1.57	

Changes	To Forest land	To Cropland	To Grassland	To Settlements	To Wetland	To Other land
From Cropland	0.29			0.35		
From Grassland				2.30	1.02	
From Settlements	1.52	0.43	2.12		0.25	
From Wetland	2.06	0.02	1.02	0.19		
From Other land						
2014	3299.38	1715.89	737.23	253.73	445.63	5.44

6.3 INFORMATION ON APPROACHES USED FOR REPRESENTING LAND AREAS AND ON LAND-USE DATABASES USED FOR THE INVENTORY PREPARATION

Spatial approach is used to represent area of forest land, grassland, cropland, wetlands, settlements and other lands. Activity data are provided by the National forest inventory (NFI)[184]. Source data of the inventory (about 16000 plots representing 400 ha each) are used in calculations of land use and land use changes, as well as drainage and rewetting of forest land. The NFI data are adapted to the harmonized country area for the whole accounting period and to land use categories used in the GHG inventory. Two cycles of the NFI (2004-2008 and 2009-2013) are used in the GHG inventory.

Research data (LANDSAT images based remote sensing studies) are used to identify forest and woody areas converted to cropland and settlement as well as extensively managed croplands, like biological farms, where considerable area of arable land is set aside for a longer time period and can be reported by the NFI teams as grassland or forest land, depending from structure of vegetation. Vegetation index were estimated in all the NFI points, including those outside forest lands in satellite image series from 1990, 1995 and 2000 to identify points where vegetation index permanently changed from values characteristic for forest lands to the one's characteristic for settlements, grassland and cropland.

Area of cropland considerably increased and area of grasslands decreased, when research data were applied, in comparison to the original NFI data, because extensively managed farmlands (biological farms and grassland utilized in forage production) are accounted under cropland category as well as lands, which at least once per 10 years have value of vegetation index typical for cropland.

Land use categories (except forest land) converted to cropland are estimated since 2009, when the 2nd cycle of the NFI was started in Latvia; however, there are no evidences of conversion of considerable area of land use categories to cropland since 1990 due to the fact that the area of cropland continuously decreased until 2008. Later according to the NFI data it is stabilizing; however, it is complicated to identify, if returning to conventional agricultural practice are occasional cases or it is continuous process. Therefore, there is 5 years delay period (between 2 NFI cycles) to approve land use change from grassland to cropland or opposite, as well as afforestation and conversion of forest land to grassland.

[184] *Source – http://www.silava.lv/userfiles/file/Meza%20statistiska%20inventarizacija/Kopsavilkumi%202014%20I%20ciklis%20(2).xlsx; http://www.silava.lv/userfiles/file/Meza%20statistiska%20inventarizacija/Kopsavilkumi%202014%20II%20ciklis%20(2).xlsx*

Area of land converted to settlements before 2004 is estimated using LANDSAT satellite images within the scope of the project "Elaboration and integration into National greenhouse gas inventory report matrices of land use changes of areas belonging to Kyoto protocol article 3.3 and 3.4 activities"[185].

6.4 FOREST LAND (CRF 4.A)

6.4.1 Category description

From 1990 to 2013 forest land was a net sink, but in 2014 forest land was a net source because the total emissions resulting from forest land were bigger than the total removals. Total GHG emissions from forest lands, excluding harvested wood products in 2014 were 745.83 kt CO_2 eq. (Figure 6.2).

Forest land category includes emissions and removals resulting from carbon stock changes in living biomass, litter, dead wood, organic soils and emissions from drainage and rewetting of organic soils as well as biomass burning. Forest land category is subdivided into Forest land remaining forest land (CRF 4.A.1) and Land converted to forest land more than 20 years ago (CRF 4.A.2). The aggregated net GHG emissions from forest land remaining forest were 370.68 kt of CO_2 eq. in Latvia in 2014, excluding removals in harvested wood products (respectively -1817.58 kt CO_2) and emissions from drainage and rewetting of organic soils (respectively 810.72 kt CO_2 eq.). The net emissions from land converted to forest in 2014 were -435.57 kt CO_2 eq. (Figure 6.2).

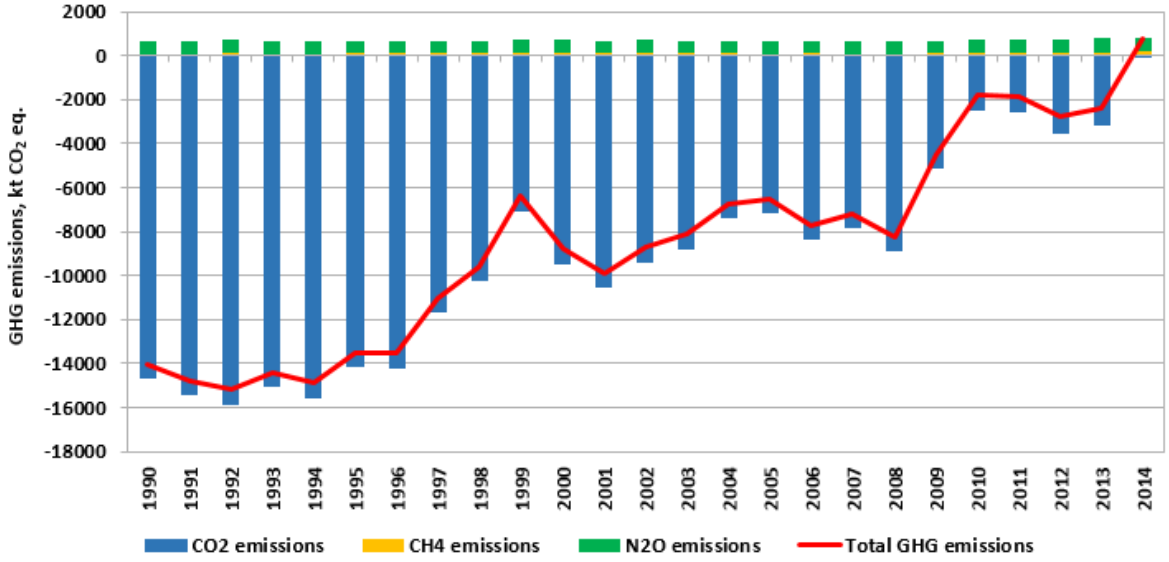

Figure 6.2 Summary of GHG emissions in forest land (kt CO_2 eq.)

There are several key source and sink categories in forest land in Latvia – CO_2 in Forest Land remaining Forest Land and CO_2 in Land converted to Forest Land as well as 3 key source categories (CO_2, CH_4 and N_2O) under Emissions and removals from drainage and rewetting

[185] *Lazdiņš and Zariņš, "Elaboration and integration into National greenhouse gas inventory report matrices of land use changes of areas belonging to Kyoto protocol article 3.3 and 3.4 activities (Report on research work contracted by the Ministry of Environment of republic of Latvia)."*

and other management of organic and mineral soils which are now evaluated separately in the CRF reporter.

The estimation of the area of forest land is based on the NFI[186].

The NFI and research data are used to estimate time series for areas and gross increment. Mortality data are calculated on the base of the NFI data and mortality factors, considering linear correlation between the modelled mortality in 2009-2014 and actual mortality data for the whole period[187]. Distinction between forest land remaining forest land and areas converted to forest land is made according to the age of dominant species in forests on afforested land – if age of dominant species was less than zero in 1990, it is considered as land converted to forest, in other cases it is considered as forest land remaining forest land.

Carbon stock changes in above and below ground living and dead biomass are reported in the submission. Decay factor for dead wood including harvesting residues not incinerated on-site is considered 20 years. Changes of organic carbon in litter and soil organic matter in naturally dry and wet soils are assumed to be zero according to research data on carbon stock in forest soil in 2006 and 2012[188].

Carbon stock changes are reported separately on naturally dry and wet mineral and organic soils and drained mineral and organic soils. Soils are considered organic as defined in the NFI: a soil is classified as organic if the organic layer (H horizon) is at least 20 cm deep. Distribution of the forest site types according to the NFI is shown in Table 6.10. Conversion of forest stands on drained mineral or organic soil to naturally wet soil is accounted as rewetting.

Table 6.10 Distribution of drained, naturally dry and wet mineral and organic soils in Latvia's forests, 1000 ha

Year	Forest at the end of year	Forest on dry mineral soils	Forest on drained mineral soils	Forest on wet mineral soils	Forest on drained organic soils	Forest on wet organic soils
1990	3124.22	1544.49	611.03	262.82	432.75	273.13
1991	3128.56	1547.62	612.29	262.93	432.81	272.91
1992	3135.28	1553.75	612.63	263.38	432.83	272.70
1993	3143.49	1560.73	613.49	263.50	432.89	272.88
1994	3149.67	1564.29	616.19	263.65	432.54	273.01
1995	3160.27	1573.23	618.24	263.41	432.60	272.79
1996	3173.39	1583.28	619.44	265.04	433.06	272.58
1997	3185.24	1592.98	619.68	265.83	433.90	272.87
1998	3197.95	1602.72	620.49	266.87	434.45	273.42
1999	3209.19	1612.69	622.15	266.75	434.28	273.31
2000	3222.13	1623.61	622.71	267.53	434.87	273.41
2001	3236.66	1636.02	625.28	267.29	434.76	273.30

[186] *http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls*

[187] *Lazdiņš, Donis, and Strūve, Latvijas Meža Apsaimniekošanas Radītās Ogļskābās Gāzes (CO_2) Piesaistes Un Siltumnīcefekta Gāzu (SEG) Emisiju References Līmeņa Aprēķina Modeļa Izstrāde (Elaboration of calculation model for evaluation of GHG emissions and CO_2 removals due to forest management).*

[188] *Lazdiņš et al., "Temporary Carbon Stock Changes in Forest Soil in Latvia"; Lazdiņš et al., Mežsaimniecisko Darbību Ietekmes Uz Siltumnīcefekta Gāzu Emisijām Un CO_2 Piesaisti Novērtējums (pārskats Par 2012. Gada Darba Uzdevumu Izpildi).*

Year	Forest at the end of year	Forest on dry mineral soils	Forest on drained mineral soils	Forest on wet mineral soils	Forest on drained organic soils	Forest on wet organic soils
2002	3248.73	1647.32	626.10	267.61	434.54	273.16
2003	3257.90	1655.39	627.50	267.46	434.52	273.03
2004	3270.95	1667.23	627.79	267.83	435.20	272.89
2005	3281.85	1677.04	628.80	268.08	435.18	272.75
2006	3289.65	1684.20	629.60	267.91	435.33	272.62
2007	3297.27	1689.66	630.73	268.88	435.11	272.88
2008	3307.06	1698.81	631.23	268.73	435.30	273.00
2009	3305.78	1676.17	681.61	260.91	445.56	241.54
2010	3304.50	1653.52	731.99	253.08	455.83	210.08
2011	3303.22	1630.88	782.36	245.26	466.10	178.62
2012	3301.94	1608.24	832.74	237.43	476.37	147.15
2013	3300.66	1585.59	883.12	229.61	486.64	115.69
2014	3299.38	1586.32	882.16	229.39	485.96	115.55

The carbon stock change in living biomass is estimated with the default method of the 2006 IPCC Guidelines – carbon uptake and release of the living biomass correspond to the mean gross annual increment of forest growing stock, annual harvesting of trees and decay due to natural mortality.

The time series for annual increment of growing stock of trees on a forest land remaining forest are given in Table 6.11 and in the land converted to forest – in Table 6.12.

The dynamics of carbon stock changes in living biomass is very much affected by commercial felling. The demand for timber products was low at the beginning of the 1990s; therefore, felling was also at a low level and the CO_2 sink of trees was high. The felling stock increased during 1990s and reached top average in early 2000s. Updated figures[189] of felling, including biofuel gathering, are shown in Table 6.13.

The Land converted to forest land provides relatively small net increment of growing stock of trees – about 0.27 mill. M^3 in 2014. Taking into account that these forests are generally young stands, no emissions from commercial felling are considered. Areas afforested 20 years ago (in 1990-1993) are accounted under the forest land remaining forest land category.

Table 6.11 Annual increment of growing stock of trees on the forest land remaining forest, 1000 m^3

Year	Aspen	Grey alder	Birch	Spruce	Black alder	Oak, ash	Other	Pine	Total
1990	3684.80	2033.55	7745.47	4015.37	1666.90	281.19	531.56	6345.51	26304.35
1991	3681.85	2031.92	7739.27	4012.15	1665.57	280.96	531.14	6340.43	26283.28
1992	3678.90	2030.29	7733.06	4008.93	1664.23	280.74	530.71	6335.35	26262.21
1993	3675.95	2028.66	7726.86	4005.72	1662.89	280.51	530.28	6330.26	26241.14
1994	3757.81	2187.73	7872.38	4593.49	1826.05	288.24	470.81	6397.34	27393.83
1995	3754.79	2185.97	7866.05	4589.80	1824.58	288.00	470.43	6392.19	27371.81
1996	3753.27	2185.08	7862.85	4587.93	1823.84	287.89	470.24	6389.60	27360.7
1997	3751.74	2184.19	7859.66	4586.07	1823.10	287.77	470.05	6387.00	27349.58
1998	3750.22	2183.31	7856.46	4584.20	1822.36	287.65	469.86	6384.41	27338.46

[189] *Values updated according to results of the second NFI cycle.*

Year	Aspen	Grey alder	Birch	Spruce	Black alder	Oak, ash	Other	Pine	Total
1999	3378.42	2251.29	7748.63	5315.08	1865.29	275.51	455.05	6575.32	27864.59
2000	3377.04	2250.37	7745.48	5312.92	1864.53	275.40	454.87	6572.65	27853.26
2001	3375.32	2249.22	7741.54	5310.21	1863.58	275.26	454.63	6569.30	27839.08
2002	3373.61	2248.08	7737.60	5307.51	1862.63	275.12	454.40	6565.96	27824.91
2003	3371.89	2246.93	7733.66	5304.81	1861.68	274.98	454.17	6562.61	27810.73
2004	2333.51	2386.37	6740.73	5176.77	1474.25	297.33	372.51	7467.19	26248.65
2005	2332.32	2385.15	6737.30	5174.13	1473.50	297.18	372.32	7463.38	26235.27
2006	2331.13	2383.93	6733.86	5171.49	1472.75	297.03	372.13	7459.57	26221.88
2007	2329.94	2382.72	6730.42	5168.85	1471.99	296.88	371.94	7455.76	26208.5
2008	2328.75	2381.50	6726.99	5166.21	1471.24	296.72	371.75	7451.95	26195.11
2009	2675.44	2137.61	6420.48	5238.86	1514.00	382.17	230.97	6268.39	24867.92
2010	2675.01	2137.26	6419.45	5238.02	1513.76	382.11	230.93	6267.38	24863.93
2011	2676.48	2138.43	6422.97	5240.90	1514.59	382.32	231.06	6270.82	24877.56
2012	2680.01	2141.26	6431.44	5247.81	1516.59	382.82	231.36	6279.09	24910.38
2013	2684.83	2145.10	6443.00	5257.24	1519.31	383.51	231.78	6290.37	24955.14
2014	4019.14	2394.16	4504.76	3311.98	4099.90	1584.68	266.02	4121.84	24302.47

Table 6.12 Increment of growing stock of timber on the Land converted to forest[190]

Year	Net increment, m^3	Stem biomass, 1000 tonnes	Crown biomass, 1000 tonnes	Below-ground biomass, 1000 tonnes	Total biomass, 1000 tonnes
1990	123.46	0.05	0.02	0.02	0.08
1991	503.10	0.21	0.06	0.06	0.34
1992	1280.42	0.53	0.16	0.17	0.85
1993	2586.57	1.06	0.33	0.33	1.72
1994	4457.40	1.83	0.57	0.58	2.98
1995	7045.30	2.89	0.90	0.91	4.71
1996	10494.13	4.31	1.35	1.36	7.01
1997	14868.59	6.10	1.91	1.92	9.94
1998	20248.26	8.31	2.60	2.62	13.53
1999	26663.37	10.90	3.50	3.48	17.88
2000	34194.50	13.98	4.48	4.46	22.92
2001	42959.33	17.57	5.63	5.60	28.8
2002	52978.38	21.67	6.95	6.91	35.52
2003	64202.65	26.26	8.42	8.37	43.04
2004	76724.97	31.15	10.17	10.01	51.33
2005	90560.76	36.77	12.00	11.81	60.58
2006	105645.13	42.89	14.00	13.78	70.67
2007	121948.77	49.51	16.16	15.91	81.58
2008	139524.09	56.65	18.49	18.20	93.33
2009	158210.04	64.29	21.13	20.68	106.11
2010	177913.00	72.30	23.77	23.26	119.32
2011	198587.36	80.70	26.53	25.96	133.19
2012	220202.45	89.48	29.42	28.79	147.69
2013	242735.73	98.64	32.43	31.73	162.8
2014	266169.86	108.25	37.08	32.94	178.26

[190] *Andis Lazdiņš and Juris Zariņš, "Elaboration and integration into National greenhouse gas inventory report matrices of land use changes of areas belonging to Kyoto protocol article 3.3 and 3.4 activities (Report on research work contracted by the Ministry of Environment of republic of Latvia)" (LVMI Silava, 2010).*

Table 6.13 Harvesting stock, in 1000 m^3

Year	Total excluding deforestation	Aspen	Grey alder	Birch	Spruce	Black alder	Oak, ash	Other	Pine
1990	6297.55	568.35	405.01	1827.46	1355.42	109.19	24.32	0.01	2007.79
1991	5531.97	499.26	355.78	1605.3	1190.64	95.92	21.36	0.01	1763.71
1992	5056.33	456.33	325.19	1467.27	1088.27	87.67	19.53	0.01	1612.06
1993	5991.69	540.75	385.34	1738.7	1289.59	103.89	23.14	0.01	1910.28
1994	7217.00	651.33	464.15	2094.27	1553.31	125.13	27.87	0.01	2300.93
1995	8672.69	782.71	557.77	2516.69	1866.62	150.37	33.49	0.01	2765.04
1996	8519.11	768.85	547.89	2472.12	1833.56	147.71	32.9	0.01	2716.07
1997	11239.43	1014.36	722.84	3261.52	2419.05	194.88	43.41	0.01	3583.36
1998	12632.65	1140.1	812.44	3665.81	2718.91	219.03	48.79	0.02	4027.55
1999	16925.69	1527.54	1088.54	4911.59	3642.9	293.47	65.36	0.02	5396.26
2000	13855.70	1269.63	666.58	4099.53	3867.38	0.00	50.45	0.00	3902.15
2001	13037.03	1235.76	593.86	3613.68	3394.98	233.06	34.57	0.00	3931.13
2002	14090.92	1399.42	816.16	3979.92	3512.58	223.99	40.51	0.00	4118.34
2003	14599.66	1473.65	996.39	3944.79	3300.02	231.89	48.93	0.00	4604
2004	13542.74	1282.88	1075.65	3795.57	2934.95	246.67	45.72	0.00	4161.3
2005	14209.18	847.32	839.85	3597.28	3705.24	261.3	83.08	0.00	4875.1
2006	12340.08	1180.35	860.65	3561.31	2380.31	255.29	52.55	0.00	4049.62
2007	12752.59	1178.77	1076.25	3854.25	2548.87	254.88	64.54	0.19	3774.86
2008	11287.94	990.28	894.22	3294.99	1982.87	256.93	46.12	0.00	3822.53
2009	13512.24	1214	767.53	3959.2	2155.57	254.86	55.14	0.00	5105.93
2010	16349.84	1424.07	1036.82	5710.6	2397.14	374.76	56.47	0.00	5349.99
2011	16021.22	1427.85	1247.55	4373.28	2738.8	280.85	83.37	10.64	5858.88
2012	14769.69	1170.11	4402.3	1257.07	2372.49	219.03	57.44	10.81	5280.43
2013	14685.05	1188.45	4311.92	1305.46	2413.89	285.54	76.3	9.63	5093.86
2014	16565.55	1725.32	2713.66	3185.66	2592.08	434.41	85.75	786.25	5199.67

The total area of the Land converted to forest is shown in Table 6.14 and Table 6.15. In 2010 it start to reduce, because area afforested in 1990-1993 in the convention reporting is accounted under the forest land remaining forest land category.

Table 6.14 Total area of the land converted to forest, 1000 ha

Year	Land converted to forest at the end of year	Forest on dry mineral soils	Forest on drained mineral soils	Forest on wet mineral soils	Forest on drained organic soils	Forest on wet organic soils
1990	4.66	3.97	0.38	0.26	0.00	0.05
1991	11.50	8.31	2.12	0.62	0.40	0.05
1992	20.73	15.66	2.94	1.31	0.76	0.05
1993	31.43	23.86	4.29	1.67	1.16	0.45
1994	40.11	28.63	7.46	2.07	1.16	0.79
1995	53.20	38.79	10.00	2.07	1.56	0.79
1996	67.59	50.05	11.68	2.71	2.36	0.79
1997	80.71	60.37	12.16	3.62	3.37	1.19
1998	94.67	70.72	13.22	4.79	4.09	1.85
1999	107.17	81.31	15.12	4.79	4.09	1.85
2000	121.38	92.84	15.92	5.69	4.86	2.06
2001	137.48	105.86	18.74	5.89	4.92	2.06
2002	151.14	117.93	19.86	6.37	4.92	2.06
2003	161.88	126.77	21.57	6.37	5.12	2.06
2004	176.51	139.38	22.16	6.89	6.01	2.06
2005	188.98	149.96	23.47	7.29	6.2	2.06

Year	Land converted to forest at the end of year	Forest on dry mineral soils	Forest on drained mineral soils	Forest on wet mineral soils	Forest on drained organic soils	Forest on wet organic soils
2006	198.37	157.88	24.58	7.29	6.57	2.06
2007	207.56	164.11	26.02	8.41	6.57	2.46
2008	218.93	174.03	26.82	8.41	6.97	2.71
2009	222.81	177.11	27.29	8.56	7.09	2.76
2010	226.68	180.19	27.77	8.71	7.21	2.8
2011	230.55	183.27	28.24	8.86	7.34	2.85
2012	234.42	186.35	28.71	9.0	7.46	2.9
2013	238.30	189.42	29.19	9.15	7.58	2.95
2014	242.17	192.5	29.66	9.3	7.71	3.0

Table 6.15 Area of the land converted to forest more than 20 years ago, 1000 ha

Year	Land converted to forest > 20 years ago	Forest on dry mineral soils	Forest on drained mineral soils	Forest on wet mineral soils	Forest on drained organic soils	Forest on wet organic soils
2010	4.66	3.97	0.38	0.26	0.00	0.05
2011	11.50	8.31	2.12	0.62	0.40	0.05
2012	20.73	15.66	2.94	1.31	0.76	0.05
2013	31.43	23.86	4.29	1.67	1.16	0.45
2014	40.11	28.63	7.46	2.07	1.16	0.79

6.4.2 Methodological issues

6.4.2.1 Forest land remaining forest land (CRF 4.A.1)

Calculations of carbon stock changes and GHG emissions in forest lands are based on activity data provided by the NFI (area, living biomass and dead wood) and Level I forest monitoring data (soil organic carbon). National statistics (State forest service) are used to estimate commercial felling related emissions and removals. The calculation of GHG emissions and CO_2 removals in historical forest lands is based mainly on research report "Elaboration of the model for calculation of the CO_2 removals and GHG emissions due to forest management"[191] and factors and coefficients elaborated within the scope of the research program on impact of forest management on GHG emissions and CO_2 removals[192].

Changes of the carbon stock and GHG emissions are estimated according to the Tier 2 methods with country specific data. Default method (the carbon loss to be subtracted from the carbon removals for the reporting year) is used in calculations of removals and emissions of CO_2 in living biomass.

Methodologies for estimation of carbon stock changes and GHG emissions are considerably improved; they are now merged together into the "Emissions projection & inventory model (EPIM)", which is complex spreadsheet. Separate versions (with different input data) are elaborated for the UNFCCC and the Kyoto protocol reporting. In future these tools will be

[191] *Lazdiņš, A., Donis, J., Strūve, L., 2012. Latvijas meža apsaimniekošanas radītās ogļskābās gāzes (CO_2) piesaistes un siltumnīcefekta gāzu (SEG) emisiju references līmeņa aprēķina modeļa izstrāde (Elaboration of the model for calculation of the CO_2 removals and GHG emissions due to forest management) (No. 5.5-9.1-0070-101-12-91). LVMI Silava, Salaspils. Lazdiņš, A., Donis, J., Strūve, L., 2012b. Latvia's national methodology for reference level of forest management activities (English summary).*

[192] *Lazdiņš et al., Mežsaimniecisko Darbību Ietekmes Uz Siltumnīcefekta Gāzu Emisijām Un CO_2 Piesaisti Novērtējums (pārskats Par 2013. Gada Darba Uzdevumu Izpildi).*

merged to simplify calculations. The tool is still under development, current working version can be downloaded from the website "Land use, land use change and forestry sector in Latvia"[193].

The concept of the EPIM:

Land use and land use change data are elaborated separately to simplify tool structure, the connection is organized as linked tables;

- main input data – area under different growth and management conditions, species composition, gross annual increment, mortality per area, harvesting rate and species composition and others;
- calculations are done on annual basis using periodic (5 years period) and annual input data;
- historical data (1990-2004) – backward calculation on the base of the NFI data; for 1970-1989 research data and expert judgements are utilized;
- all modules in the spreadsheet are merged together following to the forest management cycle (from growth to decay);
- the tool combines all land use and land use change categories.

Content of the tool (separate calculation sheets):

- living biomass (annual increment of living biomass, summary of growing stock and characteristics of biomass);
- mortality (natural reduction of number of living trees, estimation of decay of harvesting residues, calculation of dynamics of carbon stock in dead biomass);
- commercial harvesting (input to the harvested wood products, losses in above-ground and below-ground biomass);
- harvested wood products (carbon stock change in locally originated and consumed harvested wood products);
- emissions from soils (CO_2, CH_4 and N_2O from drained organic soils and CH_4, DOC, CO_2 emissions from rewetted soils in forest land and wetlands);
- fire (emissions of CO_2, CH_4 and N_2O due to incineration of harvesting residues and wildfires);
- conversion from forests (as a land use change to estimate area of managed forests);
- afforestation (carbon stock change in living biomass, dead wood and litter);
- cropland (emissions from soil, carbon stock change in living and dead biomass);
- grassland (emissions from soil, carbon stock change in living and dead biomass, wildfires);
- conversion of farmland (emissions or removals in soil);

[193] *https://drive.google.com/folderview?id=0Bxv4jQ_04jXZNTM5aGNDTVdRVzQ&usp=sharing*

- settlements (carbon stock change in soil, living and dead biomass);
- managed wetlands (emissions from soil, carbon stock change in living and dead biomass).

Module for estimation of the gross annual increment of living biomass:

- increment figures on the base of the NFI data on timber stock changes and mortality rate[194];
- species, age of stands and dimensions specific gross increment equations for the most common tree species (values specific for birch are used for other tree species);
- species specific wood densities (Table 6.16), different BEFs (Table 6.17);
- average carbon stock in biomass is provided in Table 6.18.

The figures in are based on stock change in forest stands with different dominant species.

Table 6.16 Wood density[195]

Species	Density, tonnes m^{-3}
Aspen	0.40
Grey alder	0.41
Birch	0.47
Spruce	0.36
Black alder	0.41
Oak, ash	0.41
Other species (mostly *Salix* sp.)	0.41
Pine	0.38

Table 6.17 Coefficients for calculation of above ground biomass from stem biomass

Species	Stem biomass to crown biomass	Stem biomass to below-ground biomass
Aspen	1.22	0.28
Grey alder	1.45	0.34
Birch	1.19	0.29
Spruce	1.58	0.43
Black alder	1.45	0.28
Oak, ash	1.45	0.18
Other species	1.45	0.27
Pine	1.27	0.31

[194] *Jānis Donis, Latvijas Meža Resursu Ilgtspējīgas, Ekonomiski Pamatotas Izmantošanas Un Prognozēšanas Modeļu Izstrāde (Salaspils: LVMI Silava, 2011), http://www.zm.gov.lv/doc_upl/MAF2011_S82.pdf; Lazdiņš, Donis, and Strūve, Latvijas Meža Apsaimniekošanas Radītās Ogļskābās Gāzes (CO_2) Piesaistes Un Siltumnīcefekta Gāzu (SEG) Emisiju References Līmeņa Aprēķina Modeļa Izstrāde.*

[195] *Lazdiņš et al., Mežsaimniecisko Darbību Ietekmes Uz Siltumnīcefekta Gāzu Emisijām Un CO_2 Piesaisti Novērtējums (pārskats Par 2013. Gada Darba Uzdevumu Izpildi).*

Table 6.18 Average carbon stock in living biomass

Species	C, kg in tonne of dry biomass[196]
Aspen	508
Grey alder	522
Birch	521
Spruce	528
Black alder	522
Oak, ash	522
Other species	522
Pine	531

Mortality and decay:

- species specific coefficients of mortality (Table 6.19) not dependant on size of tree (dominant or undergrowth trees), depend on the age of stand and average dimensions of trees;
- calculations on the base of NFI using backward calculation for 5 years period, assuming equal rate of commercial thinning in the 1990s;
- 20 years decomposition period (mortality since 1970 considered as emissions);
- constant mortality values considered for periods before 1990.

Table 6.19 Average periodic mortality (m^3 ha^{-1} yr^{-1})[197]

Species	1970-1993	1994-1998	1999-2003	2004-2008	2009-2012	2013	2014
Aspen	1.97	2.35	2.37	2.32	2.32	2.94	2.97
Grey alder	0.36	0.40	0.43	0.58	0.58	2.60	2.54
Birch	1.92	2.01	1.90	1.72	1.72	2.17	2.10
Spruce	1.95	2.12	2.33	2.48	2.48	3.00	2.77
Black alder	1.57	1.71	1.78	1.98	1.98	2.58	2.65
Oak, ash	2.76	3.20	3.21	3.46	3.46	4.84	4.88
Other species	0.90	0.79	0.81	0.93	0.93	2.79	1.70
Pine	1.39	1.49	1.66	1.78	1.78	1.67	1.79

Commercial felling:

- dominant species specific harvesting data since 1970 (1990-2013 Central statistical bureau updated by NFI data, 2014 NFI, 1970-1989 research papers[198]);
- decomposition of crown and underground biomass – 20 years; species specific wood densities and different BEFs for coniferous and deciduous trees (Table 6.16 and Table 6.17).

The methodology for harvested wood products is based on Rüter, S., 2011[199]. More detailed description follows in further chapters.

[196] Dried at 105 °C temperature.

*[197] Lazdiņš et al., Mežsaimniecisko Darbību Ietekmes Uz Siltumnīcefekta Gāzu Emisijām Un CO_2 Piesaisti Novērtējums (pārskats Par 2013. Gada Darba Uzdevumu Izpildi); Lazdiņš, Donis, and Strūve, Latvijas Meža Apsaimniekošanas Radītās Ogļskābās Gāzes (CO_2) Piesaistes Un Siltumnīcefekta Gāzu (SEG) Emisiju References Līmeņa Aprēķina Modeļa Izstrāde.**

[198] Zigurds Saliņš, Mežs - Latvijas Nacionālā Bagātība (Jelgava: Jelgavas tipogrāfija, 2002); Zigurds Saliņš, Meža izmantošana Latvijā: stāvoklis, perspektīvas (Jelgava [Latvia]: LLU Meza izmantosanas katedra, 1999).

Emissions from drained soils are accounted – 2.6 tonnes C ha^{-1} and 2.8 kg N_2O-N ha^{-1} (IPCC Wetlands Supplement) annually from organic soils.

Area of organic soils in the forest lands is reported according to structure of distribution of the forest stand types. Total area of organic soils as well as total area of forests was updated according to research data on land use structure according to the NFI[200].

New project was implemented in 2014 to estimate carbon stock change in organic forest soil due to establishment of drainage system[201]. The empiric material is collected in experimental trials established in early 60^{ths}. According to the study results no soil carbon losses take place due to drainage of organic soil in comparison to naturally wet site; however, more experimental data are necessary to extrapolate these results to the whole area of Latvia.

Drained organic soil in forest land is source of CH_4 emissions. CH_4 emissions are calculated by equation 2.6 in IPCC Wetlands Supplement (equation No. 1 in the NIR).

$$CH_{4_organic} = A * \left(\left(1 - Frac_{ditch}\right) * EF_{CH_4_land} + Frac_{ditch} * EF_{CH_4_ditch} \right); \text{ where}$$

$CH_{4_organic}$ – annual CH_4 loss from drained organic soils, kg $CH_4\, yr^{-1}$

A – land area of drained organic soils in a land – use category, ha

$EF_{CH_4_land}$ – emission factor for direct CH_4 emissions from drained organic soils, kg $CH_4\, ha^{-1}\, yr^{-1}$

$EF_{CH_4_ditch}$ – emission factor for CH_4 emissions from drainage ditches, kg $CH_4\, ha^{-1}\, yr^{-1}$

$Frac_{ditch}$ – fraction of the total area of drained organic soil which is ocupied by ditches

(1)

The CH_4 emission factor for organic soils of drained forest land (Table 2.3 and Table 2.4 in IPCC Wetlands Supplement) is 2.5 kg CH_4 ha^{-1} yr^{-1} and emission factor for drainage ditches is 217 kg CH_4 ha^{-1} yr^{-1}. Data for fraction of drainage ditches of total drained area on organic soils is obtained by evaluation fraction of ditches in state managed forest lands to all drained forest organic soils.

GHG emissions from rewetted organic soils are estimated according to the Tier 1 methods. CO_2 emissions are calculated using equation 3.3:

$$CO_2 - C_{rewetted\ org\ soil} = CO_2 - C_{composite} + CO_2 - C_{DOC}; \text{ where}$$

$CO_2 - C_{rewetted\ org\ soil}$ – CO_2 – C emissions / removals from rewetted organic soils, tonnes C yr^{-1}

$CO_2 - C_{composite}$ – CO_2 – C emissions / removals from the soil and non – tree vegetation, tonnes C yr^{-1}

$CO_2 - C_{DOC}$ – off – site CO_2 – C emissions from dissolved organic carbon exported from rewetted organic soils, tonnes C yr^{-1}

(2)

[199] *Projection of Net Emissions from Harvested Wood Products in European Countries, Johann Heinrich von Thünen Institute, Hamburg.*

[200] *Lazdiņš and Zariņš, "Elaboration and integration into National greenhouse gas inventory report matrices of land use changes of areas belonging to Kyoto protocol article 3.3 and 3.4 activities (Report on research work contracted by the Ministry of Environment of republic of Latvia)."*

[201] *Andis Lazdiņš, Aldis Butlers, and Ainārs Lupiķis, "Case Study of Soil Carbon Stock Changes in Drained and Afforested Transitional Bog," in Foresst Ecosystems and Its Management: Towards Understanding the Complexity (presented at the 9th Baltic theriological conference, Ilgas: Latvian State Forest Research Institute "Silava," 2014); Andis Lazdiņš and Ainārs Lupiķis, Hidrotehniskās Meliorācijas Ietekme Uz CO_2 Emisijām Mežaudzēs Uz Susinātām Augsnēm (Salaspils, 2014), Salaspils.*

complemented by equations 3.4 and 3.5 of the IPCC Wetlands Supplement.

$$CO_2-C_{composite}=\sum_{c,n}\left(A*EF_{CO2}\right);\ where$$

$A_{c,n}-area\ of\ rewetted\ organic\ soils\ in\ climate\ zone\ c\ and\ nutrient\ status\ n,\ ha$
$EF_{CO2c,n}-CO_2-C\ emission\ factor\ for\ rewetted\ organic\ soils\ in\ climate\ zone\ c,\ nutrient\ status\ n,\ tonnes\ C\ ha^{-1}\ yr^{-1}$

(3)

$$CO_2-C_{DOC}=\sum_{c}\left(A*EF_{DOC_REWETTED}\right);\ where$$

$A_c-area\ of\ rewetted\ organic\ soils\ in\ climate\ zone\ c,\ ha$
$EF_{DOC_rewetted,c}-CO_2-C\ emission\ factor\ from\ DOC\ exported\ from\ rewetted\ organic\ soils\ in\ climate\ zone\ c,\ tonnes\ C\ ha^{-1}\ yr^{-1}$

(4)

Emission factors for CO_2-C (0.5 tonnes CO_2-C ha^{-1} yr^{-1}) and DOC (0.24 tonnes CO_2-C ha^{-1} yr^{-1}) are taken from Tables 3.1 and 3.2 of the IPCC Wetlands Supplement. N_2O emissions from rewetted organic soils according to Tier 1 method are assumed to be negligible and are not estimated, CH_4 emissions are calculated applying Tier 1 method using equation 3.7 of the IPCC Wetlands Supplement (equation No. 5). Default emission factor (216 kg CH_4-C ha^{-1} yr^{-1}) from Table 3.3 was used (Table 6.20).

$$CH_4-C_{rewetted\ org\ soil}=\frac{\sum_{c,n}\left(A*EF_{CH4soil}\right)c,n}{1000};\ where$$

$CH_4-C_{rewetted\ org\ soil}-CH_4-C\ emissions/removals\ from\ rewetted\ organic\ soils,\ tonnes\ C\ yr^{-1}$
$A_c,n-area\ of\ rewetted\ organic\ soils\ in\ climate\ zone\ c\ and\ nutrient\ status\ n,\ ha$
$EF_{CH4soil}-emission\ factor\ from\ rewetted\ organic\ soils\ in\ climate\ zone\ c\ and\ nutrient\ status\ n,\ kg\ CH_4-C\ ha^{-1}\ yr^{-1}$

(5)

Table 6.20 Emission factors for rewetted organic soils, tonnes C ha^{-1} yr^{-1}

No	GHG	Emission factor
1	CO_2	0.5
2	CH_4	0.216

Rewetting is reported under forest land – conversion of forests on drained organic soils to forest on naturally wet soil. The conversion is usually approved by changes in ground vegetation and groundwater table during the site visits. Rewetting takes place due to wearing of drainage systems. In 2014, total rewetted area according to comparison of the NFI data is 12.04 kha. It is assumed, that the rewetting was linear and 2 kha of forests were rewetted every year from 2009 to 2014 according to an average figures for 2009-2013 provided by the NFI and linear extrapolation of 5 years average in 2014. Total emissions from soil due to rewetting in 2014 approached to 108.7 kt CO_2 eq. (Figure 6.3).

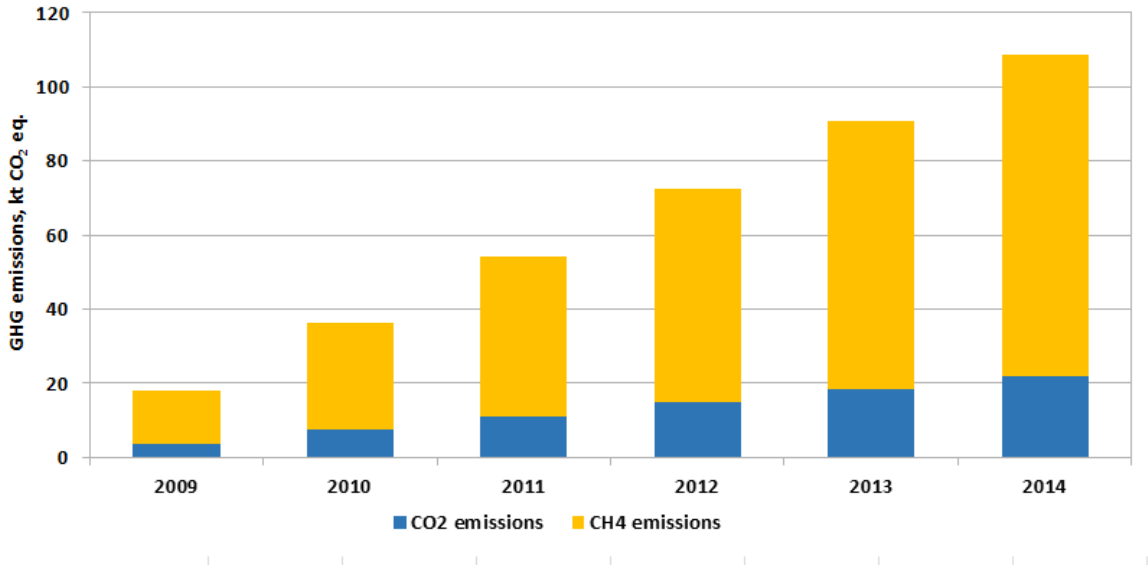

Figure 6.3 Emissions due to rewetting (kt CO_2 eq.)

6.4.2.2 Land converted to forest land (CRF 4.A.2)

In section lands converted to forest land all categories except grasslands converted to forest land are noted as NO because other conversions do not take place in practice. Grasslands converted to forest land are estimated using spatial approach – analysis of the NFI data about forests on former farmland (land being cropland and grassland before 1990) which was afforested after 1990. Areas where trees did not reach 2 cm diameter at breast height were excluded from estimation and accounted under grassland category to avoid accounting of extensively managed farmlands under forest land category. The year of afforestation of every single NFI plot selected for analysis was determined by subtraction of age of stand from a year when field measurements were done.

Gains in living biomass on afforested lands are estimated using interpolation (stock change method assuming that the increment structure in areas afforested in different periods is similar)[202]. Weighted average wood density for a particular year in forest land remaining forest is used to convert stem volume to biomass. Similarly, average carbon stock in living biomass and BEFs characteristic for particular year were applied to calculation. 2015 is the second year, when, both, carbon stock change in living biomass in land remaining forest and land converted to forest is calculated using Tier 2 method.

Losses of living biomass in afforested lands are noted as NO because no commercial felling takes place in these stands (the smallest commercially and legally valuable harvesting age is 30 years for grey alder).

Emissions from organic soils in afforested lands were calculated using the same approach as for emissions from drained organic soils on lands remaining forest.

[202] *L.U. Consulting, "Augšņu un reljefa izejas datu sagatavošana un Eiropas Komisijas izstrādāto augsnes un reljefa kritēriju mazā labvēlīgo apvidu noteikšanai piemērošanas simulācija (Projekta kopsavilkuma ziņojums)" (Elaboration of soil and terrain data and simulation of application of the criteria elaborated by the European Commission for identification of less valuable regions (Summary of the project report)), Latvijas Republikas Zemkopības Ministrija, 2010.*

This is the second year when dead wood and litter are accounted as sink categories in afforested lands. It is assumed that average stock of dead wood, and consequently in litter in historical forest lands and afforested lands becomes equal at certain stand age. The assumption is based on the NFI field measurements considering that increment of the dead wood stock in afforested areas will follow linear regression and will reach values characteristic for the forest land within 150 years.

It is assumed in the calculation, that dead wood stock in afforested lands will reach 1.1 tonnes C ha^{-1} within 150 years. Values of average carbon stock in dead wood in 1990-2014 were used in calculation. Similarly, weighted average above-ground and below-ground biomass expansion factors and carbon content in living biomass for a particular year obtained in living biomass calculations are used to convert stem biomass to the total biomass.

Average carbon stock in litter is 12.1 tonnes C ha^{-1} according to the BioSoil project forest soil inventory data[203]. Considering the same transformation period of 150 years, average increment of carbon stock in the litter carbon pool is 0.08 tonnes C ha^{-1}.

No removals in soil are accounted due to conversion to forest land, because there are no scientific evidences of increase of carbon stock in soil after afforestation. The project started in 2012 on comparison of carbon stock in historical cropland and grassland shows no difference in carbon stock between grassland, recently afforest land and historical forest land in the upper soil layer (0-40 cm)[204]; however, there are evidences of statistically significant carbon stock changes in deeper soils layers after afforestation[205].

6.4.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainties are estimated on the base the NFI and expert judgement. Uncertainty of soil carbon (CO_2) emissions are estimated according to data obtained within the scope of the international forest soil monitoring project BioSoil and values provided in the IPCC Wetlands Supplement. The uncertainty of CO_2 emission factor according to IPCC Wetlands Supplement (Table 2.1) in organic soil is 25 %.

The uncertainty of area (Table 6.21) is estimated as standard error of proportion (equation No. 10).

[203] *Bārdule et al., "Forest soil characteristic in Latvia according results of the demonstration project BioSoil (Latvijas meža augsņu īpašību raksturojums demontrācijas projekta BioSoil rezultātu skatījumā)."*

[204] *Andis Lazdiņš, Atbalsts Klimata Pētījumu Programmai (starpziņojums Par 2012. Gada Darba Uzdevumu Izpildi) (Salaspils: LVMI Silava, 2012), https://sites.google.com/site/lvlulucf/research-projects/atbalstsklimatapetijumuprogrammaistarpzinojumspar2012gadarezultatiem.*

[205] *R. Kasparinskis et al., "Long term impact of afforestation on soil morphology and properties, Lauksaimniecības zemju apmežošanās ilgtermiņa ietekme uz augsnes morfoloģiju un īpašībām," Forest science no. 24(57) p. 17–40 (2011), http://agris.fao.org/agris-search/search/display.do?f=2012%2FLV%2FLv1203.xml%3BLV2012000112.*

Table 6.21 Uncertainty of the forest land use data in 2014

Land use category	Number of NFI plots	Share of NFI plots, %	Uncertainty, %
Forest land	8322	51.5	1.5
forest land remaining forest land	7885	48.8	1.6
drained organic soil	1116	6.9	5.3
other soil	5040	31.2	2.3
land converted to forest land	437	2.7	8.0
drained organic soil	10	0.1	43.5
other soil	380	2.4	8.7

Uncertainty of annual increment of growing stock of trees in forest lands is 0.9 %, uncertainty of increment on afforested lands 16 %. Uncertainties calculated according to 2006 IPCC Guidelines Volume 1, Chapter 3 as twice the relative standard error. For harvesting stock, uncertainty according to forest regulations is 10 %. BEFs utilized in calculations according to expert judgement have uncertainty level of 0.9-2.0 % for different species, 0.8 % in average according to the study results. Combined category uncertainty is calculated according to 2006 IPCC Guidelines TIER 1 – simple propagation of errors.

95 % confidence interval for CH_4 emission factor for drained organic soil of forest land is -0.6-+5.7 kg CH_4 ha^{-1} yr^{-1}. Uncertainty range of CH_4 emission factor for drainage ditches in drained forest land is 41-393 kg CH_4 ha^{-1} yr^{-1} (IPCC Wetlands Supplement, Table 2.3 and Table 2.4).

Uncertainty range of CO_2-C emission factor for rewetted organic soils is -0.71-+1.71 tonnes CO_2-C ha^{-1} yr^{-1} (IPCC Wetlands Supplement, Table 3.1). Uncertainty range of CO_2-C emission factor from DOC exported from rewetted organic soils is 0.14-0.36 tonnes CO_2-C ha^{-1} yr^{-1} (IPCC Wetlands Supplement, Table 3.2). 95% range of CH_4-C emission factor from rewetted organic soils is 0-856 kg CH_4-C ha^{-1} yr^{-1} (IPCC Wetlands Supplement, Table 3.3).

6.4.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the LULUCF sector in order to achieve these quality objectives.

Quality control procedures listed in 2006 IPCC Guidelines Chapter 4.4.3 were implemented for all calculations, including elaboration of country specific BEFs, wood density and carbon content factors. Several quality meetings are held annually between experts.

The NFI data have gone through the following QC measures:

- field gauges and instruments were checked and calibrated;
- new instruments were tested to find possible differences in measurement results compared with the old ones;
- before field surveying, field personnel has had a training period to ascertain that observers are able to use the equipment correctly, that observers do measurements and classifications correctly and that the guidelines and instructions are understood correctly;
- verification measurements were carried out during field seasons;

- field data are checked by evaluation if all sample plots are measured, no required information is missing (if missing entries are found, they are completed and re-measurement is done, if necessary), the compatibility between data variables is checked using logical controls;
- calculated results are compared with the results of previous inventories. If considerable or unexpected changes are found, reasons for the changes were clarified and explained.

Work on improvement of tree height and timber equations used in calculations in the NFI and development of verification tools continues therefore changes in the input data provided by the NFI are possible.

The NFI team applies quality guidelines and QA/QC measures to the all work stages. Documentation is in Latvian with brief descriptions of NFI methods and measurements in English[206].

The data based on forest statistics were produced by the LSFRI Silava[207]. Data descriptions are available including the applied definitions, methods of data compilation, reliability and comparability. It was confirmed that all data used in this section cover whole land area of Latvia.

6.4.5 Category-specific recalculations

Recalculations are done due to recalculation of the NFI data based on repeated measurement of borders of the plots and their sectors. Summary of the impact of recalculation on the aggregated net GHG emissions from forest land is shown in Figure 6.4.

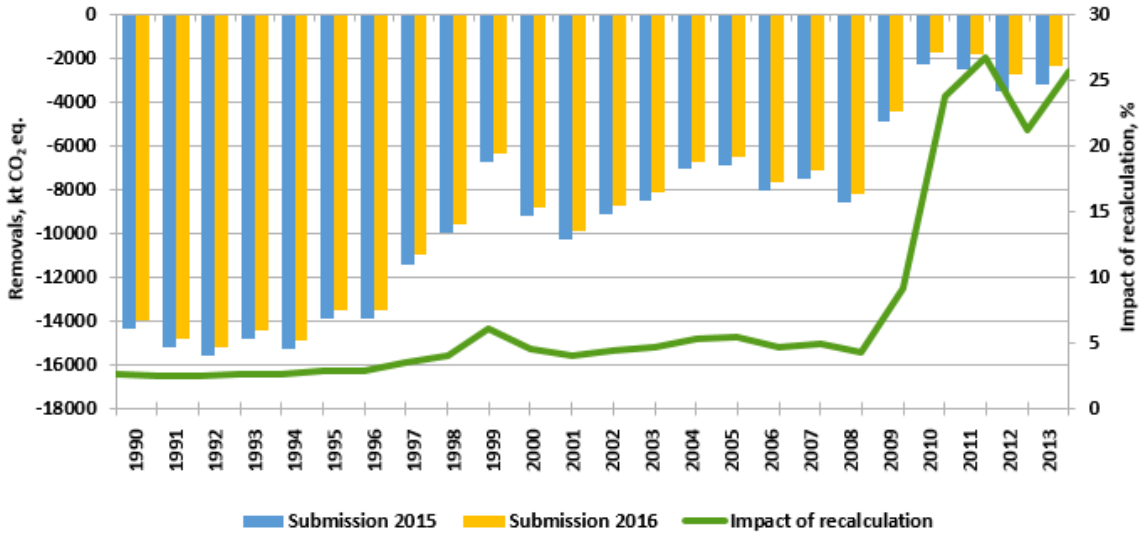

Figure 6.4 Impact of recalculation on the aggregated net GHG emissions from forest land

[206] *Zemkopības ministrija, "Meža statistiskās inventarizācijas veikšanas un mežaudzes sekundāro parametru aprēķināšanas metodika (instrukcija Nr. 10 no 17.03.2004.)" (Latvijas Republikas Zemkopības ministrija, 2004),https://sites.google.com/site/lvlulucf/literature/MSI_metodika_Instrukcija_%282004%29.pdf?attredirects=0&d=1; LSFRI Silava, "Methods utilized to recalculate historical forest increment data" (LSFRI Silava, 2007), https://sites.google.com/site/lvlulucf/literature/Recalculationsofhystoricalremovals2007.pdf?attredirects=0&d=1.*

[207] *http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls*

6.4.6 Category-specific planned improvements

The most important planned improvements:

- estimation of decay period for dead wood (harvesting residues and below-ground biomass, planned to complete until report 1990-2015);
- estimation of carbon stock changes in drained organic soils in forest lands (2016);
- estimation of transition period for dead wood and litter carbon stock in afforested lands (2015-2018);
- development of production version of EPIM tool, including instantaneous calculation of uncertainties, broader representation of land use change options and closer integration of Kyoto protocol and the UNFCCC reporting (2016);
- improvement and simplification of structure of land use change calculation tool, including uncertainty estimates.

6.5 CROPLAND (CRF 4.B)

6.5.1 Category description

Cropland remaining cropland and land converted to cropland is a key source category of CO_2 emissions. Under the cropland's category emissions from organic soils (CO_2, N_2O and CH_4), living and dead woody biomass (CO_2) are reported. Net aggregated emissions from cropland remaining cropland were 2589.20 kt of CO_2 in 2014 (excluding 119.05 kt of CO_2 eq. emissions from drained organic soils, Figure 6.5). Decrease of CO_2 emissions in cropland remaining cropland is associated with land use change from cropland to grassland. The net GHG emissions from land converted to croplands in 2014 (excluding emissions from drainage of organic soils) were 182.15 kt CO_2 eq. (Figure 6.6).

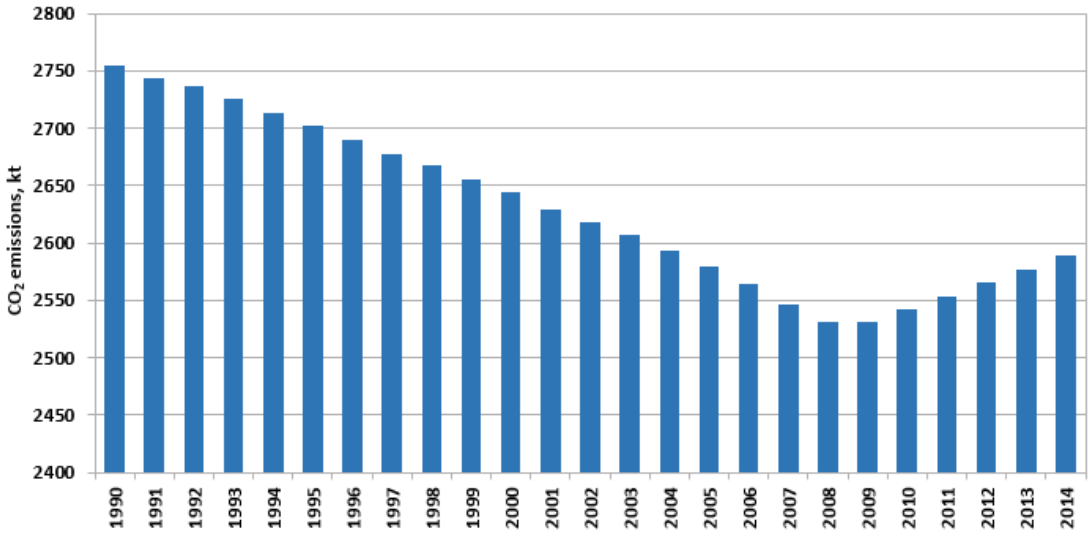

Figure 6.5 Summary of CO_2 emissions in cropland remaining cropland (kt)

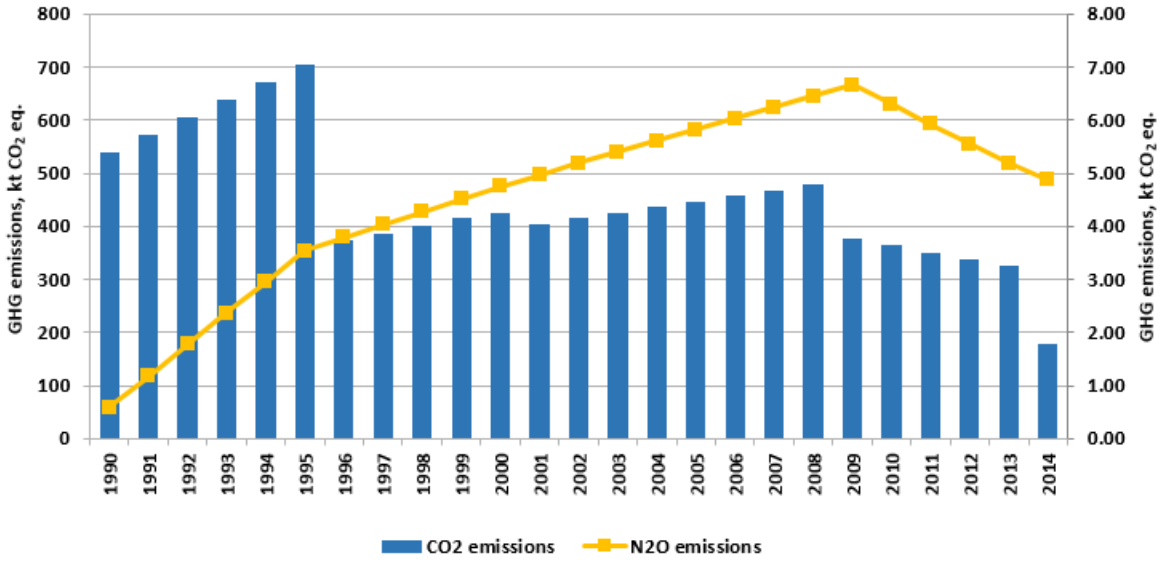

Figure 6.6 Summary of GHG emissions from land converted to cropland[208] (kt CO_2 eq.)

The total area of croplands is estimated using the approach described further in chapter Category-specific recalculations and following to research results. Updated values split into cropland remaining cropland, land converted to cropland at least 20 years ago and land converted to cropland less than 20 years ago are shown in Table 6.22. The land converted to cropland more than 20 years ago are reported under cropland remaining cropland category. The most of the land converted to cropland is forest land. Other types of land use changes have minor impact.

There is statistically significant increase of volume of growing stock of trees in cropland. After completion of the 2nd round of the NFI, the stock change method can be applied to characterize biomass of living trees in cropland on the base of stock changes during 5 years period.

Table 6.22 Area of cropland (1000 ha)

Year	Cropland	Land remaining cropland		Land converted to cropland	
		organic soil	other soils	organic soil	other soils
1990	1842.24	95.33	1745.00	0.43	1.48
1991	1837.27	94.97	1738.49	0.86	2.95
1992	1833.98	94.70	1733.56	1.29	4.43
1993	1828.93	94.34	1726.96	1.72	5.91
1994	1823.50	93.96	1720.00	2.15	7.39
1995	1817.85	93.57	1712.84	2.58	8.86
1996	1810.36	93.14	1704.99	2.76	9.47
1997	1802.95	92.72	1697.21	2.94	10.08
1998	1797.12	92.38	1690.94	3.12	10.69
1999	1789.13	91.92	1682.61	3.30	11.30
2000	1782.39	91.53	1675.48	3.48	11.91
2001	1773.20	91.02	1666.10	3.64	12.44

[208] *N_2O on secondary axis*

Year	Cropland	Land remaining cropland		Land converted to cropland	
		organic soil	other soils	organic soil	other soils
2002	1766.53	90.64	1659.13	3.80	12.97
2003	1759.41	90.23	1651.72	3.96	13.50
2004	1750.97	89.76	1643.06	4.12	14.03
2005	1742.26	89.27	1634.15	4.28	14.56
2006	1733.30	88.77	1625.00	4.44	15.09
2007	1724.07	88.26	1615.59	4.60	15.62
2008	1714.58	87.73	1605.94	4.76	16.15
2009	1714.80	87.70	1605.33	4.87	16.90
2010	1715.02	87.67	1604.73	4.98	17.64
2011	1715.24	87.63	1604.12	5.09	18.40
2012	1715.45	87.60	1603.51	5.19	19.16
2013	1715.67	87.57	1602.90	5.28	19.93
2014	1715.89	87.53	1602.29	5.37	20.70

6.5.2 Methodological issues

6.5.2.1 Cropland remaining cropland (CRF 4.B.1)

Activity data for calculations are provided by research project[209] (area of organic soils). Area of land remaining cropland is estimated using remote sensing based research data[210] on the base of the NFI. Area of organic soils in farmland according to summaries of land surveys is 5.18 ± 0.5 %. This value characterizes area of cropland before 1990, because it is based on field measurements completed in 60^{ths}, 70^{ths} and early 80^{ths}. It is assumed that share of organic soil in cropland remaining cropland, cropland converted to grassland, grassland converted to cropland and grassland remaining grassland is equal. Minor changes are introduced by conversion of forest land on organic soil to cropland and grassland. Therefore, the area of organic soil in cropland is linearly correlating with the total area of cropland. In 2014 according to this estimation there were 89.72 kha of organic soil in cropland remaining cropland and 3.34 kha in land converted to cropland. The study data on distribution of organic soil show that only about 2.2 % of farmlands are located on organic soil, including 1.0 % of cropland and 2.9 % of grassland; however, this study does not demonstrate, what are the driving forces of reduction of area of cropland on organic soil – if it is land use change or decomposition of organic layer driven phenomena[211].

Carbon stock change in living and dead woody biomass is based on activity data provided by the NFI. The biomass increment is used in calculations before 2009 and stock change method is applied for calculations in 2009-2014 assuming linear increment of carbon stock in cropland. Carbon stock in living and dead biomass is calculated using the same coefficients

[209] *L.U. Consulting, "Augšņu un reljefa izejas datu sagatavošana un eiropas komisijas izstrādāto augsnes un reljefa kritēriju mazā labvēlīgo apvidu noteikšanai piemērošanas simulācija (Projekta kopsavilkuma ziņojums)."*

[210] *Lazdiņš and Čugunovs, Oglekļa Dioksīda (CO₂) Piesaistes Un Siltumnīcefekta Gāzu (SEG) Emisiju Un Zemes Lietojuma Veida Ietekmes Novērtējums Intensīvi Un Ekstensīvi Kultivētās Aramzemēs, Daudzgadīgos Zālājos Un Bioloģiski Vērtīgos Zālājos; Lazdiņš and Zariņš, Vēsturiskās (1990. Gada) Apsaimniekoto Aramzemju Platības Noteikšana Un Līdz 2009. Gadam Notikušo Aramzemju Platības Izmaiņu Novērtēšana.*

[211] *Lazdiņš et al., Atbalsts Klimata Pētījumu Programmai (Pārksats Par Projekta 2013. Gada Darba Uzdevumu Izpildi).*

as in calculations of carbon stock changes in forested land. All conversion factors for estimation of carbon in biomass are developed domestically[212].

Net carbon stock changes in mineral soil in cropland are reported as not occurring because no significant changes in management systems took place since 1990 and according to Tier 1 method of the 2006 IPCC Guidelines Chapter 5[213] the carbon stock changes in mineral soil should be reported in case of changes in management practice.

The assumptions used in EPIM tool for estimation of carbon stock change in living and dead biomass are shown in Table 6.23, default 20 years decay period is considered for dead wood.

Table 6.23 Assumptions for calculation of carbon stock changes in living and dead biomass in cropland

Year	Cropland with woody vegetation, 1000 ha	Gross increment of living biomass		Wood density, kg m^{-3}	Natural mortality, m^3 ha^{-1}	BEFs		Carbon content, kg t^{-1}
		mill. M^3	m^3 ha^{-1}			stem to crown	stem to below-ground	
1990	2.34	0.01	2.52	0.41	0.48	0.31	0.31	523
1991	2.34	0.01	2.52	0.41	0.48	0.31	0.31	523
1992	2.34	0.01	2.52	0.41	0.48	0.31	0.31	523
1993	2.34	0.01	2.52	0.41	0.48	0.31	0.31	523
1994	2.65	0.01	2.52	0.41	0.49	0.31	0.32	523
1995	2.65	0.01	2.52	0.41	0.49	0.31	0.32	523
1996	2.65	0.01	2.52	0.41	0.49	0.31	0.32	523
1997	2.65	0.01	2.52	0.41	0.49	0.31	0.32	523
1998	2.65	0.01	2.52	0.41	0.49	0.31	0.32	523
1999	2.65	0.01	2.52	0.41	0.5	0.32	0.32	523
2000	2.65	0.01	2.52	0.41	0.5	0.32	0.32	523
2001	2.65	0.01	2.52	0.41	0.5	0.32	0.32	523
2002	2.65	0.01	2.52	0.41	0.5	0.32	0.32	523
2003	2.65	0.01	2.52	0.41	0.5	0.32	0.32	523
2004	2.65	0.01	2.52	0.41	0.54	0.33	0.32	524
2005	2.65	0.01	2.52	0.41	0.54	0.33	0.32	524
2006	2.65	0.01	2.52	0.41	0.54	0.33	0.32	524
2007	1.45	0.01	6.19	0.41	1.34	0.33	0.32	524
2008	1.45	0.01	6.19	0.41	1.34	0.33	0.32	524
2009	1.45	0.01	6.19	0.41	1.42	0.33	0.32	524
2010	1.45	0.01	6.19	0.41	1.42	0.33	0.32	524
2011	1.45	0.01	6.19	0.41	1.42	0.33	0.32	524
2012	1.45	0.01	6.10	0.41	1.40	0.33	0.32	524
2013	1.46	0.01	6.19	0.41	1.82	0.33	0.32	524
2014	1.46	0.01	6.29	0.41	1.85	0.34	0.30	524

CO_2 emissions from drained organic soils in croplands were calculated using IPCC Wetlands Supplement Tier 1 method. Emission factor – 7.9 t C ha^{-1} annually.

Drained organic soil in cropland is source of CH_4 emissions. CH_4 emissions are calculated by equation 2.6 in IPCC Wetlands Supplement. The emission factor for organic soils (Table 2.3 and table 2.4 in IPCC Wetlands Supplement) is 0±2.8 kg CH_4 ha^{-1} yr^{-1} (cropland, drained) and

[212] Andis Lazdiņš et al., Mežsaimniecisko Darbību Ietekmes Uz Siltumnīcefekta Gāzu Emisijām Un CO_2 Piesaisti Novērtējums (pārskats Par 2013. Gada Darba Uzdevumu Izpildi) (Salaspils, 2013), Salaspils.

[213] Section 5.2.3.1 Choice of Method, Tier 1.

emission factor for drainage ditches 1165±830 kg CH_4 ha^{-1} yr^{-1} (deep – drained cropland); respectively, only CH_4 emissions from ditches are calculated. Drainage systems on organic soils are considered. Area of ditches is considered equally proportional to area of drained organic soil in cropland. High resolution satellite images were used to estimate coverage of ditches in organic soils – 30 randomly selected drainage systems overlapping with former or current peat extraction sites (Figure 6.7) and obtained value (0.3 km ha^{-1}) was extrapolated to all organic soils.

Figure 6.7 Sample area used to estimate area of ditches in organic soils

6.5.2.2 Land converted to cropland (CRF 4.B.2)

Transition period for all land use changes is considered 20 years; respectively, land converted to cropland in 1990 is accounted under the cropland remaining cropland category in 2010. Land use changes to cropland in 1990-2008 are estimated using remote sensing based evaluation of vegetation index. The same data are used to identify extensively managed cropland, initially reported under grassland remaining grassland category.

Area of organic soil in land converted to cropland is calculated using different approach than in cropland remaining cropland. Instead of using proportion of area of organic soil in the final land use category, the values characteristic for initial land use are applied. Respectively, if share of organic soil in forest land remaining forest in 1990 is 22 %, it is considered, that area of organic soil in forest land converted to cropland in 1990 is 22 %[214].

Unlike to cropland remaining cropland carbon stock change in living biomass in forest land converted to cropland is calculated as losses in living biomass due to felling of trees, considering average carbon stock in living biomass in forest land remaining forest in a particular year. Losses in dead wood are accounted similarly, as loss of average carbon stock in dead wood in a particular year. Carbon stock in litter is considered as constant value 12.14 ± 2.8 t C ha-1 according to the BioSoil project results in fertile stand types (*Hylocomiosa, Oxalidosa, Myrtilloso-sphagnosa, Myrtillosoi-polytrichosa, Myrtillosa mel.,*

[214] *Lazdiņš, Bārdule, and Stola, "Preliminary Results of Evaluation of Area of Organic Soils in Arable Lands in Latvia."*

Mercurialosa mel.). Instant oxidation method is applied to living biomass, dead wood and litter carbon pools.

Carbon stock changes in mineral soil are estimated using Equation 2.25 of the 2006 IPCC Guidelines. Impact factors for calculations of the carbon stock change under different management activities are taken from Table 5.5 in 2006 IPCC Guidelines:

- FLU 0.69 (Long-term cultivated, Temperate moist);
- FMG 1.00 (Full tillage, Temperate dry and wet);
- FI 1.00 (Medium input, all).

The initial carbon stock in mineral forest soil at 0-30 cm depth (reference C stock) is 82.6 ± 7.8 t ha^{-1} according to the forest soil monitoring project BioSoil[215]. Forest stand types similar to agricultural lands are selected to calculate average carbon stock in forest soil (*Hylocomiosa, Oxalidosa, Myrtilloso-sphagnosa, Myrtillosoi-polytrichosa, Myrtillosa mel., Mercurialosa mel.*). Initial carbon stock at 0-30 cm depth in grassland is considered 77 ± 6.9 t ha^{-1}. The carbon stock in forest land converted to cropland after transition period of 20 years according to the Equation 2.25 is 57 t C ha^{-1} at 0-30 cm depth; respectively, reduction of carbon stock in mineral soils is 25.6 t ha^{-1} or 1.3 t C ha^{-1} annually. The carbon stock in grassland converted to cropland after transition period of 20 years according to the Equation 2.25 is 52.7 t C ha^{-1} at 0-30 cm depth; respectively, reduction of carbon stock in mineral soils is 23.7 t ha^{-1} or 1.2 t C ha^{-1} annually.

In organic soil of forest land and grassland converted to cropland the factor for cropland remaining cropland (7.9 t C ha^{-1} annually) is used to estimate carbon stock changes.

The same approach as for cropland remaining cropland is used to calculate CH_4 emissions from drainage ditches.

6.5.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty of area estimates is provided in Table 6.24.

Table 6.24 Uncertainty of the cropland use data in 2014

Land use category	Number of NFI plots	Share of NFI plots, %	Uncertainty, %
Cropland	4295	26.6	2.6
cropland remaining cropland	4255	26.3	2.6
organic soil	221	1.4	13.3
other soil	4034	25.0	2.7
land converted to cropland	40	0.3	53.4
organic soil	5	0.03	113.9
other soil	35	0.2	64.5

[215] *Lazdiņš et al., Mežsaimniecisko Darbību Ietekmes Uz Siltumnīcefekta Gāzu Emisijām Un CO_2 Piesaisti Novērtējums (pārskats Par 2013. Gada Darba Uzdevumu Izpildi).*

The uncertainty of CO_2 emission factor for organic soil is determined according to IPCC Wetlands Supplement. According to Table 5.5 of the 2006 IPCC Guidelines the uncertainty of impact factor for different management practices applied in croplands is 12 % for long term cultivating. No uncertainty is considered for full tillage and medium input (impact factor – 1). Uncertainty of CH_4 emission factor for drainage ditches is 71 % (Table 2.4 in IPCC Wetlands Supplement).

Uncertainty of average carbon stock in litter in forests is 23 %, uncertainty of carbon stock in mineral soil in forest land at 0-30 cm is 9 %, uncertainty of dead wood stock in forests is 2 %, uncertainty of carbon stock in dead wood according to the expert judgement is 30 %; the combined uncertainty of carbon stock in dead wood is 31 %.

Consistency of time series of calculations is secured by use of the NFI data for the cropland and grassland area and the NFI based remote sensing analysis for land use changes. The estimation of area of organic soil represents situation before 1990. Area of cropland on organic soil might be overestimated; however, more accurate data are expected in the Agricultural soil mapping project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy ", which will be completed in 2016.

6.5.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the LULUCF sector in order to achieve these quality objectives.

The QA/QC plans for the cropland category includes the QC measures based on the IPCC (2006 IPCC Guidelines, Chapter 5.4.3, Tier 1 based QA/QC). The QA/QC procedures are implemented during every inventory. Several quality meetings are held annually between experts. Potential errors and inconsistencies are documented and corrections are made if necessary. Land use, as well as carbon stock in living and dead biomass related QA/QC procedures is implemented within the scope of the standard NFI procedure by re-measuring of 20 % of all sample plots. Training of the NFI field teams takes place every spring before starting the field works.

A part of remote sensing data (10 %) was evaluated manually during the remote analysis to estimate uncertainty of the automatic classification of vegetation index.

6.5.5 Category-specific recalculations

Recalculations are done due to recalculation of the NFI data based on repeated measurement of borders of the plots and their sectors. Summary of the impact of recalculation on the aggregated net GHG emissions from cropland is shown in Figure 6.8.

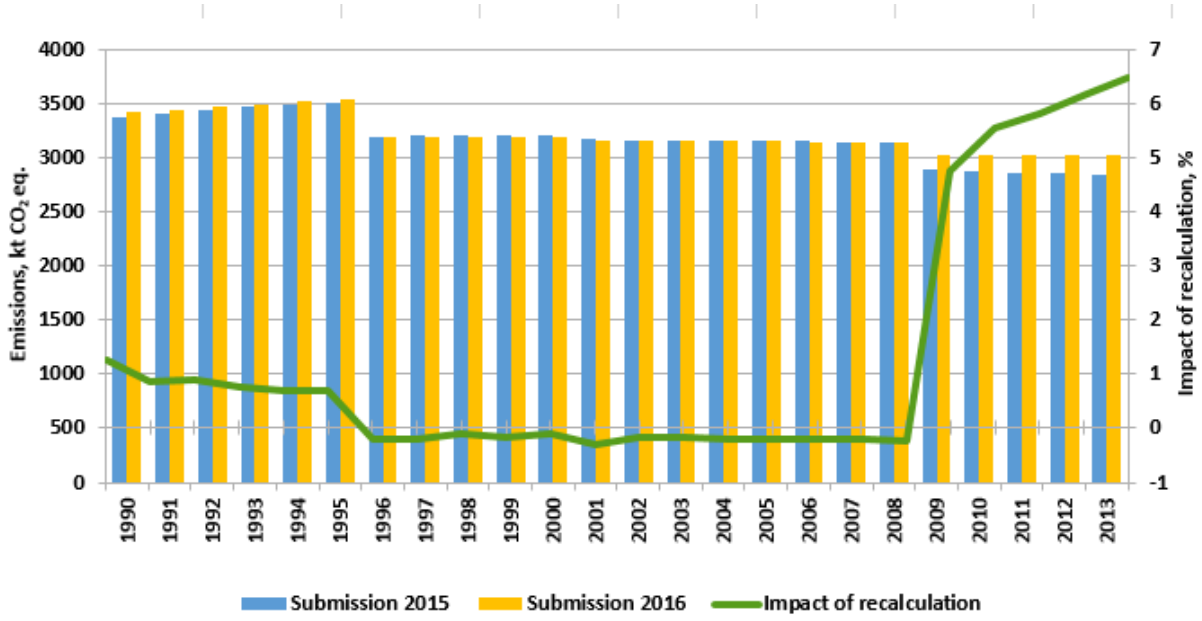

Figure 6.8 Impact of recalculation on the aggregated net GHG emissions from cropland

6.5.6 Category-specific planned improvements

There are several improvements proposed for the following inventories:

- updated area of organic soil in cropland according to the NFI study started in 2012[216]; the same values of share of organic soil will be used for land converted to cropland. Logarithmic regression will be used in time series to reduce share of organic soil in cropland before 1990 (5.18 %) to the actual value;
- updated CO_2 emissions from organic soil considering area changes and recent findings in Nordic and Baltic countries, particularly, doctoral thesis by Jüri-Ott Salm "Emission of greenhouse gases CO_2, CH_4, and N_2O from Estonian transitional fens and ombrotrophic bogs: the impact of different land-use practice"[217].
- updated N_2O emissions due to land use changes using emphyrical data on carbon stock changes in soil;
- Tier 1 methodology to estimate carbon stock changes in cropland considering changes of cropping practices since 1970.

Losses in living biomass, dead wood, litter and soil due to conversion of forest land to cropland are reported using Tier 1 approach, resulting in high emissions, which can lead to overestimation or underestimation of actual emissions, therefore Tier 2 approach will be developed. This activity is of special importance considering that the most of the land use conversions in projections of the processes in LULUCF sector relates to conversion of naturally afforested lands to cropland or grassland resulting in considerably smaller emissions than it is estimated according to Tier 1 approach.

[216] *Lazdiņš, A., 2012. Atbalsts klimata pētījumu programmai (starpziņojums par 2012. gada darba uzdevumu izpildi) (No. 020512/S68). LVMI Silava, Salaspils.*

[217] *Salm, J.O., 2012. Emission of greenhouse gases CO2, CH4, and N2O from Estonian transitional fens and ombrotrophic bogs: the impact of different land-use practice (Doctoral thesis). Tartu Ülikooli Kirjastus, Tartu.*

6.6 GRASSLAND (CRF 4.C)

6.6.1 Category description

The grassland's category is a key source of CO_2 emissions from soils. Total area of grassland in Latvia in 2014 was 737.23 kha, including 590.38 kha of grassland remaining grassland. Grassland remaining grassland is divided into mineral and organic soils. Area of the grassland is estimated using research data[218] on the base of remote sensing data analysis. The net emissions from grassland remaining grassland were 633.84 kt CO_2 eq. (including emissions from biomass burning) in Latvia in 2014 (Figure 6.9). The CO_2 removals are accounted in living and dead biomass in forest lands not fulfilling criteria of forest definition. The most of the emissions are associated with organic soils.

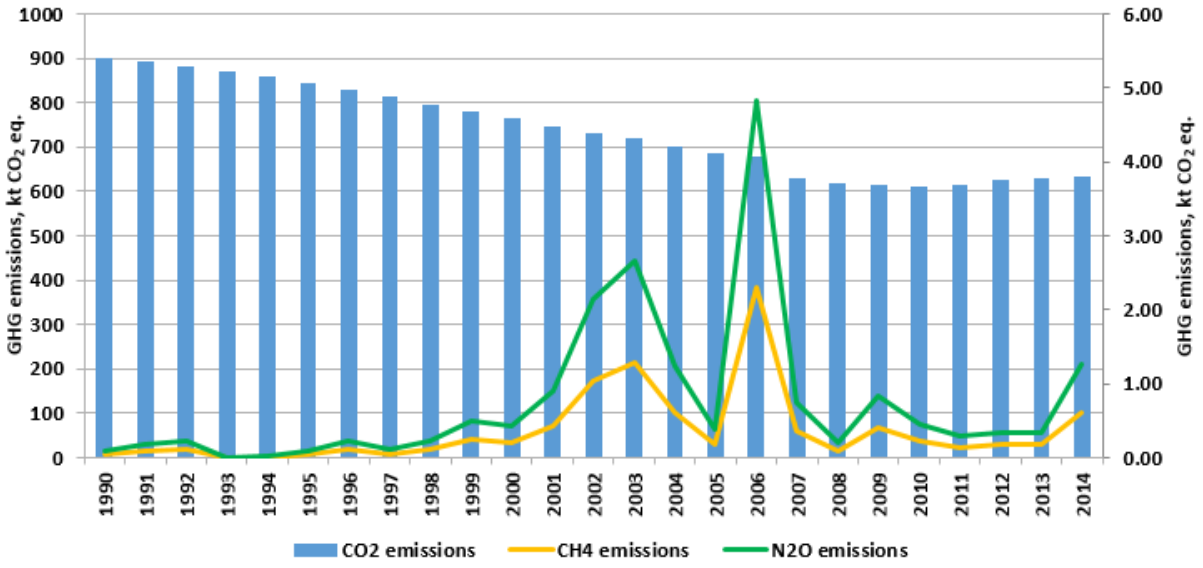

Figure 6.9 Summary of GHG emissions from grassland remaining grassland[219] (kt CO_2 eq.)

Land converted to cropland category is key source of CO_2 removals due to sequestration of carbon in mineral soil after conversion of cropland to grassland. Under this category all lands converted to grassland less than 20 years ago[220] are accounted and the total area is estimated to be 146.86 kha in 2014. Net GHG emissions in land category land converted to grassland excluding emissions from drained organic soil in 2014 were -219.86 kt CO_2 eq. (Figure 6.10). Increase of removals of CO_2 in land converted to grassland is associated with removals of CO_2 in soil due to land use change from cropland to grassland.

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[218] *Lazdiņš and Čugunovs, Oglekļa Dioksīda (CO_2) Piesaistes Un Siltumnīcefekta Gāzu (SEG) Emisiju Un Zemes Lietojuma Veida Ietekmes Novērtējums Intensīvi Un Ekstensīvi Kultivētās Aramzemēs, Daudzgadīgos Zālājos Un Bioloģiski Vērtīgos Zālājos.*

[219] *CH_4 and N_2O emissions on secondary axis*

[220] *Lazdiņš and Zariņš, "Elaboration and integration into National greenhouse gas inventory report matrices of land use changes of areas belonging to Kyoto protocol article 3.3 and 3.4 activities (Report on research work contracted by the Ministry of Environment of republic of Latvia)"; Lazdiņš, "Harmonization of Land Use Matrix in Latvia according to Requirements of International Greenhouse Gas Reporting System - Extending Outputs of National Forest Inventory Program"; Lazdiņš and Čugunovs, Oglekļa Dioksīda (CO_2) Piesaistes Un Siltumnīcefekta Gāzu (SEG) Emisiju Un Zemes Lietojuma Veida Ietekmes Novērtējums Intensīvi Un Ekstensīvi Kultivētās Aramzemēs, Daudzgadīgos Zālājos Un Bioloģiski Vērtīgos Zālājos.*

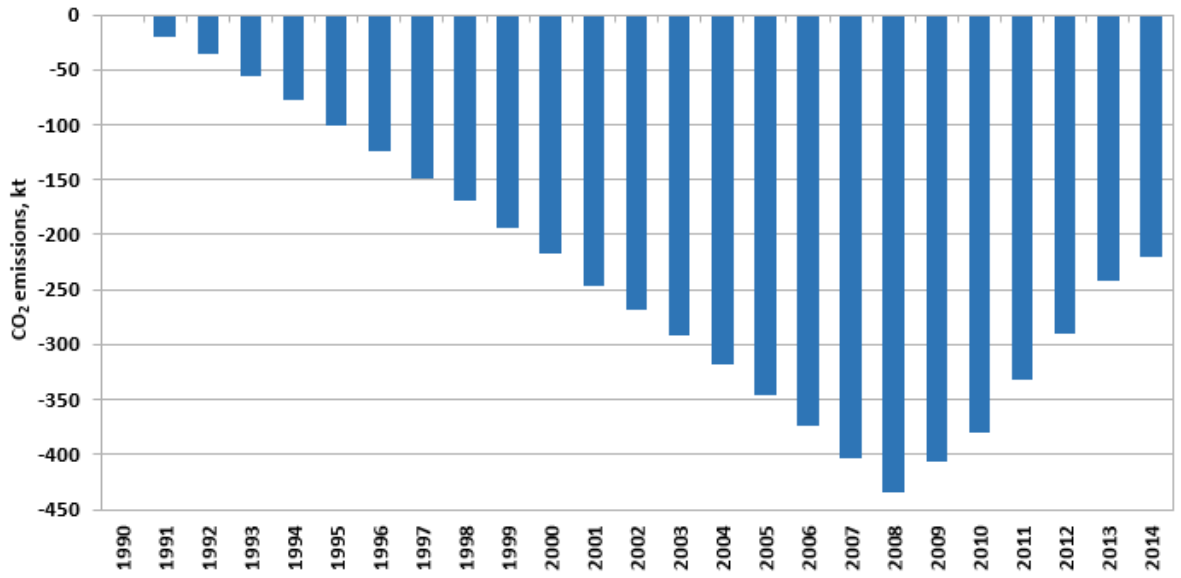

Figure 6.10 Summary of CO_2 emissions in land converted to grassland (kt)

Grassland remaining grassland is divided into mineral (95% of total area of grassland remaining grassland) and organic (5% of total area of grassland remaining grassland) soils. It is assumed that mineral soils are neither a source nor sink of CO_2. It could be changed depending on management level (degraded or improved) in grasslands; however, according to the expert judgement the inventory team considered that all grasslands are managed in way that there are no degraded or improved grasslands. The judgement is based on the fact that husbandry production in Latvia decreased considerably since 1990, but area of pastures and grasslands is increased. This fact demonstrates extensive use of former pastures and lands used in fodder production before 1990. This type of management systems is not associated with decrease of carbon stock in soil. Organic soils are considerable source of CO_2 emissions. Organic soils and drainage ditches in grasslands are accounted as a source of methane also as it is recommended in IPCC Wetlands Supplement Chapter 2.

All categories of land use change to grassland, except cropland to grassland, are reported as NO, because there are no evidences of such conversions. Conversion from cropland to grassland takes place due to abandonment of cropland. Grassland is reported in the managed lands category.

Increase of the area of organic soils in the land converted to cropland category is associated with conversion of cropland to grassland during the 1990s and during the last decade. Opposite process – reduction of area of grassland – took place due to afforestation (both natural expansion of forest and planting) of farmlands.

6.6.2 Methodological issues

6.6.2.1 Grassland remaining grassland (CRF 4.C.1)

Area of the grassland is estimated using research data[221] on the base of remote sensing data analysis. Information about area of organic agricultural soils is provided by the research report (5.18 % ± 11 % of total area of farmlands)[222]. These figures are based on soil mapping data and characterizes situation before 1990 (data utilized in calculation were obtained from the 60^{ths} to early 80^{ths}).

Woody biomass increment figures for 2004-2014 are taken from the NFI, but for the historical data results of recalculation of increment of living biomass in grassland are considered[223]. Mortality factors are taken directly from forest land remaining forest assuming that mortality in grassland is equal to average mortality (in percent of increment of living biomass) in forest land in a particular year. Decay period for dead wood is considered 20 years according to 2006 IPCC Guidelines.

The assumptions for biomass calculations used in EPIM tool are shown in Table 6.25 default 20 years decay period is considered for dead wood.

Table 6.25 Relative stock changes for grassland management in mineral soils

Factor	Level	Climate regime	IPCC default	Uncertainty
Land use	All	All	1.0	NA
Management	Nominally managed (non-degraded)	All	1.0	NA
Management	Moderately degraded grassland	Temperate / Boreal	0.95	± 13%
Management	Severely degraded	All	0.7	± 40%
Management	Improved grassland	Temperate / Boreal	1.14	± 11%
Input (applied only to improved grassland)	Medium	All	1.0	NA
Input (applied only to improved grassland)	High	All	1.11	± 7%

The calculations are done in EPIM tool, which is still in development stage. The assumptions used in EPIM tool are shown in Table 6.26, default 20 years decay period is considered for dead wood.

[221] Lazdiņš and Čugunovs, Oglekļa Dioksīda (CO_2) Piesaistes Un Siltumnīcefekta Gāzu (SEG) Emisiju Un Zemes Lietojuma Veida Ietekmes Novērtējums Intensīvi Un Ekstensīvi Kultivētās Aramzemēs, Daudzgadīgos Zālājos Un Bioloģiski Vērtīgos Zālājos.
[222] L.U. Consulting, "Augšņu un reljefa izejas datu sagatavošana un eiropas komisijas izstrādāto augsnes un reljefa kritēriju mazā labvēlīgo apvidu noteikšanai piemērošanas simulācija (Projekta kopsavilkuma ziņojums)."
[223] Jansons, Methods Utilized to Recalculate Historical Forest Increment Data.

Table 6.26 Assumptions for calculation of carbon stock changes in living and dead biomass in grassland

Year	Grassland with woody vegetation, 1000 ha	Gross increment of living biomass		Wood density, kg m^{-3}	Natural mortality, m^3 ha^{-1}	BEFs		Carbon content, kg t^{-1}
		mill. M^3	m^3 ha^{-1}			stem to crown	stem to below-ground	
1990	19.13	0.02	0.97	0.41	0.18	0.31	0.31	523
1991	19.44	0.02	0.95	0.41	0.18	0.31	0.31	523
1992	19.75	0.02	1	0.41	0.19	0.31	0.31	523
1993	20.07	0.02	0.99	0.41	0.19	0.31	0.31	523
1994	20.38	0.02	0.99	0.41	0.19	0.31	0.32	523
1995	20.69	0.02	0.97	0.41	0.19	0.31	0.32	523
1996	21.00	0.02	0.96	0.41	0.19	0.31	0.32	523
1997	21.32	0.02	0.96	0.41	0.19	0.31	0.32	523
1998	21.63	0.02	0.94	0.41	0.19	0.31	0.32	523
1999	21.94	0.02	0.98	0.41	0.2	0.32	0.32	523
2000	22.26	0.02	0.97	0.41	0.19	0.32	0.32	523
2001	22.57	0.02	0.96	0.41	0.19	0.32	0.32	523
2002	22.88	0.02	0.94	0.41	0.19	0.32	0.32	523
2003	23.19	0.02	0.93	0.41	0.19	0.32	0.32	523
2004	23.51	0.02	0.92	0.41	0.2	0.33	0.32	524
2005	23.82	0.02	0.91	0.41	0.2	0.33	0.32	524
2006	24.13	0.02	0.89	0.41	0.19	0.33	0.32	524
2007	23.54	0.05	2.12	0.41	0.46	0.33	0.32	524
2008	23.54	0.05	2.12	0.41	0.46	0.33	0.32	524
2009	23.54	0.05	2.12	0.41	0.49	0.33	0.32	524
2010	23.54	0.05	2.12	0.41	0.49	0.33	0.32	524
2011	23.54	0.05	2.12	0.41	0.49	0.33	0.32	524
2012	23.62	0.04	1.88	0.41	0.43	0.33	0.32	524
2013	23.76	0.05	1.93	0.41	0.57	0.33	0.32	524
2014	23.95	0.05	1.98	0.41	0.58	0.34	0.30	524

The emission factor of drained organic soils is considered to be 6.1 t C ha^{-1} yearly according to IPCC KP Supplement.

Emission factors for CH_4 emissions from drained organic soil and drainage ditches are respectively 16 kg and 1165 kg CH_4 yearly according to Tables 2.3 and 2.4 in IPCC KP Supplement. Total area of drainage ditches is estimated by using the same approach as explained in cropland. Ditch density on organic soils is assumed to be 0.045 ha ha^{-1}.

Default coefficients on impact of different management regime on carbon emissions obtained from 2006 IPCC Guidelines Chapter 6, Table 6.2 are used to calculate carbon stock changes in mineral soil (Table 6.27). Combined impact factor for carbon stock changes in mineral soil is equal to 1 (land use – all, management – non-degraded, input – medium).

Table 6.27 Relative stock changes due to grassland management on mineral soils

Factor	Level	Climate regime	IPCC default	Uncertainty
Land use	All	All	1.0	NA
Management	Nominally managed (non-degraded)	All	1.0	NA
Management	Moderately degraded grassland	Temperate / Boreal	0.95	± 13%

Factor	Level	Climate regime	IPCC default	Uncertainty
Management	Severely degraded	All	0.7	± 40%
Management	Improved grassland	Temperate / Boreal	1.14	± 11%
Input (applied only to improved grassland)	Medium	All	1.0	NA
Input (applied only to improved grassland)	High	All	1.11	± 7%

N_2O and CH_4 emissions from biomass burning are calculated according to methodology described in following chapter on Biomass burning.

6.6.2.2 Land converted to grassland (CRF 4.C.2)

Carbon stock changes in mineral soils in cropland converted to grassland are reported as net removals, because there are research evidences, that carbon stock in grasslands in average at 0-30 cm depth is significantly higher than in cropland[224] and the difference is 23.7 t C $ha^{-1.}$ These data are based on comparison of 80 NFI sample plots and will be updated in future by continuous monitoring of carbon stock change in soil.

Methane emissions from ditches on organic soils have been included in estimates also for lands converted to grasslands and it is calculated with the same approach as grassland remaining grassland.

6.6.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty of area estimates is provided in Table 6.28.

Table 6.28 Uncertainty of the grassland use data in 2014

Land use category	Number of NFI plots	Share of NFI plots, %	Uncertainty, %
Grassland	1747	10.8	4.2
grassland remaining grassland	1407	8.7	5.0
organic soil	73	0.5	25.7
other soil	1334	8.3	5.1
land converted to grassland	340	2.1	9.8
organic soil	17	0.1	55.1
other soil	324	2.0	10.0

The uncertainty estimate for the CO_2 emission factor for organic soils is 19 % according to the Table 2.1 in IPCC Wetlands Supplement.

Uncertainties for emission factors used in calculation of CH_4 emissions from organic grasslands and drainage ditches are 83 % and 71 % according to Table 2.3 and Table 2.4 in IPCC Wetlands Supplement.

[224] *Lazdiņš, Bārdule, and Stola, "Preliminary Results of Evaluation of Carbon Stock in Historical Cropland and Grassland"; Lazdiņš et al., Atbalsts Klimata Pētījumu Programmai (Pārksats Par Projekta 2013. Gada Darba Uzdevumu Izpildi).*

The time series of emissions from grasslands is consistent; however, overestimation is possible due to lack of knowledge about current area and distribution of organic soils. Recent studies shows that area of organic soils in grassland is less than 1.5 %[225].

6.6.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the LULUCF sector in order to achieve these quality objectives.

The QA/QC plans for the Grassland's category includes the QC measures based on the IPCC (2006 IPCC Guidelines, Chapter 6.4.3, Tier 1 approach). These measures are implemented every year during the inventory. Potential errors and inconsistencies are documented and corrections are made if necessary. The files and documents used in preparation of the inventory are archived annually and back-up copies are made weekly. Several quality meetings are held annually between experts.

6.6.5 Category-specific recalculations

Recalculations are done due to recalculation of the NFI data based on repeated measurement of borders of the plots and their sectors. Summary of the impact of recalculation on the aggregated net GHG emissions from grassland is shown in Figure 6.11.

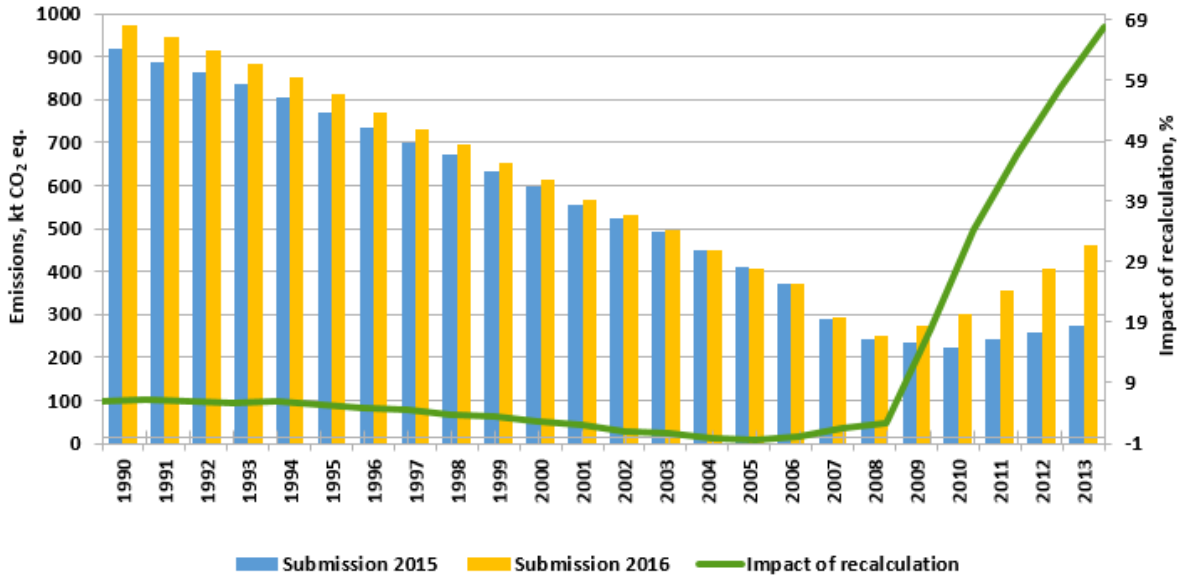

Figure 6.11 Impact of recalculation on the aggregated net GHG emissions from grassland

6.6.6 Category-specific planned improvements

It is planned to improve accounting for ditch area in organic soil in next years. Now we have very limited knowledge about organic soils and drainage ditches in grasslands. In 2016 new

[225] *Andis Lazdiņš et al., Atbalsts Klimata Pētījumu Programmai (Pārksats Par Projekta 2013. Gada Darba Uzdevumu Izpildi) (Salaspils, 2013), Salaspils; Andis Lazdiņš, Atbalsts Klimata Pētījumu Programmai (starpziņojums Par 2012. Gada Darba Uzdevumu Izpildi) (Salaspils, 2012), Salaspils, https://sites.google.com/site/lvlulucf/research-projects/atbalstsklimatapetijumuprogrammaistarpzinojumspar2012gadarezultatiem.*

NFI inventory data and results about organic soils in grassland will be available and on the basis of the NFI inventory it will be possible to specify accounting.

Country specific data are necessary to estimate carbon stock changes according to the soil mapping data, as well as to estimate share of organic soil in land converted to grassland.

6.7 WETLANDS (CRF 4.D)

6.7.1 Category description

Wetlands remaining wetlands is a key source category of CO_2 emissions mainly due to commercial peat extraction for horticulture and emissions of CO_2 from drained soil. The net GHG emissions in wetlands in 2014 were 1014.57 kt CO_2 eq (Figure 6.12).

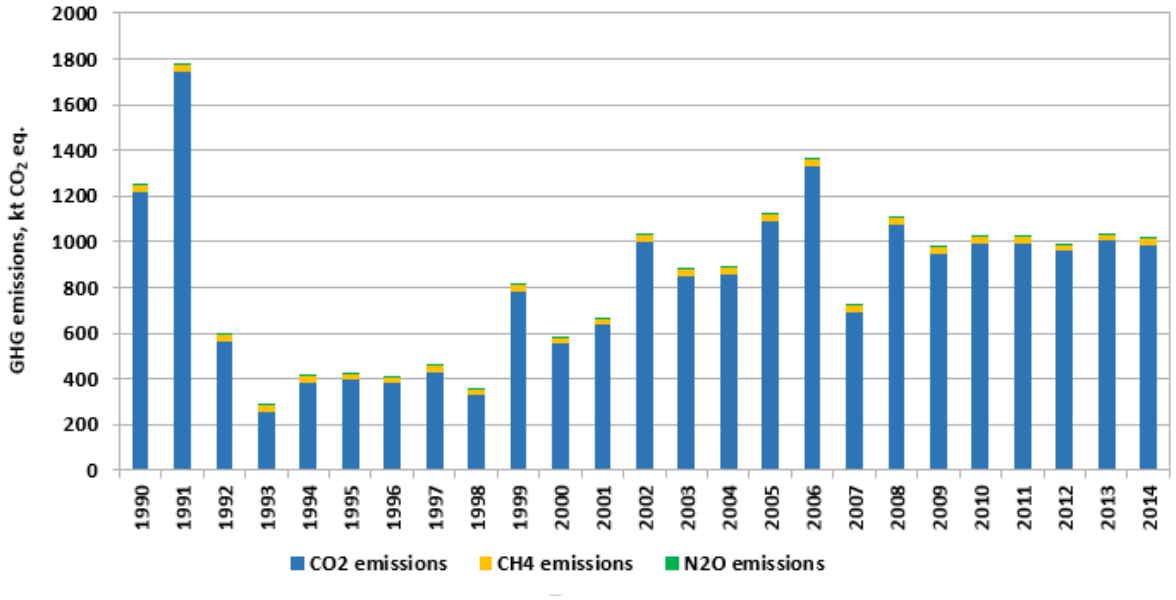

Figure 6.12 Summary of GHG emissions from wetlands (kt CO_2 eq.)

According to the 2006 IPCC Guidelines wetlands include land that is covered or saturated by water for all or part of the year and that does not fall into the forest land, cropland, and grassland or settlement categories. Total area of wetlands (445.63 kha) is reported according to the research results, including 27.0 kha of peat-lands drained for peat extraction (Table 3a.3.3 of the IPCC GPG LULUCF 2003).

Latvia reports CO_2 emissions associated mainly with industrial peat extraction in this category. The rest of the area of wetlands is not managed and CO_2 emissions are not calculated, exception is area with woody vegetation located adjacent to water courses, water body or swamps and which does not fit to definition of forest land category. According to the Table 3a.3.3 of the IPCC GPG LULUCF 2003 the default value for area of industrial peat-lands in Latvia is 27 kha; using extraction rate method calculations result in 3 kha in 2014. Taking into account considerable annual fluctuations in peat production, more conservative default method is used in calculations.

Aggregated emissions from industrial peat-lands are equal for the whole time series due to lack of data about status of industrial peat-lands prepared for extraction 20-40 years ago. However, there are no evidences of new industrial peat-lands prepared for peat extraction

after 1990; therefore, the risk of underestimation of emissions does not exist. N_2O contributes to about 0.4 % of net emissions from peat-lands. Removals in this category are reported in living and dead biomass.

6.7.2 Methodological issues

Activity data – area of peat-lands prepared for extraction, is taken from Table 3a.3.3[226] of the IPCC GPG LULUCF 2003. Emission factor for carbon stock changes (2.8 t C ha^{-1} yr^{-1}) due to drainage is taken from IPCC Wetlands Supplement[227]. Carbon content in air dry peat (0.45 t C per tonne of peat) is considered according to Table 7.5 of 2006 IPCC Guidelines[228]. Moisture of peat reported in national statistics is considered 40 %.

Off-site CO_2-C emissions associated to the horticultural (non-energy) use of peat extracted and removed are reported using instant oxidation method. Off-site emissions from peat used for energy are reported in the Energy Sector (1.A.1. Energy industries, 1.A.2. Manufacturing industries and construction and 1.A.4. Other sectors), and is therefore not included here.

Data on peat extraction for horticulture purposes is taken from statistical reports using extrapolation method for the periods, when official data are not available. Carbon content in peat is considered 54 %, relative moisture – 40 %, according to a methodology used in statistical accounting.

CH_4 emissions from drained organic soils are calculated according to methodology applied in drained forests on organic soil. As drainage of wetlands in national conditions is occurring only in territories for peat extraction default emission factors for drained organic soil (6.1 kg CH_4 ha^{-1} yr^{-1}) and drainage ditches (542 kg CH_4 ha^{-1} yr^{-1}) for peat extraction are utilized. Density of ditches is considered 0.07 ha per 1 ha of peatland.

The calculations are done in EPIM tool, which is still in development stage. The assumptions used in EPIM tool are shown in Table 6.29, default 20 years decay period is considered for dead wood.

Table 6.29 Assumptions for calculation of carbon stock changes in living and dead biomass in wetlands

Year	Wetlands with woody vegetation, 1000 ha	Gross increment of living biomass		Wood density, kg m^{-3}	Natural mortality, m^3 ha^{-1}	BEFs		Carbon content, kg $tonne^{-1}$
		mill. M^3	m^3 ha^{-1}			stem to crown	stem to below-ground	
1990	189.25	0.06	0.33	0.41	0.06	0.31	0.31	523
1991	191.55	0.07	0.37	0.41	0.07	0.31	0.31	523
1992	193.42	0.08	0.41	0.41	0.08	0.31	0.31	523
1993	194.24	0.08	0.42	0.41	0.08	0.31	0.31	523
1994	195.72	0.09	0.44	0.41	0.09	0.31	0.32	523
1995	196.29	0.09	0.45	0.41	0.09	0.31	0.32	523
1996	197.92	0.09	0.46	0.41	0.09	0.31	0.32	523

[226] *Estimates of peatland areas and use for tier 1 in 1000 hectares*
[227] *EMISSION FACTORS FOR CO2–C AND ASSOCIATED UNCERTAINTY FOR LANDS MANAGED FOR PEAT EXTRACTION, BY CLIMATE ZONE*
[228] *CONVERSION FACTORS FOR CO2–C FOR VOLUME AND WEIGHT PRODUCTION DATA*

Year	Wetlands with woody vegetation, 1000 ha	Gross increment of living biomass		Wood density, kg m^{-3}	Natural mortality, m^3 ha^{-1}	BEFs		Carbon content, kg $tonne^{-1}$
		mill. M^3	m^3 ha^{-1}			stem to crown	stem to below-ground	
1997	199.26	0.09	0.46	0.41	0.09	0.31	0.32	523
1998	201.05	0.09	0.47	0.41	0.09	0.31	0.32	523
1999	201.2	0.09	0.47	0.41	0.09	0.32	0.32	523
2000	202.54	0.1	0.47	0.41	0.09	0.32	0.32	523
2001	203.12	0.1	0.47	0.41	0.09	0.32	0.32	523
2002	204.27	0.1	0.47	0.41	0.09	0.32	0.32	523
2003	205.96	0.1	0.47	0.41	0.09	0.32	0.32	523
2004	206.59	0.1	0.46	0.41	0.1	0.33	0.32	524
2005	206.71	0.1	0.46	0.41	0.1	0.33	0.32	524
2006	210.16	0.1	0.46	0.41	0.1	0.33	0.32	524
2007	97.62	0.18	1.85	0.41	0.4	0.33	0.32	524
2008	97.62	0.18	1.85	0.41	0.4	0.33	0.32	524
2009	97.62	0.18	1.85	0.41	0.43	0.33	0.32	524
2010	97.62	0.18	1.85	0.41	0.43	0.33	0.32	524
2011	97.62	0.18	1.85	0.41	0.43	0.33	0.32	524
2012	97.62	0.17	1.73	0.41	0.40	0.33	0.32	524
2013	97.62	0.17	1.79	0.41	0.53	0.33	0.32	524
2014	97.62	0.18	1.84	0.41	0.54	0.34	0.30	524

6.7.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty of area estimates is provided in Table 6.30.

Table 6.30 Uncertainty of the wetland use data in 2014

Land use category	Number of NFI plots	Share of NFI plots, %	Uncertainty, %
Wetlands	1123	7.0	5.7
wetlands remaining wetlands	1119	6.9	5.9
drained soil	68	0.4	24.2
wet soil	1051	6.5	6.1
land converted to wetlands	4	0.03	13.4

The uncertainty estimate for the CO_2 emission factor for organic soils is 55 % according to the Table 2.1 in IPCC Wetlands Supplement.

Uncertainty range of emission factors for drained organic soil and drainage ditches are 1.6-11 kg CH_4 ha^{-1} yr^{-1} (77%) and 102-981 kg CH_4 ha^{-1} yr^{-1} (81%) according to the Table 2.3 and Table 2.4 in IPCC Wetlands Supplement.

Complete consistency of the time-series is secured by use of the same data source for estimation of area and emissions for the whole time period. Emissions associated with peat extraction might be considerably overestimated because this industry is reduced during last decades and area of peat-lands prepared for extraction is reduced too. However, there are no statistically verifiable data about technical status of peat quarries therefore default values of activity data based on situation before 1990 are used in calculations.

6.7.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the LULUCF sector in order to achieve these quality objectives.

Quality control procedures named in 2006 IPCC Guidelines were done, particularly, data about peat extraction were compiled from different sources (national statistics and Union of peat producers) as well as emission factors provided by different authors were compared. Several quality meetings are held annually between experts.

6.7.5 Category-specific recalculations

No recalculations are done in this sector.

6.7.6 Category-specific planned improvements

Non-CO_2 GHG might be considerable part of emissions from wetlands; therefore, it is necessary to develop method for estimation impact of ditches and other types of wetlands on N_2O and CH_4 emissions. Considering growth potential of peat extraction for energy purposes from abandoned peat-lands and forests on wet organic soils, it is important to be able to calculate impact of drainage on non-CO_2 emissions as well as to be able to separate wetlands on nutrients rich organic soils (high N_2O emissions) and poor organic soils (low N_2O emissions). Wetlands are one of the priorities in further development of GHG inventory in LULUCF sector in Latvia.

6.8 SETTLEMENTS (CRF 4.E)

6.8.1 Category description

Net CO_2 emissions from settlements remaining settlements in 2014 were -95.28 kt CO_2 (Figure 6.13). However, removals in woody vegetation and dead biomass in settlements remaining settlements were compensated by emissions due to land use change (land converted to settlements category). Net CO_2 emissions from land converted to settlements in 2014 were 992.36 kt CO_2 (Figure 6.14).

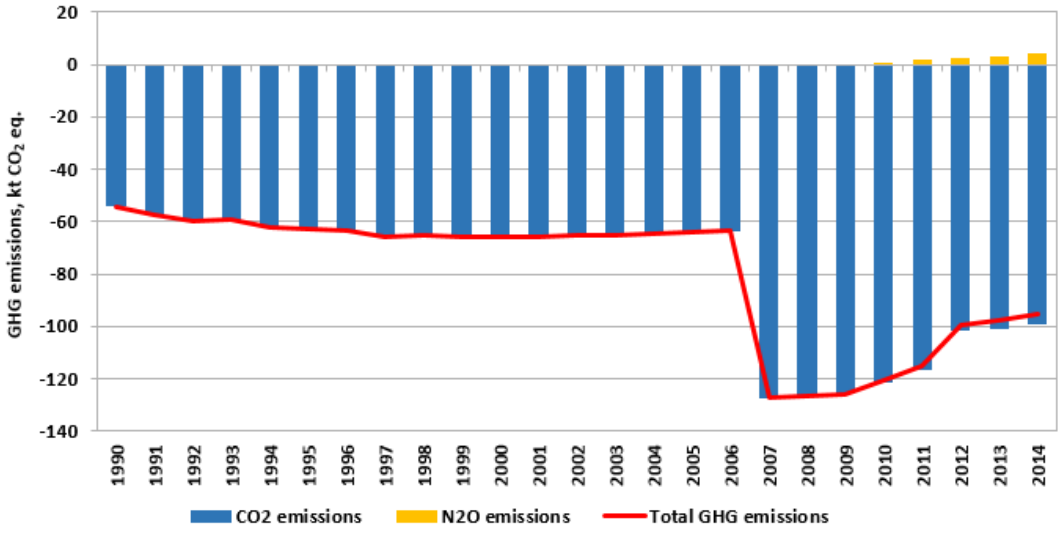

Figure 6.13 Summary of net GHG emissions from settlements remaining settlements (kt CO_2 eq.)

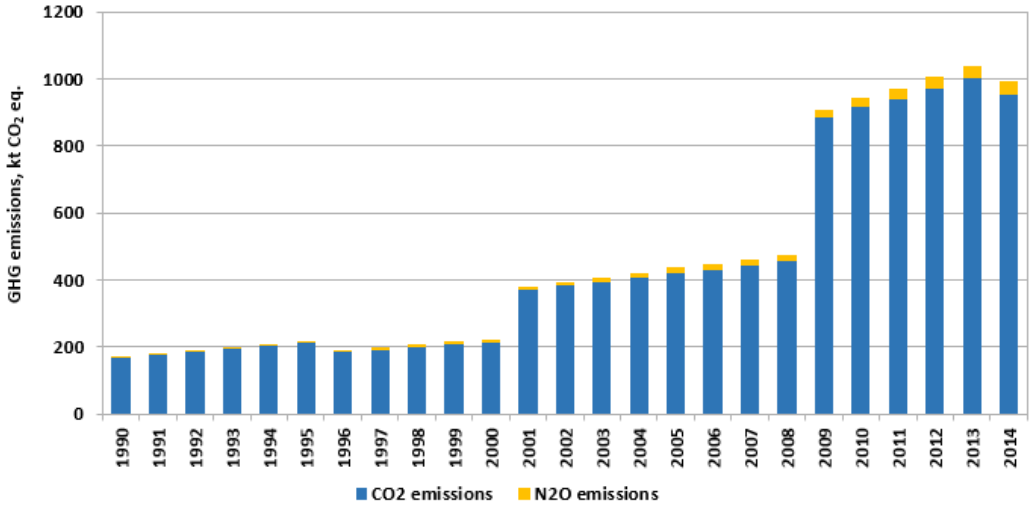

Figure 6.14 Summary of net GHG emissions from land converted to settlements (kt CO_2 eq.)

Land converted to settlements is a key source of CO_2 emissions according to trend and level assessment due to losses in carbon stock in living biomass, dead wood, litter and soil carbon pool. The role of conversion of forest land to settlements is increasing with a growth of economic activity and road construction in rural regions, because more than half of the country area is covered by forests, so that any new constructions are always associated with conversion of forest lands. At the same time abandoned farmlands conversion to forest land is more intensive; however, young forests on farmlands can not fully compensate emissions due to the forest lands conversion to settlements.

Under the settlements category emissions from soils, litter, living and dead biomass due to conversion of land use type are reported. In 2014 removals in living and dead biomass in settlements are accounted using the NFI data on increment of growing stock in settlements, which is represented mostly by overgrowing of roadsides, power lines and other infrastructure.

Total area of settlements in 2014 was 253.73 kha, including 215.28 kha of settlements remaining settlements since 1990. The total area of settlements is estimated according to

the information provided by the NFI. According to the expert estimation, increase of area of settlements during last 20 years occurred due to conversion of forest land. Increase of area of settlements (deforestation) is generally associated with road construction. All roads, including forest roads are reported in the settlements category; therefore, the deforested area is considerably higher than official statistics, where forest roads are not accounted as deforested area and still belong to forest land.

6.8.2 Methodological issues

6.8.2.1 Settlements remaining settlements (CRF 4.E.1)

Area of land remaining settlements is assumed constant until 2008 (238.23 kha) according to the NFI data. In 2010-2014 areas converted to settlements in 1990-1994 are accounted under settlements remaining settlements.

The CO_2 removals are accounted for living and dead biomass categories in settlements remaining settlements based on the NFI data. Removals are accounted based on weighted (by area) gross increment, mortality factors, BEFs, carbon content and wood density in a particular year in forest land remaining forest. For emissions from dead wood pool in settlements remaining settlements 20 years transition period is considered. Age of woody vegetation on settlements is counted backwards and as soon as age of trees reach "0", it is considered, that there is no more vegetation and no increment calculations are done. EPIM tool is used in calculations.

Emissions from soils in settlements remaining settlements are calculated according 2006 IPCC Guidelines. It is assumed that inputs equal outputs so that settlement mineral soil C stocks do not change in settlements remaining settlements. Emissions from organic soils in settlements remaining settlements are calculated using equation 2.26 in 2006 IPCC Guidelines (equation No. 6). If soils are drained and the peat is not removed, the emissions are calculated using emission factors for cultivated organic soils, due to deep drainage in settlements similar to cropland. Annual emission factor (EF) for cultivated organic soils in cool temperate climatic temperature regime is 5.0 tonnes C ha^{-1} yr^{-1} (2006 IPCC Guidelines, Table 5.6).

$$L_{Organic} = \sum_c (A \cdot EF)_c, \text{ where}$$

$L_{Organic}$ = annual carbon loss from drained organic soils, tonnes C yr^{-1};
A= land area of drained organic soils in climate type c, ha;
EF= emission factor for climate type c, tonnes C $ha^{-1} yr^{-1}$. (6)

6.8.2.2 Land converted to settlements (CRF 4.E.2)

Area of land converted to settlements is estimated by evaluation of vegetation index of the NFI points (23 thousand plots across the country) in series of satellite images produced in 1990, 1995 and 2000. Final land use was considered according to empiric data obtained during field visits (2009-2013). Points, where the vegetation index permanently changed from forest to non-forest land were marked as potentially deforested. Then logical selection was used to separate those points where removal of woody vegetation is not associated with land use change (for instance, cleaning of roadsides outside forest lands and buffer zones of railways) or changes in vegetation index were not permanent (for instance, forest in

1990, non-forest in 1995, forest in 2000 and settlement with woody vegetation in 2004-2008 according to the NFI), and the rest of points, mostly forest roads, were noted as deforested.

Linear regression based on remote sensing data was used to elaborate prognosis for conversion of forest land to other land uses in 2004-2008. NFI data are used to estimate land converted to settlements in 2009-2014.

Area of land converted to settlement since 1990 is estimated using satellite image analysis. Total area of land converted to settlements in 2014 is 38.45 kha.

The emissions (losses in carbon pools) are reported under category forest land converted to settlements. Carbon stock changes associated with commercial felling, including removal of woody vegetation on forest infrastructure (roadsides, ditches etc.) are accounted considering that losses in living biomass are equal to average growing stock in forest land remaining forest in a particular year. Similarly, dead wood stock in forest land remaining forest in a particular year is considered as carbon losses from dead wood due to conversion of forest land to settlements. Instant oxidation method is considered for living and dead wood carbon pools.

Carbon stock changes in dead biomass are accounted using instant oxidation method considering that all dead biomass converts to emissions in the year of the land use change. Average carbon stock in dead biomass (12.14 t C ha^{-1} in litter and 6.0 t C ha^{-1} in dead wood) is used in calculations. Carbon stock in dead wood in converted land is considered to be equal to average carbon stock in dead biomass in forest land remaining forest land in a year of the conversion.

Losses due to commercial felling in forest areas converted to settlements are accounted considering that the losses are equal to average growing stock of living biomass in forest land remaining forest in the year of conversion (BEFs, carbon content and wood density are considered as weighted (Figure 6.15) by total biomass distribution between species).

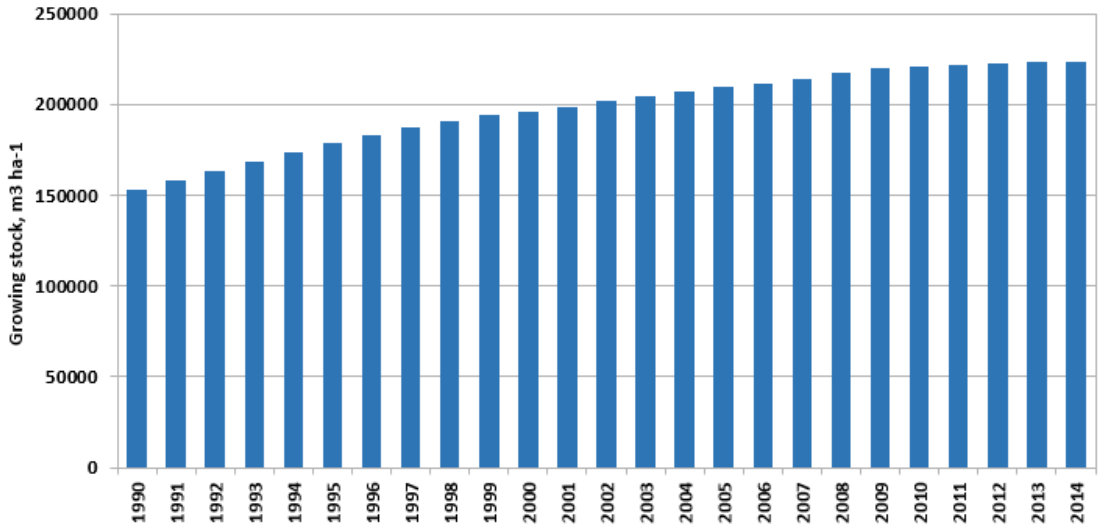

Figure 6.15 Assumption for average growing stock of living biomass in forest areas converted to settlements (m^3 ha^{-1})

The total change in soil C stocks for land converted to settlements is computed using equation 2.24 in 2006 IPCC Guidelines, which combines the change in soil organic C stocks

for mineral soils and organic soils. Change in soil organic C stocks is estimated for mineral soils with land-use conversion to settlements using Equation 2.25 in 2006 IPCC Guidelines (equation No. 7). Emission from mineral soil due to land use change to settlements is accounted according to average carbon stock in forest mineral soil, assuming that carbon accumulated in upper 30 cm (82.6 tonnes C ha^{-1}) partially turns into emissions within 20 years (0.8 tonnes C h^{-1} annually). The impact factor (F_{LU} x F_{MG} x F_I) is 0.8.

$$\Delta C_{Mineral} = \frac{\left(SOC_0 - SOC_{(0-T)}\right)}{D}$$

$$SOC = \sum_{c,s,i} \left(SOC_{REFc,s,i} \cdot F_{LUc,s,i} \cdot F_{MGc,s,i} \cdot F_{Ic,s,i} \cdot A_{c,s,i}\right), \text{ where}$$

$\Delta C_{Mineral}$ = 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;
$SOC_{(0-T)}$ = soil organic carbon stock at the beginning of the inventory time period, tonnes C;
D = time dependence of stock change factors which is the default time period for transition between equilibrium SOC values, yr;
c = represents the climate zones;
s = the soil types;
i = the set of management systems that are present ∈ a country;
SOC_{REF} = the reference carbon stock, tonnes C ha^{-1};
F_{LU} = stock change factor for land−use systems or sub-system for a particular land−use, dimensionless;
F_{MG} = stock change factor for management regime, dimensionless;
F_I = stock change factor for input of organic matter, dimensionless;
A = land area of the stratum being estimated, ha.

(7)

Land converted to settlements on organic soils within the inventory time period is treated the same as settlements remaining settlements. Carbon losses are computed using equation 2.26 in 2006 IPCC Guidelines.

6.8.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty of area estimates is provided in Table 6.31.

Table 6.31 Uncertainty of the settlements use data in 2014

Land use category	Number of NFI plots	Share of NFI plots, %	Uncertainty, %
Settlements	661	4.1	7.8
settlements remaining settlements	570	3.5	8.7
organic soil	1	0.01	-
other soil	569	3.5	8.7

Land use category	Number of NFI plots	Share of NFI plots, %	Uncertainty, %
land converted to settlements	91	0.6	19.6
organic soil	12	0.1	47.0
other soil	78	0.5	22.0

Uncertainty of average carbon stock in litter in forests is 6.1 %, uncertainty of carbon stock in soil layer 0-30 cm is 15.6 %, uncertainty of dead wood stock in forests is 1.7 %, and uncertainty of carbon stock in dead wood is 30 %. Combined uncertainty of carbon stock in dead wood is 30 %. Combined uncertainty of carbon stock change is 14.6 %.

Consistency of time series is secured by using the same activity data (NFI) for the whole period. Extrapolation is used to elaborate prognosis of deforestation for 2009.

Uncertainty of annual carbon stock change factor (EF) for cultivated organic soils in cool temperate climatic temperature regime is ± 18 % (IPCC Wetlands Supplement, Table 2.1).

Uncertainties of emission factors for estimation of CH_4 emissions from drained organic soils are indicated under chapter Cropland.

6.8.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the LULUCF sector in order to achieve these quality objectives.

The QA/QC plans for the settlements' category include the QC measures based on the 2006 IPCC Guidelines. Specific QA/QC checks across the settlements methodology were done. Potential errors and inconsistencies are documented and corrections are made if necessary. The files and documents used in preparation of the inventory are archived annually and back-up copies are made weekly. Several quality meetings are held annually between experts.

6.8.5 Category-specific recalculations

Recalculations are done due to revision of the NFI data based on repeated measurement of borders of the plots and their sectors. Summary of the impact of recalculation on the aggregated net GHG emissions from settlements is shown in Figure 6.16.

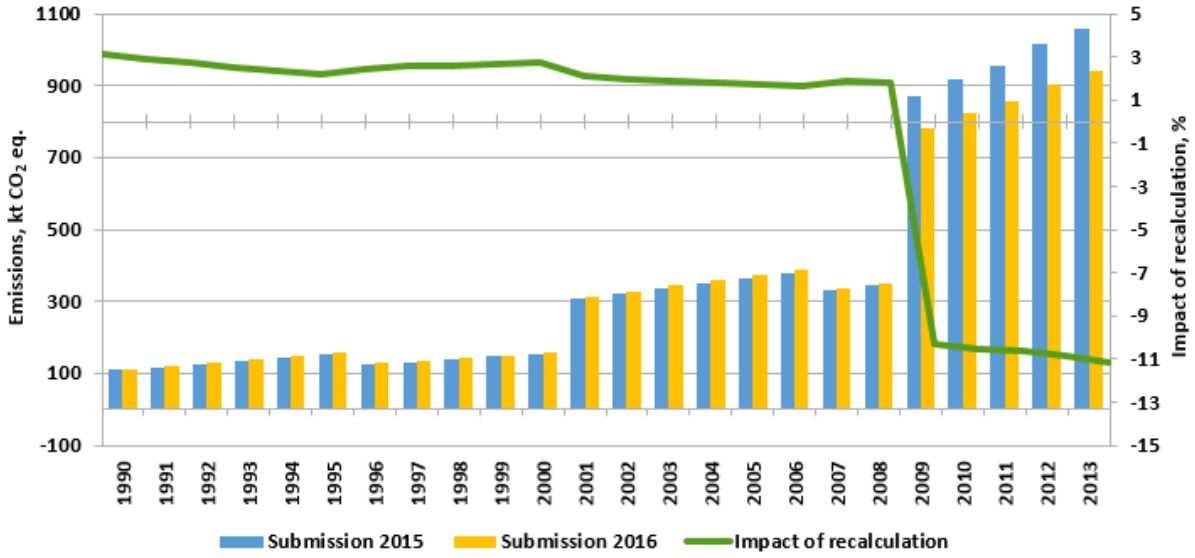

Figure 6.16 Impact of recalculation on the aggregated net GHG emissions from settlements

6.8.6 Category-specific planned improvements

Lack of knowledge about distribution of settlements with vegetation coverage and without it leads to overestimation of soil emissions, because all settlements are considered as loosing soil carbon, in spite certain area is continuing to sequestrate carbon (like buffer zones around roads); therefore it is important to elaborate method to calculate proportion of settlements with and without vegetation coverage and different methods for calculation of soil carbon losses in these areas. It is planned to use satellite images with high resolution in several pilot areas (representing different economic activity and dominant type of vegetation) in this study.

In spite of ability to calculate carbon stock changes in living and dead biomass since 2004, historical figures cannot be easily restored. It is planned to use high resolution satellite images to evaluate dynamics of carbon stock in living biomass in certain pilot areas since 1990 and to extrapolate obtained results to all NFI plots to avoid potential overestimation of removals of CO_2 in living biomass.

Losses in living biomass, dead wood, litter and soil due to conversion of forest land to settlements are reported using Tier 1 approach, resulting in high emissions, which can lead to overestimation or underestimation of actual emissions, therefore Tier 2 approach (based on a single tree accounting in the NFI) will be developed.

6.9 OTHER LAND (CRF 4.F)

According to the 2006 IPCC Guidelines other lands are territories without vegetation like rocks, glaciers as well as the rest of unmanaged lands which are not included in other land use categories. According to the national land use statistics other lands include unmanaged lands, wetlands and settlements (1 459.3 mill. Ha in 2008). Instead of other lands defined by national land use statistics since 2009 the NFI is used to estimate area of other lands. It is assumed that other lands are dunes not covered by woody vegetation. Total area of these lands is considered constant for the whole reporting period (5.44 kha). No GHG emissions or CO_2 removals are reported in this category.

6.10 BIOMASS BURNING (CRF 4(V))

Source category descriptionThis source category includes greenhouse gas emissions (CO_2, CH_4, N_2O) and other emissions (NO_x and CO) from biomass burning on forest land comprising wildfires and controlled burning, as well as wildfires in grassland. Total aggregated emissions from biomass burning in 2014 were 110.2 kt of CO_2 eq. (Figure 6.17).

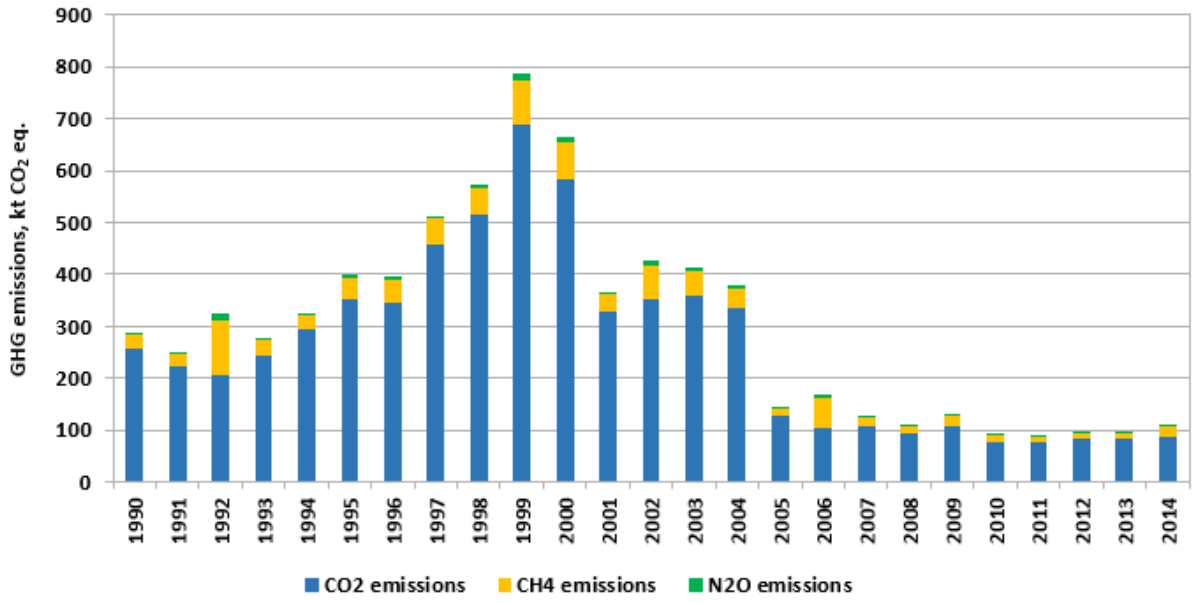

Figure 6.17 Aggregated emissions from biomass burning (kt CO_2 eq.)

Biomass burning occurs in forest land and grassland. Taking into account that wetlands (bogs and fens) belong to forest land according to national land use definitions, emissions associated with wildfires in wetlands cannot be separated and are reported under forest lands remaining forests. No evidences of forest fires or grassland wildfires are found in land converted to forest in the NFI plots having special forest land category – burnt forest; therefore it is considered that no forest fires takes place in afforested area. The approach used in the Latvia's GHG inventory (reporting emissions under land use categories according to national statistics) secures that emissions from biomass burning are not overlapping.

The area statistics on forest wildfires are compiled by the State forest service and they are based on information given by the local units. Area of forest fires and biomass in burned area is shown in Figure 6.18.

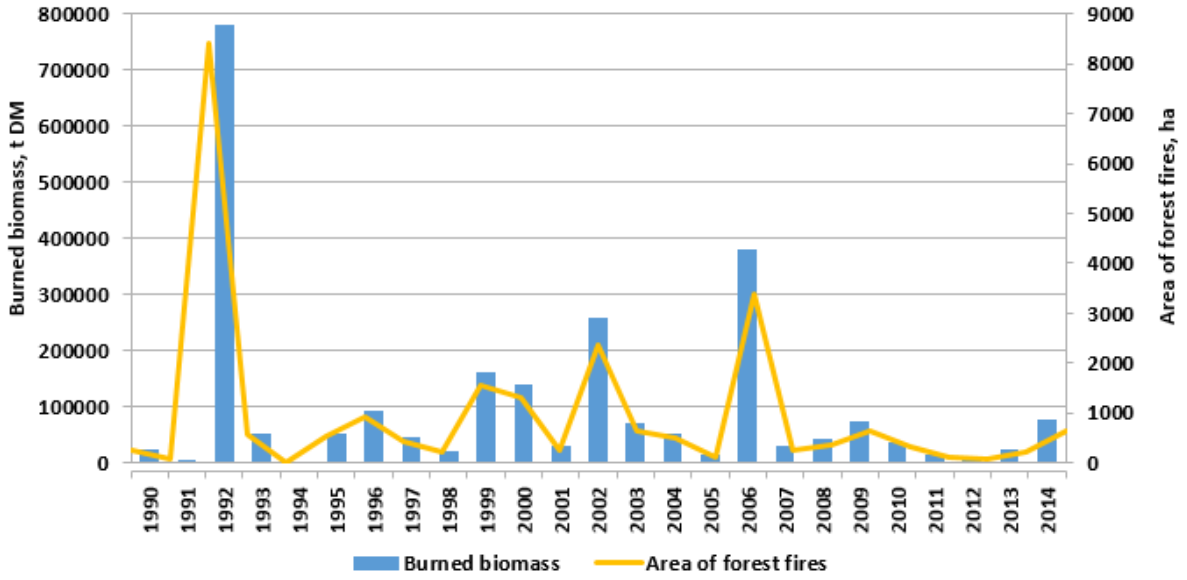

Figure 6.18 Area of forest fires and biomass in burned area

Area of grassland burning is provided by the State fire safety service (SFSS), cartographic information about location of wildfires in grasslands since 2005 is provided by the Rural Support Service. Wildfires in grasslands are more common in south eastern part of the country and around Riga. Concentration of wildfires in the south-east correlates with area of abandoned farmlands. Total area of burned grassland is shown in Table 6.32. For 1990-1992 no statistical information exists. It was decided to use extrapolated burned area of following years period for 1990-1992 instead of notification key NO.

Table 6.32 Burned area of grassland since 1990

Year	Area, ha
1990	555
1991	893
1992	1232
1993	21
1994	98
1995	526
1996	1 224
1997	576
1998	1 255
1999	2 685
2000	2 262
2001	4 800
2002	11 547
2003	14 335
2004	6 717
2005	2 027
2006	25 806
2007	4 048
2008	1 170
2009	4 462

Year	Area, ha
2010	2 495
2011	1 618
2012	1 872
2013	1 885
2014	6 819
Total	98 248

Emissions from biomass burning are represented by incineration of harvesting residues during forest logging operations. The activity data for this calculation was based on an outdated study until 2010[229]. Now a questionnaire for private forest owners on utilization of harvesting residues is used[230]. This switch leads to reduction of emissions in 2005. In case of on-site incineration of harvesting residues during commercial harvesting, all emissions also are applied to the forest land remaining forest land category, because no commercial felling takes place in young stands (younger than 20 years) on land converted to forest land.

6.10.1 Methodological issues

Tier 1 and 2 methods of calculation provided in the 2006 IPCC Guidelines were utilized. Emissions from any type of fires were calculated using equation 2.27 of the 2006 IPCC Guidelines:

$$L_{fire} = A * M_B * C_f * G_{ef} * 10^{-3};\ where$$

L_{fire} – *amount of greenhouse gas emissions from fire, tonnes of each GHG e.g.* CH_4, N_2O, *etc.;*
A = *area burnt, ha;*
M_B = *mass of fuel available for combustion, tonnes* ha^{-1}. *This includes biomass, ground litter and dead wood. When Tier 1 methods are used then litter and dead wood pools are assumed zero, except where there is a land-use change;*
C_f = *combustion factor, dimensionless;*
G_{ef} = *emission factor, g* kg^{-1} *dry matter burnt.*

(8)

6.10.1.1 Forest wildfires

Tier 1 method and default emission factors of calculation provided in the 2006 IPCC Guidelines was utilized. Amount of burned biomass is considered according to average growing stock of living biomass, dead wood and litter in a particular year. Combustion efficiency or fraction of biomass combusted (dimension-less) is considered 0.45 according to Table 2.6 of 2006 IPCC Guidelines[231]. Factors of emissions are shown in Table 6.33.

Table 6.33 Emission factor for each GHG (g kg^{-1} dry matter burned)

Gas	CH_4	CO	N_2O	NO_x	CO_2
Emission factor	6.1±2.2	78±31	0.06	1.1±0.6	1550±95

[229] *Leonards Līpiņš, "Assessment of wood resources and efficiency of wood utilization (Koksnes izejvielu resersu un to izmantošanas efektivitātes novērtējums)" (LLU, 2004), http://www.zm.gov.lv/index.php?sadala=258&id=803.*
[230] *Lazdiņš, A., Lazdiņa, D., 2013. Meža ugunsgrēku un mežizstrādes atlieku dedzināšanas radītās siltumnīcefekta gāzu emisijas Latvijā (Greenhouse gas emissions in Latvia due to incineration of harvesting residues and forest fires), in: Referātu Tēzes. Presented at the Latvijas Universitātes 71. zinātniskā konference "Ģeogrāfija, ģeoloģija, vides zinātne", Latvijas Universitāte, Rīga, pp. 133–137.*
[231] *Combustion factor values (proportion of prefire biomass consumed) for fires in a range of vegetation types.*

6.10.1.2 Grassland wildfires

Tier 1 method and default emission factors of calculation provided in the 2006 IPCC Guidelines was utilized. Emissions from wildfires in grassland were calculated using equation 2.27 of the 2006 IPCC Guidelines. Mass of available fuel in grassland's fires – 2.1 t dm ha^{-1} (Table 2.4 of 2006 IPCC Guidelines[232]), fraction of the biomass combusted 0.74 (Table 2.6 of 2006 IPCC Guidelines[233]). Factors of emissions for grassland fires are shown in Table 6.34.

Table 6.34 Emission factors for grassland's wildfires[234]

No	Gas	Factor, g kg^{-1} dry matter burned
1.	CO	65±20
2.	CH_4	2.3±0.9
3.	NO_x	3.9±2.4
4.	N_2O	0.21±0.10

6.10.1.3 Controlled fires in forests

Tier 2 method and default emission factors of calculation provided in the 2006 IPCC Guidelines was utilized. Emissions from controlled fires were calculated considering average stock of harvesting residues (BEF for conversion of stem biomass to above-ground biomass), which considerably increased due to increase of estimates of harvesting stock. Factors of emissions are shown in Table 6.33. The following assumptions have been made for burned harvesting residues calculation:

- 1990 to 2000 – 50 % of harvesting residues are left for incineration and 67 % of the left residues are incinerated, the rest are left to decay;
- 2001 to 2004 – 30 % of harvesting residues are left for incineration and 67 % of the left residues are incinerated, the rest are left to decay;
- 2005 to 2009 – 7 % of harvesting residues are left for incineration and 100 % of the left residues are incinerated; the rest of the residues are left for decay or extracted for bioenergy production.
- starting from 2010 – 4 % of harvesting residues are left for incineration and 100 % of the left residues are incinerated; the rest of the residues are left for decay or extracted for bioenergy production.

CO_2 emissions are calculated only from wildfires taking into account that carbon located in harvesting residues is already accounted as losses in living biomass. Incinerated residues are extracted from removals in dead wood.

6.10.2 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

[232] Fuel (dead organic matter plus live biomass) biomass consumption values for fires in a range of vegetation types.
[233] Combustion factor values (proportion of prefire biomass consumed) for fires in a range of vegetation types.
[234] IPCC 2006 Table 2.5 Emission factors (g kg^{-1} dry matter burned) for various types of burning.

Uncertainty in activity data (area) for biomass burning is estimated at ± 10 % based on expert judgement. Uncertainty concerning combustion efficiencies in combined is ± 10 % according to the expert judgement. Uncertainties in emission factors are based on the 2006 IPCC Guidelines default values.

6.10.3 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the LULUCF sector in order to achieve these quality objectives.

Quality control procedures named in 2006 IPCC Guidelines were done. Possible overlapping in emission/removal estimation with other sources has been checked as far as it is possible on the base of existing data. Land areas of wildfires and controlled burning were reviewed with latest statistics. It was confirmed that all data used in this section cover whole land area of Latvia. Several quality meetings are held annually between experts.

6.10.4 Category-specific recalculations

Only minor changes have been occurred (< 0.6%) due to the more accurate activity data. Summary of the impact of recalculation on the aggregated net GHG emissions from biomass burning is shown in Figure 6.19.

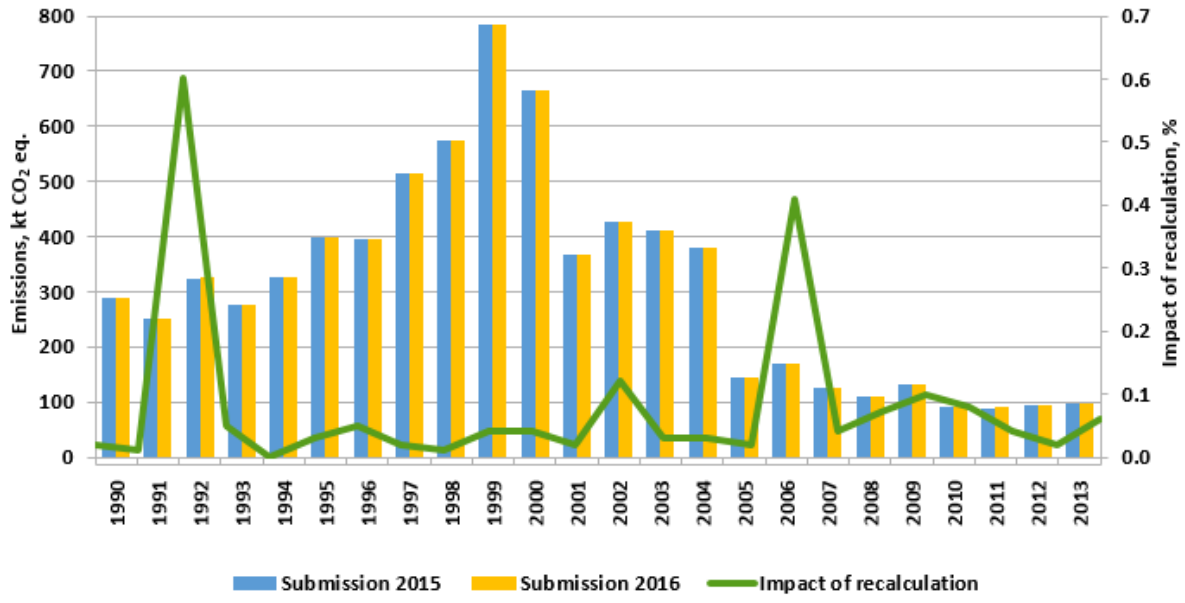

Figure 6.19 Impact of recalculation on the aggregated net GHG emissions from biomass burning

6.10.5 Category-specific planned improvements

A new methodology on estimation of incineration efficiency in forest fires will be elaborated and different types of forest fires will be separated to account the GHG emissions more accurate. Information provided by the State forest service will be used with higher level of accuracy by splitting different types of forest fires and following activities in the forest stands to avoid double accounting of harvested wood extracted in sanitary felling after

forest fires. Burning of harvesting residues will be evaluated by forest owners questionnaires.

6.11 HARVESTED WOOD PRODUCTS (CRF 4.G)

6.11.1 Category description

The category harvested wood products is a key source of CO_2 removals. The net emissions in harvested wood category in 2014 were -1818 kt CO_2. The net emissions during the reporting period are shown in Figure 6.20. Increase of removals in the harvested wood products during the last decade is associated with increase of harvesting rate and implementation of more advanced timber processing technologies.

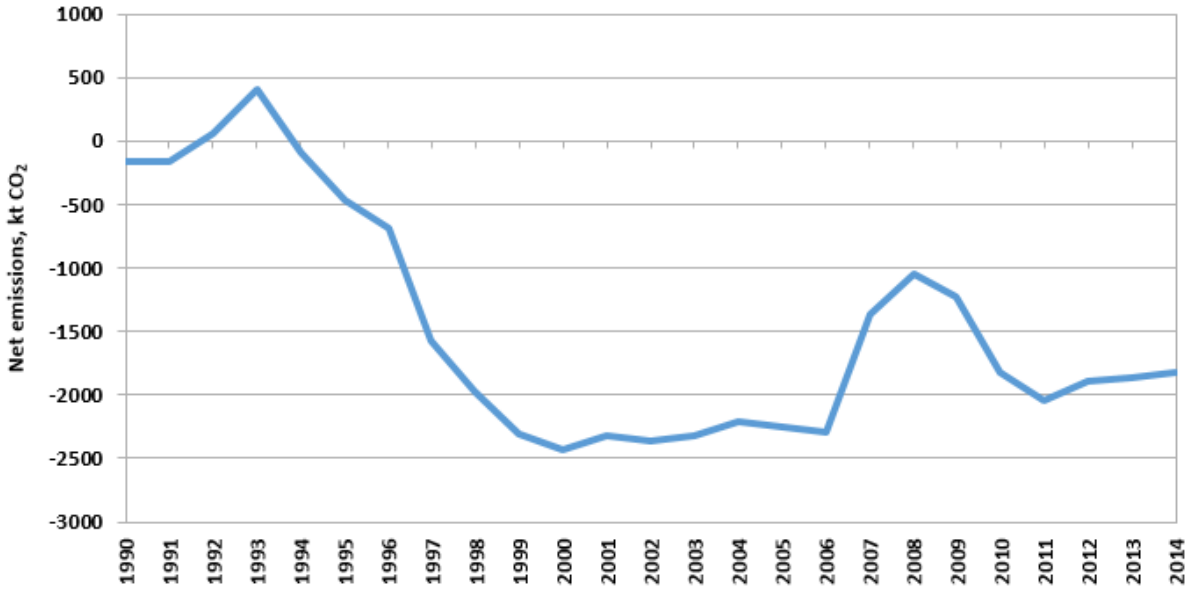

Figure 6.20 Net emissions from HWP during period 1990-2014 (kt)

Net emissions due to production of the harvested wood products are calculated according to methodology in IPCC KP Supplement. CO_2 emissions due to oundwood production in deforested land are accounted using instantaneous oxidation method.

6.11.2 Methodological issues

The net emissions from the harvested wood products are calculated according to the methodology elaborated by S. Rüter, 2011. The methodology corresponds to Tier 2 for HWP in IPCC KP Supplement for HWP. Three main HWP groups are used in calculations – sawnwod, wood based panels and paper and paperboard with more detailed division on products in Table 6.35 (according to Table 2.8.1 of IPCC KP Supplement).

Table 6.35 HWP categories and their subcategories

HWP category	HWP subcategory
Sawn wood	Coniferous sawnwood
	Non-coniferous sawnwood
Wood-based panels	Hardboard (HDF)
	Insulating board (Other board, LDF)

HWP category	HWP subcategory
	Fibreboard compressed
	Medium-density fibreboard (MDF)
	Particle board
	Plywood
	Veneer sheets
Paper and paperboard	-

The calculation is based on harvesting statistics collected by the State forest service, production statistics by the Forest industry association, FAO and EUROSTAT. Linkage with land area used in the commercial felling is secured through the State forest service stand wise forest inventory system, where all commercial harvesting activities are recorded. Only locally harvested wood is accounted in estimates.

The proportion is calculated by equation No. 9 to estimate share of harvesting stock extracted due to deforestation and is used to calculate share of domestic industrial oundwood. The data to calculate proportion is obtained from Central statistical bureau of Latvia and is collected by the State forest service. This proportion is applied to HWP to estimate how much HWP could be produced from wood obtained in deforested areas. Instant oxidation is applied to the proportion of HWP potentially produced from the wood obtained in deforested areas.

$$IRW_P(i) = \left(1 - \frac{D * M_{avg}}{MH_{total}}\right) * IRW_{total}(i);\ where$$

$IRW_P(i)$ = production of industrial roundwood excluding roundwood from deforested area in year i, Gg C yr^{-1};
D = annual deforested area, ha;
M_{avg} = average growing stock in country, $m^3 ha^{-1}$;
MH_{total} = total harvested stock volume, m^3;
$IRW_{total}(i)$ = total industrial domestic roundwood production. (9)

Historical data on production, import and export of HWP as well as share of different types of the products are used in calculation. The coefficients and numeric values used in calculation are default conversion factors recommended in IPCC KP Supplement (Table 2.8.1) and are provided in Table 6.36 and Table 6.37. Input data in calculation are extrapolated to 1900. Net emissions due to decay of harvesting residues are accounted separately considering 20 years transition period for above and below ground biomass. Instant oxidation is considered for the firewood assortment.

Table 6.36 Assumptions for estimation of carbon stock in harvested wood products

HWP categories	Density (oven dry mass over air dry volume), Mg m^{-3}	C conversion factor (per air dry volume), C m^{-3}
Sawnwood – Coniferous	0.450	0.225
Sawnwood – Non-Coniferous	0.560	0.280
Veneer sheets	0.505	0.253
Plywood	0.542	0.267
Particle board	0.596	0.269
Hardboard	0.788	0.335
MDF (Medium density fibreboard)	0.691	0.295
Fibreboard compressed	0.739	0.315

HWP categories	Density (oven dry mass over air dry volume), Mg m^{-3}	C conversion factor (per air dry volume), C m^{-3}
Insulating board	0.159	0.075
-	**oven dry mass over air dry mass, Mg Mg^{-1}**	**per air dry mass, Mg C Mg^{-1}**
Paper and paperboard (aggregate)	0.900	0.386

Share of locally originated wood in harvested wood products is calculated using equation No. 10.

$$f_{IRW}(i) = \frac{IRW_P(i) - IRW_{EX}(i)}{IRW_P(i) + IRW_{(IM)}(I) - IRW_{EX}(i)};\ where$$

$f_{IRW}(i)$ = share of industrial roundwood for the domestic production of HWP originating from domestic forests in year i;

$IRW_P(i)$ = production of industrial roundwood excluding roundwood from deforested area in year i, Gg C yr^{-1};

$IRW_{EX}(i)$ = export of industrial roundwood in year i, Gg C yr^{-1};

$IRW_{(IM)}(I)$ = import of industrial roundwood in year i, Gg C yr^{-1}. (10)

Organic carbon in harvested wood products originated from domestic wood is calculated using equation No. 11.

$$CHWP = f_{IRW}(i) * HWP_D;\ where$$

$CHWP$ = organic carbon in domestically produced HWP excluding HWP from wood produced in deforested area, Gg C yr^{-1};

HWP_D = Domestical production of HWP, Gg C yr^{-1}. (11)

The rate of the CO_2 emissions and removals in harvested wood products is calculated using equations No. 12 and 13.

$$C(i+1) = e^{-k} * C(i) + \left[\frac{1-e^{-k}}{k}\right] * inflow(i);\ where$$

$C(i+1)$ = annual carbon stock, Gg C yr^{-1};

e = exponential constant;

k = decay constant for each HWP category, units yr^{-1};

$C(i)$ = carbon stock in particular category at the begining of year i, Gg C;

$inflow(i)$ = the inflow to the particular HWP category during year i, Gg C yr^{-1};

$$k = \frac{\ln(2)}{HL};\ where$$

HL = the number of years it takes to lose one-half of the material currently in the pool, yr (12)

$$\Delta C(i) = C(i+1) - C(i);\ where$$

$\Delta C(i)$ = carbon stock change of the HWP category during year i, Gg C yr^{-1}. (13)

Table 6.37 Common coefficients to estimate balance between CO_2 emissions and removals in harvested wood products

Factors	Numeric value		
Common coefficients			
e	2.718282		
ln(2)	0.6931		
Assortment specific coefficients:			
Assortment	**Sawnwood**	**Platewood**	**Pulpwood**
HL	35	25	2
k	0.02	0.03	0.35
e^{-k}	0.98	0.97	0.71
$k = \frac{1-\ln(2)}{H * L}$	0.99	0.99	0.85

The equations of calculation of the harvested wood products are included into the National tool for calculation of the net emissions due to forest management as separate module.

6.11.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty level of the activity data for the whole time series is assumed 15 % in 1990-2014.

6.11.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the LULUCF sector in order to achieve these quality objectives.

Harvesting rate and production of harvested wood products used in the calculations is compared with other data sources, particularly statistics collected by the Latvia Forest industry federation. Several quality meetings are held annually between experts.

6.11.5 Category-specific recalculations, if applicable, including changes made in response to the review process

Changes have been occurred due to the more accurate activity data in years 2011-2013. Summary of the impact of recalculation on CO_2 emissions from HWP is shown in Figure 6.21.

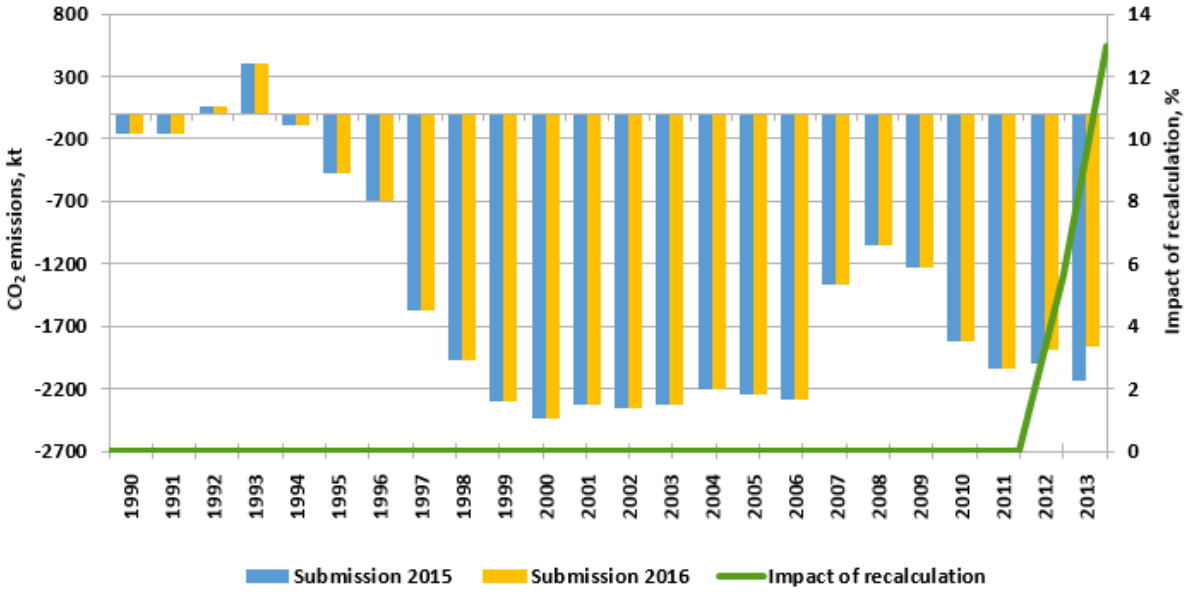

Figure 6.21 Impact of recalculation on CO_2 emissions from HWP

6.11.6 Category-specific planned improvements

There are no improvements planned for the next inventory.

6.12 DIRECT N_2O EMISSIONS FROM MANAGED SOILS

6.12.1 Category description

Direct N_2O emissions from drainage of organic soils are estimated for forest lands, croplands, settlements and wetlands land-use categories. Direct N_2O emissions corresponding to land-use change from N mineralisation associated with loss of soil organic matter from change of land use or management are estimated for land-use change to croplands and settlements on mineral soils.

6.12.2 Methodological issues

Direct emissions of N_2O due to drainage of organic soils are calculated according equation No. 14 (Equation 2.7 of the IPCC Wetlands Supplement).

$$N_2O-N_{OS}=\left[\left(F_{OS,CG,Temp}\cdot EF_{2CG,Temp}\right)+\left(F_{OS,F,Temp,NR}\cdot EF_{2F,Temp,NR}\right)\right];\ where$$

N_2O-N_{OS} = *Annual direct* N_2O-N *emissions from managed/drained organic soil,* $kg\ N_2O-N\ yr^{-1}$

F_{OS} = *Annual area of managed/drained organic soils, ha. The subscripts CG, F, Temp, NR refer to cropland and grassland, forestland, temperate and nutrient rich, respectively.*

EF_2 = *Emission factor for* N_2O *emissions from drained/managed organic soils,* $kg\ N_2O–N\ ha^{-1}yr^{-1}$

(14)

Activity data consist of areas of land remaining in a land-use category and land converted to other land-use category on drained organic soils. Data of annual area of drained organic soil

are taken from the NFI. Default N_2O emission factors for drained organic soils are shown in Table 6.38 according Table 2.5 of the IPCC Wetlands Supplement.

Table 6.38 Tier 1 N_2O emission/removal factors for drained organic soils in all land-use categories

Land-use category	Climate/ vegetation zones	Emission factor (kg N_2O-N ha^{-1} yr^{-1})	95% Confidence interval	
Forest land, drained	Temperate	2.8	-0.57	6.1
Cropland, drained	Boreal and temperate	13	8.2	18
Grassland, deep-drained, nutrient-rich	Temperate	8.2	4.9	11
Peatland managed for extraction	Boreal and temperate	0.3	-0.03	0.64

N_2O emissions from land converted to another land-use category on drained organic soils are calculated in the same way as emissions from land remaining in a land-use category.

Direct N_2O emissions from N inputs to managed soils and from N mineralisation resulted from loss of soil organic C stocks in mineral soils due to land-use change are estimated by Tier 1 methodology using equation No. 15 (equation 11.1 of 2006 IPCC Guidelines):

$$N_2O - N_{N\ inputs} = F_{SOM} * EF_1;\ where$$

$N_2O - N_{N\ inputs}$ – annual direct $N_2O - N$ emissions from N inputs to managed soils, kg $N_2O - N\ yr^{-1}$

EF_1 – emission factor for N mineralised from mineral soil as a result of loss of soil carbon, kg $N_2O - N\ (kg\ N)^{-1}$

(15)

The equation No. 15 is supplemented by equation 11.8 from 2006 IPCC Guidelines (equation No. 17 in the NIR). Default emission factor for N mineralised from mineral soil as a result of loss of soil carbon (0.01 kg N2O-N (kg N)-1) from Table 11.1 of 2006 IPCC Guidelines is used. Default C:N ratio (15) for soil organic matter is utilized for estimation of annual amount of N mineralised in mineral soils as a result of loss of soil carbon due to land use change to cropland (2006 IPCC Guidelines). As there is no fixed default emission factors for settlements provided by IPCC guidelines, default emission factors of croplands land-use category are applied, C:N ratio for soil organic matter applied based on expert judgement is 15, and annual carbon losses in organic soil in settlements are accounted using emissions factor from cropland – 5 t C ha-1 yearly (2006 IPCC Guidelines), assuming that peat is not completely removed during the conversion.

6.12.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty of soil nitrogen (N_2O) emissions are estimated according to data obtained within the scope of the international forest soil monitoring project BioSoil and values provided in the 2006 IPCC Guidelines. Uncertainty ranges of emission factors for N_2O emissions from drained organic soils are listed in Table 6.38.

Uncertainty range of emission factor for N mineralised from mineral soil as a result of loss of soil carbon is 0.003-0.03 kg N_2O-N (kg N)$^{-1}$. Uncertainty range of C:N ratio of the soil organic matter for land-use change is 10-30.

6.12.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the LULUCF sector in order to achieve these quality objectives.

QA/QC procedures include double check of area affected by the land use change and soil CO_2 emissions – under calculation of land use changes and during calculation of N_2O emissions. Several quality meetings are held annually between experts.

6.12.5 Category-specific recalculations

Recalculations are done due to recalculation of the NFI data based on repeated measurement of borders of the plots and their sectors. Summary of the impact of recalculation on indirect N2O emissions from managed soils is shown in Figure 6.22.

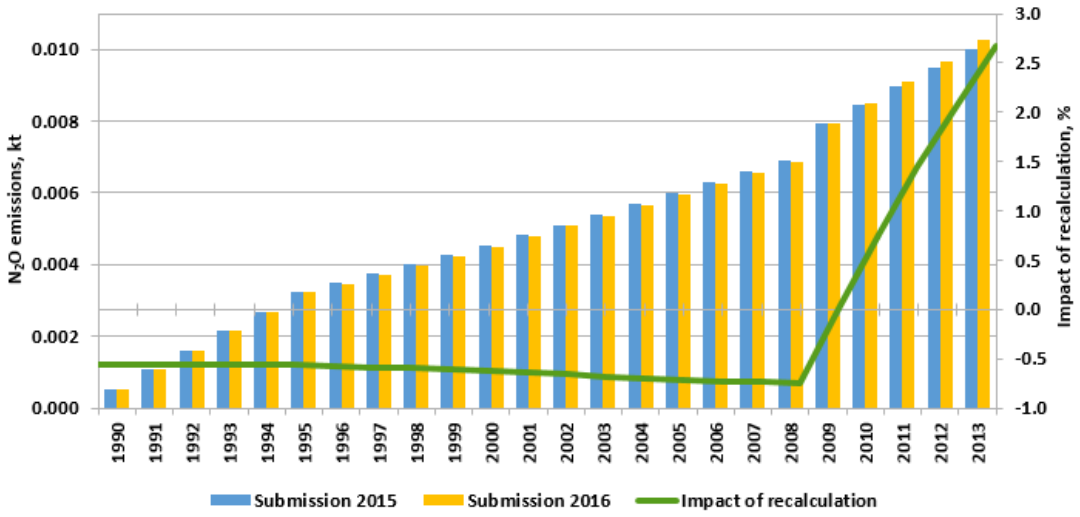

Figure 6.22 Impact of recalculation on indirect N_2O emissions from managed soils

6.12.6 Category-specific planned improvements

N_2O emissions might be considerable part of emissions from wetlands, therefore, it is necessary to develop method for estimation impact of drainage on N_2O emissions, and it is important to be able to separate wetlands on organic soils (high N_2O emissions) and mineral soils (low N_2O emissions).

6.13 INDIRECT N_2O EMISSIONS FROM MANAGED SOILS (CRF 4 (IV))

6.13.1 Category description

Indirect N_2O emissions from N mineralisation associated with loss of soil organic matter from change of land use or management are estimated for land-use change to croplands and

settlements on mineral soils. Indirect N_2O emissions from organic soils are not calculated, because 2006 IPCC Guidelines does not include such a methodology.

6.13.2 Methodological issues

Indirect N_2O emissions from land use change to cropland are calculated according to 2006 IPCC Guidelines. Amount of N_2O-N emissions produced from leaching and run-off as a result from land use change to cropland are estimated by Tier 1 methodology using equation 11.10 (equation No. 16 in the NIR).

$$N_2O_{(L)}-N = F_{SOM} * Frac_{LEACH-H} * EF_5; \text{ where}$$

$N_2O_{(L)}-N$ – annual amount of N_2O-N produced from leaching and runoff of N additions to managed soils where leaching/runoff occurs, kg $N_2O-N\ yr^{-1}$

$Frac_{LEACH-(H)}$ – fraction of all N added to/ mineralised in managed soils in regions where leaching/ runoff occurs that is lost through leaching and runoff, kg $N\ (kg\ of\ N\ additions)^{-1}$

EF_5 – emission factor for N_2O emissions from leaching and runoff, kg $N_2O-N\ (kg\ N\ leached\ and\ runoff)^{-1}$

(16)

It is supplemented by equation 11.8 from 2006 IPCC Guidelines (equation No. 17 in the NIR).

$$F_{SOM} = \left|\Delta C_{Mineral} * \frac{1}{R}\right| * 1000; \text{ where}$$

F_{SOM} – the net annual amount of N mineralised in mineral soils as a result of loss of soil carbon throught chenge in land use or management, kg N.

$\Delta C_{Mineral}$ – average annual loss of soil carbon for land – use type, tonnes C

R – C : N ratio of the soil organic matter

(17)

Default C:N ratio (15) for soil organic matter (2006 IPCC Guidelines) is utilized for estimation of annual amount of N mineralised in mineral soils as a result of leaching/run-off associated with loss of soil carbon through land use change to cropland. Carbon losses are calculated according to the Tier 1 method of the 2006 IPCC Guidelines. Default values of fraction of all N added to/mineralised in managed soils due to leaching and run-off (0.3 kg N (kg of N additions)$^{-1}$) and emission factor for N_2O emissions from N leaching and run-off (0.0075 kg N_2O-N (kg N leached and run-off)$^{-1}$) are taken from table 11.3 of 2006 IPCC Guidelines.

Indirect N_2O emissions from land use change to settlements are also accounted using the 2006 IPCC Guidelines Tier 1 method. Amount of N_2O-N emissions produced from leaching and run-off as a result from land use change to settlements are estimated by Tier 1 methodology using equation 11.10 supplemented by equation 11.8 from 2006 IPCC Guidelines. C:N ratio 15 for soil organic matter based on expert judgement is utilized for estimation of annual amount of N mineralised in mineral soils as a result of leaching/run-off associated with loss of soil carbon thorough land use change to settlements. Tier 1 method of the 2006 IPCC Guidelines (loss of 20 % of soil carbon in land converted to settlement) is used to estimate carbon stock changes. Default values of fraction of all N added to mineralised in managed soils due to leaching and run-off (0.3 kg N (kg of N additions)$^{-1}$) and emission factor for N_2O emissions from N leaching and run-off (0.0075 kg N_2O-N (kg N leached and run-off)$^{-1}$) are taken from table 11.3 of 2006 IPCC Guidelines.

6.13.3 Uncertainties and time-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Uncertainty range of C:N ratio of the soil organic matter for land-use change from Forest Land or Grassland to Cropland is 10-30 %. Uncertainty range of fraction of all N added to/mineralised in managed soils in regions where leaching/run-off occurs that is lost through leaching a run-off is 0.1-0.8 kg N (kg of N additions^{-1}). Uncertainty range of emission factor for N_2O emissions from N leaching and run-off according to 2006 IPCC Guidelines is 0.0005-0.025 kg N_2O-N (kg N leached and run-off^{-1}).

6.13.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the LULUCF sector in order to achieve these quality objectives. QA/QC procedures include double check of area affected by the land use change and soil CO_2 emissions – under calculation of land use changes and during calculation of N_2O emissions. Several quality meetings are held annually between experts.

6.13.5 Category-specific recalculations

Recalculations are done due to recalculation of the NFI data based on repeated measurement of borders of the plots and their sectors. Summary of the impact of recalculation on indirect N_2O emissions from managed soils is shown in Figure 6.23.

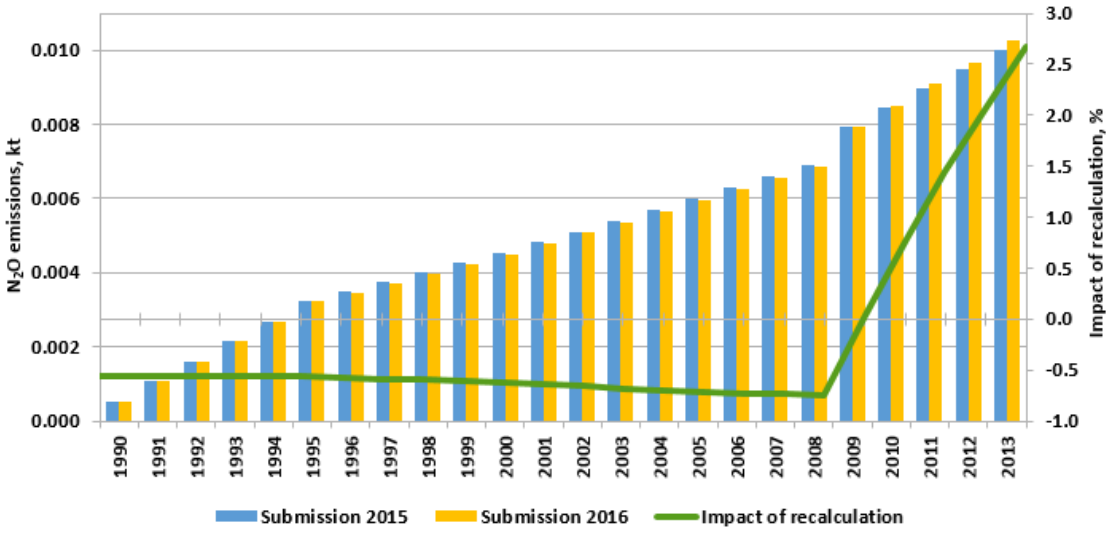

Figure 6.23 Impact of recalculation on indirect N_2O emissions from managed soils

6.13.6 Category-specific planned improvements

Information on land use changes, particularly, distribution of organic and mineral soil and losses of carbon due to land use changes should be estimated. Country specific C/N ratio will be introduced after completion of the EEA grants project "Evaluation of carbon stock in cropland and grassland".

7 WASTE (CRF 5)

7.1 OVERVIEW OF SECTOR

In 2014, emissions from the Waste sector were 836.99 kt CO_2 equivalents; it contributes about 7.4% of total GHG emissions (excluding LULUCF) (Figure 7.1). Solid waste disposal and wastewater handling are the main sources of GHG emissions in Waste sector. Incineration and Biological treatment of solid waste (composting) tohether contributes only 5.2% of GHG emissions from Waste sector in 2014.

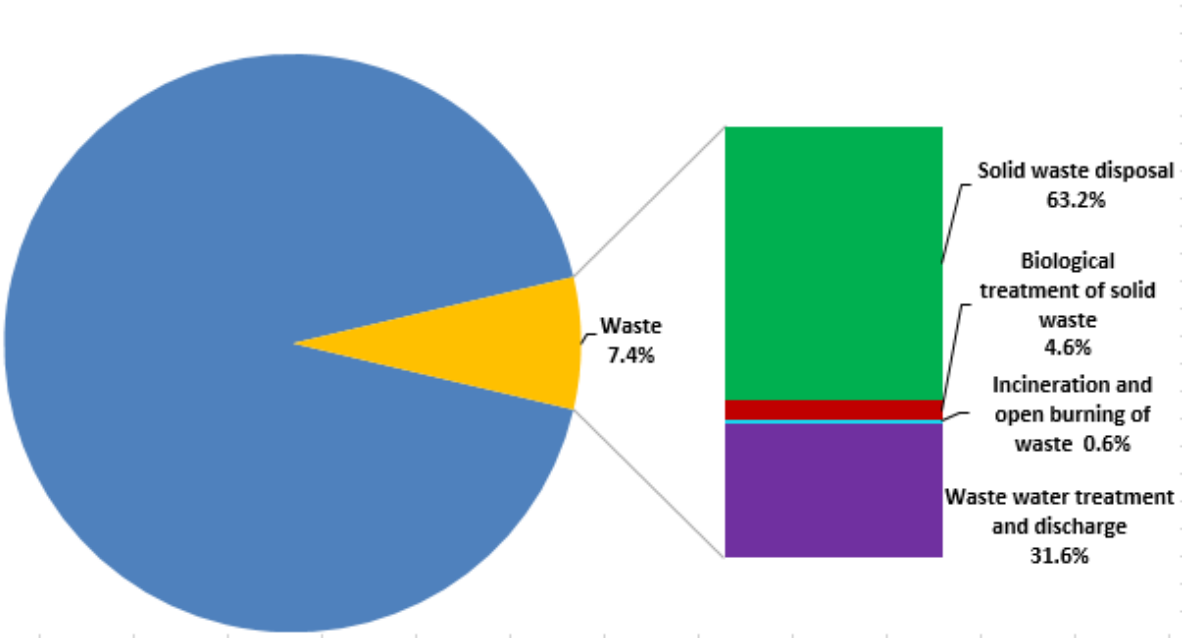

Figure 7.1 Emissions from the waste sector compared with the total emissions in 2014

Emission categories reported under Waste sector as well as methods and emission factors used are summarized in Table 7.1.

Table 7.1 Waste sector reported emissions and methods

Sector categories	Reported GHG	Methods	EF
A. Solid waste disposal			
1. Managed waste disposal sites	CH_4	Tier 2 (D)	CS, D
2. Unmanaged waste disposal sites	CH_4	Tier 2 (D)	CS, D
3. Uncategorized waste disposal sites	NO	NA	NA
B. Biological treatment of solid waste			
1. Composting	CH_4, N_2O	Tier1 (D)	CS, D
2. Anaerobic digestion at biogas facilities	NA	NA	NA
C. Incineration and open burning of waste			
1. Waste incineration	CO_2, N_2O	D	D
2. Open burning of waste	NE	NA	NA
D. Wastewater treatment and discharge			
1. Domestic wastewater	CH_4, N_2O	D	CS, D
2. Industrial wastewater	CH_4, N_2O	D	CS, D
3. Other (as specified in table 6.B)	NMVOC	D	D
E. Other (please specify)	NO	NA	NA

GHG emissions from Waste sector have been fluctuated from 1990-2014. In 2014, emissions were approximately 3.2% higher than in 1990. In 2014, emissions from the Waste sector were 836.99 kt CO_2 equivalents; it contributes about 7.4% of total GHG emissions (excluding LULUCF).

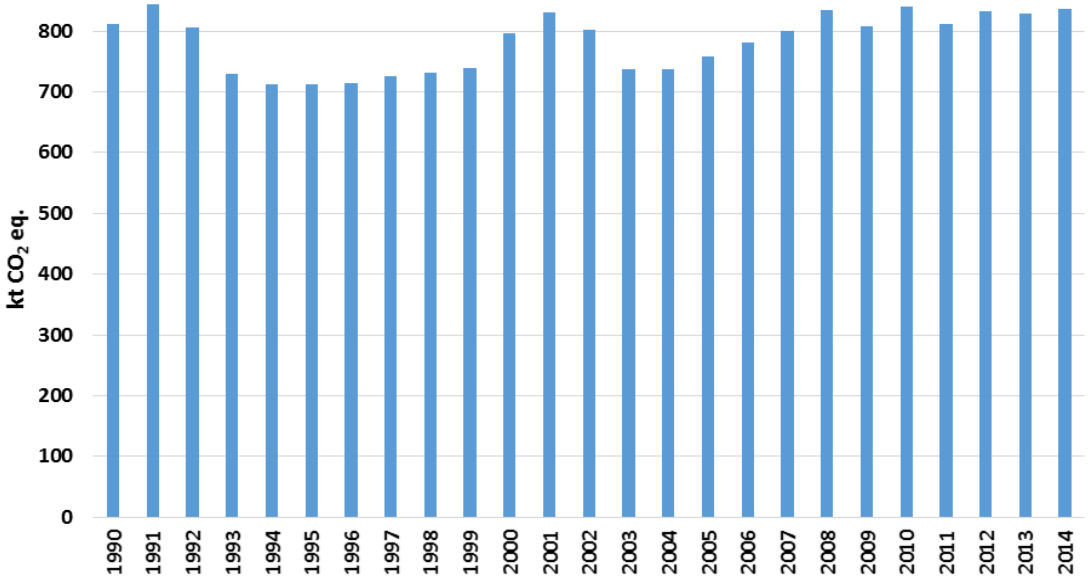

Figure 7.2 Total GHG emissions from Waste sector 1990-2014 (kt CO_2 eq.)

Fluctuations in total GHG emissions in waste sectors could be explained with changes of economic situation in last 20 years (Figure 7.2). Some industry sectors were almost closed in the middle of 1990s. Biggest influence to total emission trend in the beginning on 1990s gives GHG emissions from Waste water handling, decrease of total emissions in years 2002-2004 is due to starting of methane collection in landfills.

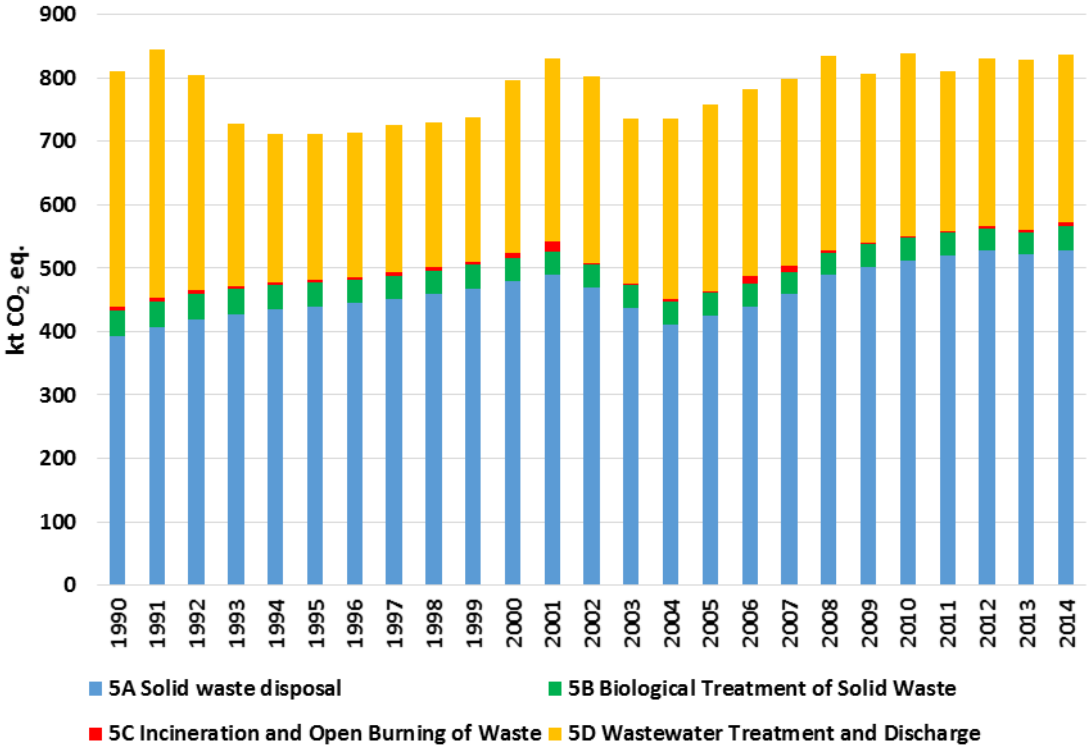

Figure 7.3 GHG Emissions in Waste subsectors 1990-2014 (kt CO_2 eq.)

Emissions from 5.C and 5.B in last year's, when emissions from these sectors were calculated, are very small in comparison with other sectors – 5.A Solid waste disposal (SWD) and 5.D Waste water treatment and discharge (WWH).

Key categories from Waste sector are summarized in Table 7.2.

Table 7.2 Key categories in Waste sector in 2014

IPCC category/Group	Gas	Identification criteria	with LULUCF	without LULUCF
5.A.1. Managed Waste Disposal on Land	CH_4	L1, L2	X	X
5.A.2. Unmanaged Waste Disposal Sites	CH_4	L1, L2,T1,T2	X	X
5.B.1. Composting	CH_4	L2,T2		X
5.B.1. Composting	N_2O	L2,T2		X
5.D.1 Domestic Wastewater	CH_4	L1, L2,T1,T2	X	X
5.D.1 Domestic Wastewater	N_2O	L2,T2		X
5.D.2 Industrial Wastewater	CH_4	L1, L2,T1,T2	X	X

According to the annual waste statistics report[235] the total generated amount of waste is shown in Table 7.3.

Table 7.3 Generated waste in Latvia (kt)

Year	Municipal (all non-hazardous) waste	Hazardous waste	Total
2006	1420.46	54.372	1474.832
2007	1386.57	41.605	1428.175

[235] *http://www.lvgmc.lv/lapas/vide/atkritumi/atkritumu-statistikas-apkopojumi/atkritumu-statistikas-apkopojumi?id=1713&nid=380*

2008	1368.79	46.400	1415.160
2009	1033.91	55.563	1089.473
2010	1131.404	55.089	1186.493
2011	1535.057	58.476	1593.533
2012	1799.440	85.121	1884.561
2013	1902.007	109.23	2011.237
2014	2128.725	80.978	2209.703

N_2O is emitted as the release from sewage purification system and waste incineration.

Data on CO_2 and N_2O emissions from waste incineration are available only since 1999. Emissions are estimated since 1990, data on incinerated amount 1990 – 1998 are extrapolated according to waste amounts. Calculation of indirect GHG emissions from cremation is shown in Section 7.4.1.1. Emissions from waste incineration with energy recovery are allocated under Energy sector (CRF 1.A.2.f Non-metalic minerals).

CH_4 and N_2O are emitted from waste composting. Enterprises data available only since 2003, when composting facilities started to report within state statistical survey about waste composting. Emissions from household waste composting are estimated since 1990. For emission calculations 2006 IPCC Guidelines and default emission factors were used.

Waste management has acquired prior significance in the environmental protection policy as one of the instruments for sustainable use of natural resources. The main directions in the waste management are the development of the construction of polygons and collecting system for non–hazardous municipal waste and the development of system for the collection and treatment of hazardous waste. At the moment 11 non-hazardous waste polygons and two polygons for hazardous waste got "A" category permits according to integrated pollution prevention and control (IPPC) directive. Biogas collection and use for energy production from biodegradable waste and sludge is set as one of waste management priorities in Latvia.

Main activity data sources for GHG emissions calculations in Waste sector are databases[236] "3-Waste", "2-Water" and data from CSB.

Data on hazardous waste in Latvia have been collected and compiled by LEGMC since 1997, but data on municipal (non-hazardous) waste since 2001. Until then the waste volume was determined on the basis of separate pilot projects and the assessments and projections by waste management experts.

Since 2002, databases about hazardous and municipal waste are combined in one database "3-Waste". Data in this database are gathered from State Statistical survey about waste, which is conducted annually.

Statistical survey must be completed annually by all enterprises, which have permits on polluting activities (A and B category) and all enterprises, which have permits on waste management operations. To estimate disposed waste amounts in preliminary years; data about population and Gross domestic product (GDP) are taken from CSB.

"2-Water" database was developed by LEGMC as well. Data of water abstraction and use, wastewater treatment and discharge have been collected since 1991 in the frame of state

[236] http://parissrv.lvgmc.lv/public_reports

statistical survey "2 – Water". State statistical survey "2-Water" must be reported by all enterprises which have issued permits on water use, water resources use or mineral deposits quarry use, or IPPC permit. Both LEGMC "2-Water" and CSB data are used as activity data for emission calculation - CSB and "2-Water" data for CH_4 emission from Domestic Waste Water Handling and Sewage Sludge, N_2O emission from Industrial Waste Water Handling and NMVOC emission, and CSB for CH_4 emission from industrial waste water handling and N_2O from Domestic Waste Water Handling.

7.2 SOLID WASTE DISPOSAL (CRF 5.A)

7.2.1 Category description

Methane emission is calculated from SWD (Table 7.4). It is main GHG source from waste sector in Latvia. Compared to 2013, CH_4 emissions have increased by 1.18% in 2014. Compared to 1990 CH_4 emissions have increased by 4.17 kt due to First order decay calculation method.

Table 7.4 Reported emissions under subcategory Solid Waste Disposal on Land

CRF	Source	Emissions reported
5.A 1	Managed Waste Disposal on Land	CH_4, NMVOC
5.A 2	Unmanaged Waste disposal Sites	CH_4, NMVOC
5.A 3	Uncategorized Waste disposal Sites	Not occurring

To estimate CH_4 emissions with First Order Decay (Tier2) method from landfills, time series for disposed waste amounts till 1970 was developed. The base year for disposed amount estimation is 1996, when research[237] about biggest landfills was done. All calculations are done according to 1996 year amount. In that research total generated solid municipal waste amount is estimated as 2 379 829 m^3. It is assumed that outstanding part of these waste is going to landfills. Amount of disposed tons are calculated - 2 379 829 m^3 x 0.2 = 475 965 tons. Waste amounts 1997 – 2001 were estimated like equal growth between 1996 and 2002 amount. Amounts 1970 – 1995 were estimated according to GDP and population changes.

Value of waste density (0.2 t/m^3) is taken from Latvian Environment agency (2002) "Handbook in use of factors for inventory of municipal waste in transition from volume to a unit of weight"[238]

Table 7.5 Estimated Disposed amounts from 1970 – 2002

Year	Population	Disposed solid waste amount (kt)	GDP/inhabitant (LVL - 2000 prices)	Disposed waste from urban areas (kt)	Disposed waste from rural areas (kt)
1970	**2351903**	409.59	1230	249.95	159.65
1971	2368671	419.60	1286.4	260.15	159.45
1972	2385439	429.60	1342.8	266.35	163.25

[237] *"Research about solid waste management in Latvia", 1998, Ltd GEO Consultants*

[238] http://www.lvgmc.lv/fs/CKFinderJava/userfiles/files/Vide/Atkritumi/statistika/Rokasgramata_atkr_faktori.pdf .

Year	Population	Disposed solid waste amount (kt)	GDP/inhabitant (LVL - 2000 prices)	Disposed waste from urban areas (kt)	Disposed waste from rural areas (kt)
1973	2402207	439.61	1399.2	276.95	162.65
1974	2418975	449.61	1455.6	283.25	166.36
1975	2435744	459.62	1512	294.15	165.46
1976	2452512	469.62	1568.4	300.56	169.06
1977	2469280	479.62	1624.8	311.76	167.87
1978	2486048	489.63	1681.2	318.26	171.37
1979	**2502816**	499.63	1737.6	332.18	167.46
1980	2508728	508.59	**1794**	335.67	172.92
1981	**2514640**	517.55	1850.4	348.50	169.05
1982	2529255	527.35	1906.8	353.32	174.02
1983	2543870	537.15	1963.2	365.26	171.89
1984	2558486	546.94	2019.6	371.92	175.02
1985	2573101	556.74	**2076**	384.15	172.59
1986	**2587716**	572.04	2169.4	393.01	179.03
1987	2607822	587.87	2262.8	405.63	182.24
1988	2627928	603.70	2356.2	416.55	187.15
1989	2648034	619.53	2449.6	430.06	189.47
1990	**2668140**	635.36	**2543**	439.97	195.39
1991	2634628	599.65	2324.6	415.62	184.02
1992	2601116	563.93	2106.2	389.90	174.03
1993	2567604	528.22	1887.8	362.42	165.80
1994	2534092	492.50	1669.4	339.96	152.54
1995	**2500580**	456.79	**1451**	314.36	142.43
1996	**2469531**	**475.96**	**1600**	326.98	148.98
1997	**2444912**	506.30	1693.75	347.36	158.94
1998	**2420789**	536.64	1787.5	368.00	168.64
1999	**2399248**	566.98	1881.25	387.30	179.68
2000	**2377383**	597.32	**1975**	406.73	190.59
2001	**2364254**	627.66	**2149**	426.81	200.85
2002	**2345768**	**658.00**	**2304**		

Figures in bold is primary data from National statistics[239] (Table 7.5). Waste amounts in all other years are estimated according to these figures. Disposed amount is estimated according to GDP and population changes. Population for 1971 -1978, 1982 – 1985, 1987 – 1988, 1991 – 1994 are calculated according to available amounts in nearest years. GDP data from 1970 – 1979 are estimated like the same decrease from 1985 - 1980.

Landfills from 1970 – 2001 are assumed as unmanaged[240]. Disposed amount are divided between rural and urban areas, according to proportion of population between these areas. Methane correction factors (MCF) for CH_4 emissions calculations in urban areas (deep sites - 0.8) and rural areas (shallow sites - 0.4) are used.

[239] *Statistical Yearbook of Latvia 2004, CSB, 2005*

[240] *"Degradable organic carbon in disposed waste", 2011, Ltd Virsma*

Data about waste disposal on land for 2002 - 2014 are taken from database "3-Waste" (Table 7.6). Starting from 2002, according to data base information, biggest sites could be assuemed as managed sites (polygons) and MCF-1 was started. For each year (2002-2014) in polygons disposed amount are determined according to disposing site profile from "3-Waste" data base.

Table 7.6 Disposed solid waste amounts from 2002-2014 (kt)

Year	Total disposed solid waste amount	Disposed in polygons (MCF-1)	Disposed in deep unmanaged sites (urban area, MCF-0.8)	Disposed in shallow unmanaged sites (rural area, MCF-0.4)
2002	**658.0**	217.46	303.97	136.57
2003	**578.9**	207.74	256.07	115.05
2004	**631.7**	282.84	240.71	108.15
2005	**610.9**	370.43	165.89	74.53
2006	**670.0**	454.39	148.78	66.84
2007	**775.1**	553.27	153.09	68.78
2008	**704.8**	566.89	95.12	42.74
2009	**637.5**	549.5	60.71	27.28
2010	**605.4**	586.9	12.73	5.72
2011	**548.7**	543.5	2.6	2.6
2012	**529.5**	525.568	1.98	1.98
2013	**534.2**	534.2	0	0
2014	**520.274**	520.274	0	0

According to information by landfill research, number of active waste disposal sites decreased from 558 in 1997 to 12 in 2014. All calculations are done for unsorted waste, because 95% of disposed waste is reported as unsorted.

According to the Latvia`s Waste management plan 2013 – 2020, in Latvia operates 11 waste disposing polygons, all other waste disposal sites are planned to close. In 2014 – 11 solid waste polygons are operating, all these sites are assumed as managed. Disposed solid waste amounts in Latvia are shown in Figure 7.4.

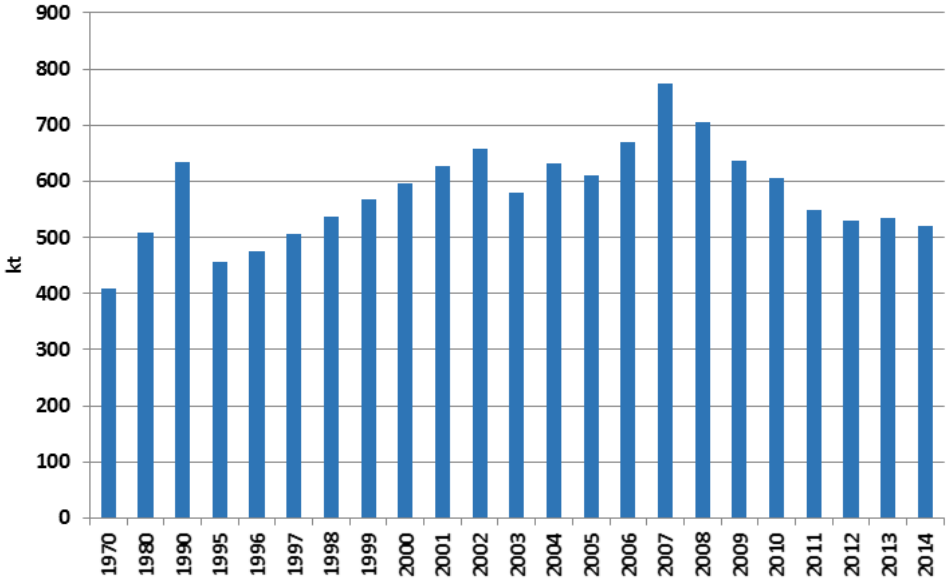

Figure 7.4 Disposed waste amounts in Latvia (kt)

Since October 2002, CH_4 recovery from landfills was started. For 2010 only in four waste facilities (*SIA Getlini EKO, SIA Liepajas RAS, SIA ZAAO Daibe, SIA Zemgale Eko*) CH_4 recovery was realized. In *SIA Getlini EKO* polygon methane was collected from old waste disposing area and from new waste disposing cells, which is specially built for waste disposing with biogas collection. In *SIA Liepajas RAS* methane collection also is developed in old landfill *Skede* and in new polygon *Kivites*. In *SIA ZAAO* polygon *Daibe* methane collection was started in the middle of 2009. In *SIA Zemgale Eko* polygon *Brakski* methane is started to collect in year 2013. In total 6.88 kt of CH_4 was collected and recovered in 2014. Recovered methane amount is presented in Figure 7.5.

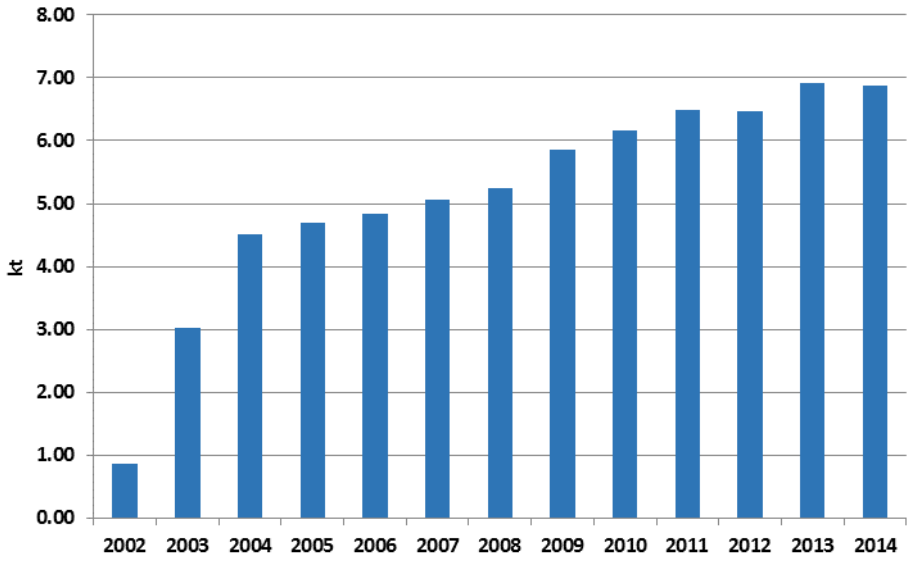

Figure 7.5 Recovered CH_4 from waste disposing (kt)

According to the Latvia's Waste Management plan 2013-2020, CH_4 recovery from landfills is one of priorities in waste management. CH_4 emission from waste disposing in SWD sites is presented in Figure 7.6.

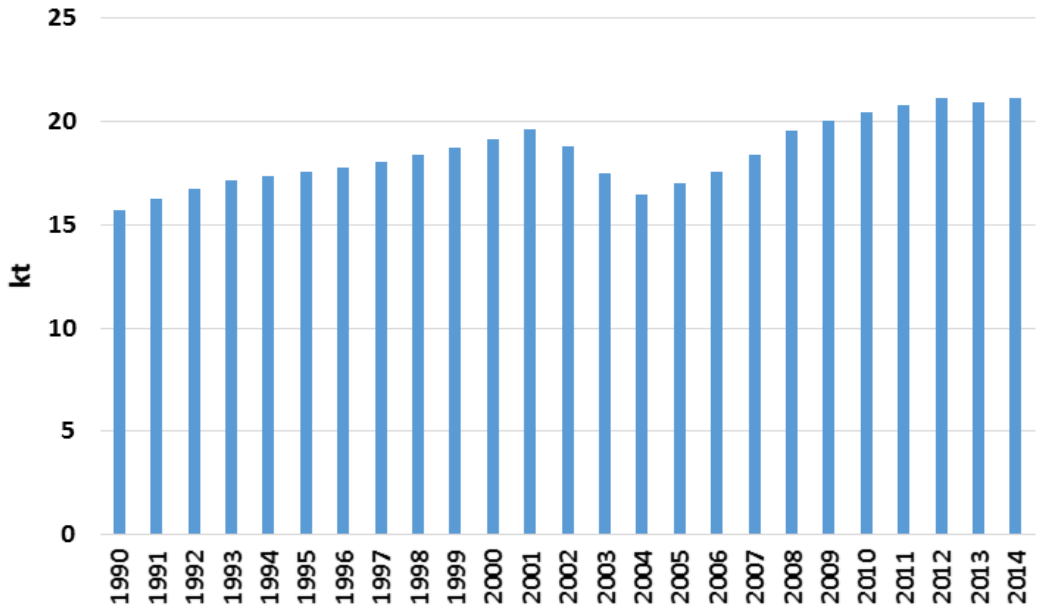

Figure 7.6 CH_4 emissions from waste disposing (kt)

7.2.2 Methodological issues

Tier 2 method from 2006 IPCC Guidelines is used for CH_4 emissions calculation and is based on IPCC Waste Model.

Emission factors used in IPCC Waste Model:

MCF – CH_4 correction factor, depend of waste disposal site type
Managed sites – 1
Deep unmanaged sites - 0.8
Shallow unmanaged sites - 0.4

DOC – degradable organic carbon (0.17)
DOCf – fraction of DOC dissimilated (0.5)
F – fraction of CH4 landfill gas (0.5)
k- methane generation rate (0.09)
OX – oxidation factor (default 0)

Fraction of CH_4 in landfill gas is estimated as 0.5 according to information, which is received from methane collection enterprises. Methane collection enterprises provide information about collected methane amount and also about methane concentration in landfill gas. Methane concentration is mutable, it diversifies from 0.47 – 0.54 depending on time frame and weather conditions.

DOC value 0.17 is used according to research which was carried out in Latvia in 2011 ("Degradable organic carbon in disposed waste", 2011, Ltd Virsma). Other emission factors are default from 2006 IPCC Guidelines.

7.2.3 Uncertainties and times-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

To calculate CH_4 emissions from SWD many emission factors are used. According to 2006 IPCC Guidelines for each factor uncertainty is estimated as:

DOC – 20%;

DOCf – 30%;

MCF – 10%;

CH_4 fraction F – 5%;

k – 40%.

$$EF_{uncert.} = \sqrt{DOC^2 + DOCf^2 + MCF^2 + F^2 + k^2}$$

Combined uncertainty for emission factors from SWD is 52%.

Uncertainty for activity data is estimated as 7%.

Uncertainty assessment of activity data is done using the proportion between disposed amount and population (2002-2014). Uncertainty is calculated as the standard medium of the average from linear trend line.

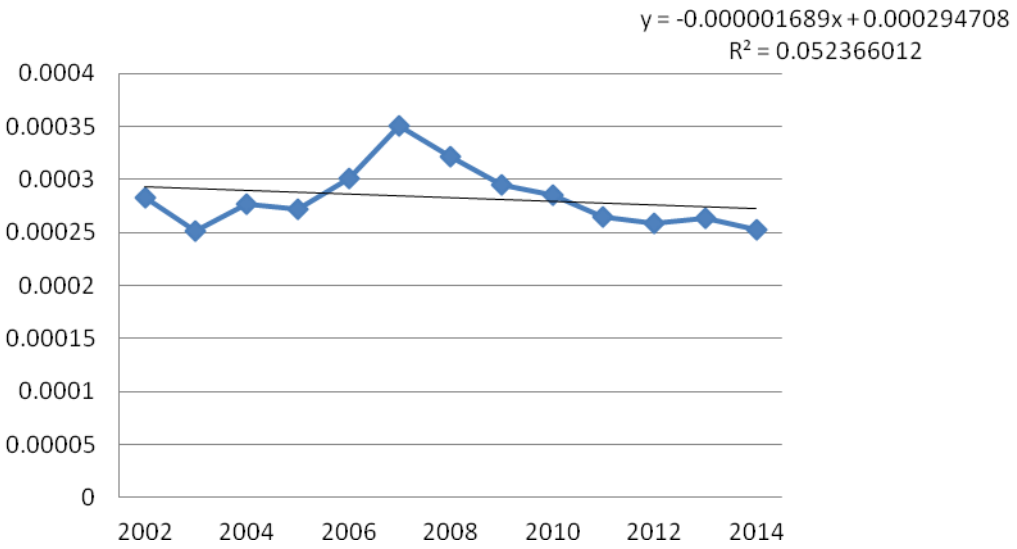

Figure 7.7 Trendline and proportion waste-to-population for waste disposal

7.2.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the waste sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

Disposed waste amount since 2002 is taken from waste data base "3-Waste". Data in this data base are checked and approved by Regional Environmental Boards.

National factor of DOC is determined in national research "Degradable organic carbon in disposed waste", 2011, Ltd Virsma. Distribution between managed and unmanaged sites is also described in this research which is available in QA/QC documentation.

Information regarding CH_4 recovery is taken directly from waste polygon reports. These reports are collected and checked by LEGMC every year. Latvia's waste polygon report is published in LEGMC website every year. Information about distribution between flaring and energy recovery is described. In Latvia`s case it is impossible to correctly estimate distribution of CH_4 recovery between managed and unmanaged sites, because old landfill and new disposing cell are located in one site. Collected CH_4 is counted together, but that does not affect final CH_4 emissions.

7.2.5 Category-specific recalculation

No recalculations are done.

7.2.6 Category-specific planned improvements

Estimation of MCF will be done for Latvia landfills for all time series. It is planned to make an efforts within the programme "European Economic Area Financial Mechanism 2009-2014 "National Climate Policy" to improve MCF. Improvement will be undertaken for the next submission.

7.3 BIOLOGICAL TREATMENT AND SOLID WASTE (CRF 5.B)

7.3.1 Composting (CRF 5.B.1)

7.3.1.1 Category description

Under 5.B.1 sector CH_4 and N_2O emissions from waste composting are calculated. Composting is set as one of priorities in waste treatment in Latvia. For composting biological degradable waste are useful. In Latvia these are mostly "park - garden" and "food production" waste.

Data about industrial composting become available since 2003, when waste treatment companies started waste composting and get IPPC permits on this activity.

Composting in private households has been very popular for many years. Composted waste amount in households is estimated according to research[241] done by Waste Management

[241] *"Composting emission factor development from waste and waste water sectors and methane correction factor estimation for Latvia landfills", 2015, Waste Management Association of Latvia*

Association of Latvia in 2015. In this research total amount of composted waste in households are estimated for 2012 – 2014. Time series are extrapolated back to 1990 according to changes in population number.

Table 7.7 Reported emissions under composting

CRF	Source	Emissions reported
5.B.1.	Compost production	CH_4, N_2O

From composting CH_4 and N_2O emissions are calculated according to 2006 IPCC Guidelines. In previous IPCC Guidelines emission factors for composting were not provided. Data regarding composted waste are taken from "3-Waste" database. In 2011 there was an increase of composted amounts in composting enterprises.

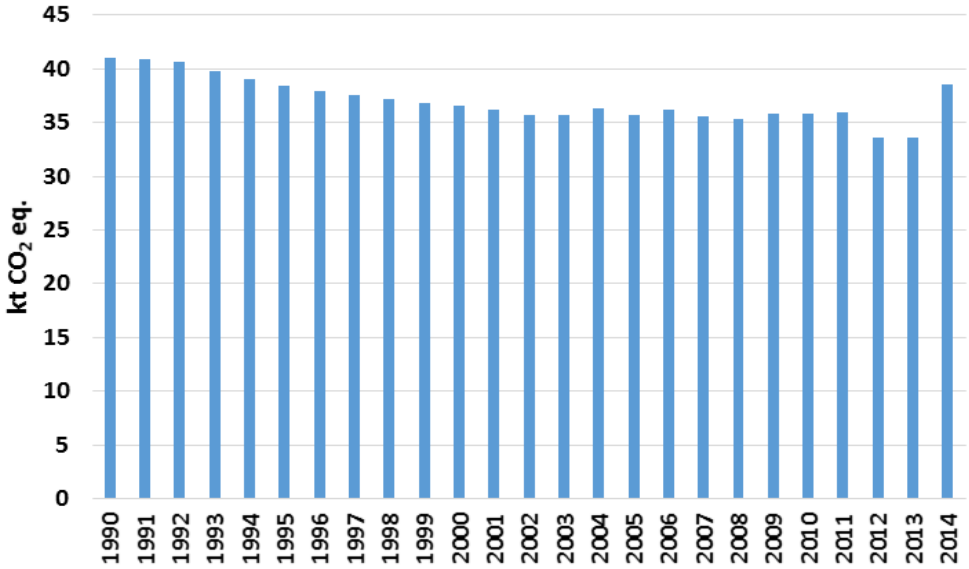

Figure 7.8 Total emissions from waste composting (kt CO_2 eq.)

7.3.1.2 Methodological issues

Default method from 2006 IPCC Guidelines is used for emission calculations from composting. Composted waste amount is multiplied with default emission factor. Composted waste amount is taken from "3-Waste" database, R3 - Recycling/reclamation of organic substances that are not used as solvents (including composting and other biological transformation processes), recovery operation for determination of composted amounts was used. Not all amounts, which are classified under recovery as R3, are composted. To determine composted waste amount, each enterprise, which reports recovery operations R3, working profile must be taken into account.

Default emission factors for composting were used from 2006 IPCC Guidelines:

Industrial composting:

1. 4 g CH_4/ kg composted waste;
2. 0.24 g N_2O/ kg composted waste.

Table 7.8 Composted waste amounts and emissions (kt)

Year	Composted amounts in households (kt)	Industrial composted amount (kt)	CH_4 emission (kt)	N_2O emission (kt)
1990	239.0918253	-	0.956367301	0.057382
1991	238.1976078	-	0.952790431	0.0571674
1992	236.8390317	-	0.947356127	0.0568414
1993	231.7021428	-	0.926808571	0.0556085
1994	227.6902168	-	0.910760867	0.0546457
1995	224.0767862	-	0.896307145	0.0537784
1996	221.2944877	-	0.885177951	0.0531107
1997	219.0883809	-	0.876353524	0.0525812
1998	216.9267207	-	0.867706883	0.0520624
1999	214.9964333	-	0.859985733	0.0515991
2000	213.4253025	-	0.85370121	0.0512221
2001	210.8865637	-	0.843546255	0.0506128
2002	207.9806931	-	0.831922772	0.0499154
2003	206.0481654	2.224	0.833088662	0.0499853
2004	203.9987864	7.905	0.847615146	0.0508569
2005	201.5975989	6.564	0.832646396	0.0499588
2006	199.639622	11.698	0.845350488	0.050721
2007	197.9339867	9.416	0.829399947	0.049764
2008	196.4079297	9.282	0.822759719	0.0493656
2009	193.8113925	15.11	0.83568557	0.0501411
2010	190.0182044	18.55	0.834272818	0.0500564
2011	185.9051984	23.699	0.838416794	0.050305
2012	178.157	17.62	0.783108	0.0469865
2013	181.3548064	14.367	0.782887226	0.0469732
2014	184.614	40.038	0.898608	0.0539165

7.3.1.3 Uncertainties and times-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

Emission factor uncertainties are calculated according range, which is published in 2006 IPCC Guidelines, Volume 5, Chapter 4, For N_2O range is 0.06 – 0.6, for CH_4 0.03 – 8, Uncertainty for N_2O emission factor is 90%, for CH_4 – 100%.

Time series for composting begins in 1990.

Uncertainty for households composted amounts are assumed as the same as for industrial composting.

Activity data uncertainty for industrial composting is estimated as 29%.

Uncertainty assessment of activity data for industrial composting is done using the proportion between composted amount and population (2004-2014). Uncertainty is calculated as the standard medium of the average from linear trend line.

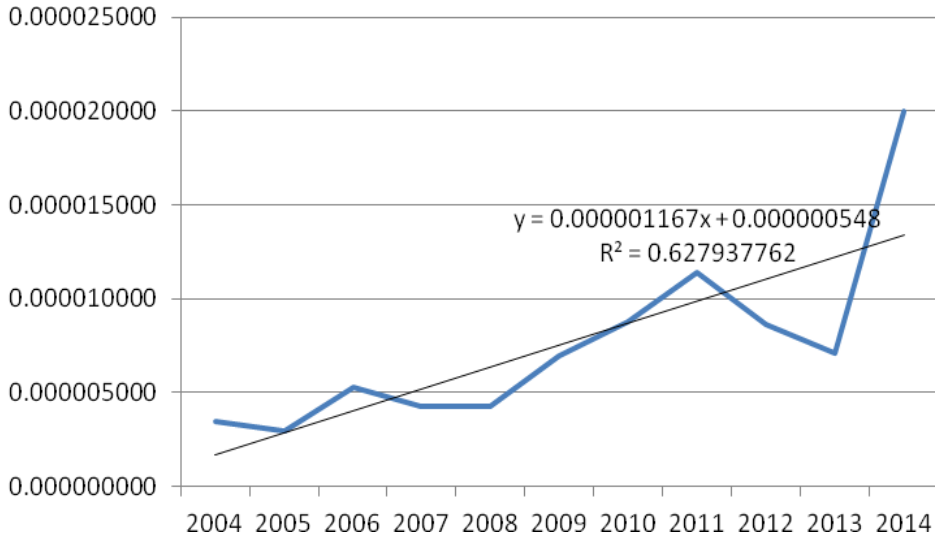

Figure 7.9 Trendline and proportion waste-to-population for waste composting

7.3.1.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the waste sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

Industrial composted waste amounts are taken from from "3-Waste" data base. Data in this data bases are checked and approved by Regional Environmental Boards.

7.3.1.5 Category-specific recalculations

For the first time composting emissions from households are calculated.

7.3.1.6 Category-specific planned improvements

New waste recovery classification in Latvia came into force in 2014. Determination of composting amounts will be more precise, because special R code will be used for composting.

7.3.2 Anaerobic Digestion at Biogas Facilities (CRF 5.B.2)

Anaerobic Digestion at biogas facilities is carried out in Latvia. All emissions are allocated under Energy sector because all biogas is used for energy production.

7.4 INCINERATION AND OPEN BURNING OF WASTE (CRF 5.C)

7.4.1 Waste Incineration (CRF 5.C.1)

7.4.1.1 Category description

Data on amount of waste incinerated in Latvia can be found in databases that are created and maintained by LEGMC. Data on hazardous waste incineration are available since 1999. In the hazardous waste data base there is a separate entry for 1997-2001 on the amount of

incinerated waste. Since 2002 the database also contains entries for recovery (R) and disposal (D) of waste, which is consistent with the EU Waste legislation.

Table 7.9 Reported emissions under category Waste Incineration

CRF	Source	Emissions reported
5.C 1	Biogenic (cremation)	SO_2, NMVOC, CO, NOx
5.C 2	Other – non biogenic (clinical (animal) and hazardous (industrial) waste)	CO_2, N_2O, SO_2, NMVOC, CO, NOx

Currently there are no large amounts of waste being incinerated in Latvia without energy recovery. The main source of emissions refer to the hazardous and clinical waste incineration. The amounts of incinerated clinical waste are registered in the hazardous waste database (from 2002 in "3-Waste" data base) as *Health service for humans and animals as well as related research waste*. Amount of incenerated animal waste (dead animals) are assumed as Clinical waste. The rest of the incinerated waste from hazardous waste database is considered as hazardous (industrial) waste.

In 2001 large increase of emissions can be observed, because one enterprise reported huge amount of incinerated waste. Incinerated amounts for 1990 – 1998 are extrapolated according to average value of incinerated amount for 2002 – 2013 which refers to disposed waste value.

In latest years incinerated amount of waste has decreased due the reason that hazardous waste incineration is not occuring in full scale. CO_2 emissions from Waste Incineration are presented in Figure 7.10.

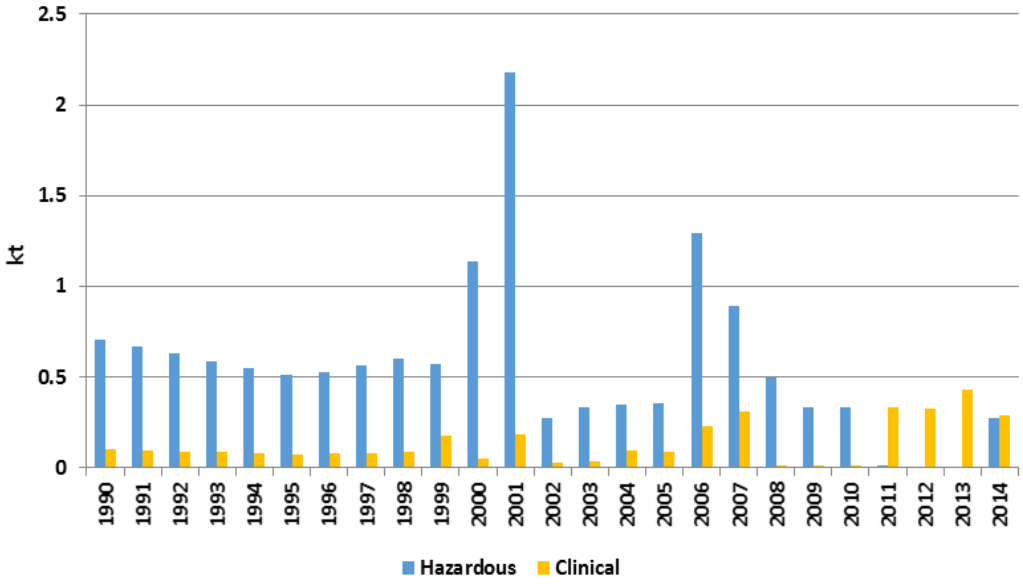

Figure 7.10 CO_2 emissions from Waste Incineration by waste type (kt)

Data about burned bodies is available from Riga crematorium since 1994. Calculations of emissions are done in accordance with the EMEP/EEA 2013 methodology. The main gases emitted during cremation are SO_x, NO_x, CO, and NMVOC, and all of them have to be reported in the inventory as indirect GHGs. These amounts are counted in Incinerated Biogenic Waste sector (Table 7.10).

Table 7.10 Burned bodies in Riga crematorium

Year	Burned bodies
1994	54
1995	564
1996	819
1997	817
1998	869
1999	982
2000	1127
2001	1297
2002	1293
2003	1389
2004	1391
2005	1529
2006	1630
2007	1959
2008	2227
2009	1977
2010	2102
2011	2158
2012	1970
2013	2150
2014	2222

7.4.1.2 Methodological issues

According to the 2006 IPCC Guidelines CO_2 and N_2O emissions are calculated from the Waste Incineration. CH_4 emissions in well-functioning incinerators are usually very small. The CH_4 emissions are particularly relevant for open burning. Usually CO_2 emissions are substantially larger than emissions of N_2O. Emissions from waste incineration without energy production are considered under the Waste sector, while emissions from waste incineration with energy production are considered under the Energy sector (CRF 1.A.2.f Non-metalic minerals).

CO_2 emissions were calculated using following 2006 IPCC Guidelines equation:

$$CO_2 \text{ emissions} = \Sigma_i [SW_{ix} \times CF_i \times FCF_i \times OX_i \times 44/12] \text{ kt/year}$$

where:
i = waste type (hazardous waste, clinical waste)
SW_i = amounts of type i waste incinerated. (kt/year)
CF_i = carbon contents in the type i waste
FCF_i = fossil carbon contents in the type i waste
OX_i = oxidation factor of type i waste
44/12 = conversion of C into CO_2

There are no national factors for carbon and fossil carbon amounts in each type of waste; therefore default emission factors from 2006 IPCC Guidelines were used (Table 7.11).

Table 7.11 Default emission factors for CO_2 emission calculation

	Clinical (animal) waste	Hazardous (industrial) waste
C contents in waste (CCW)	0.6	0.5
Fossil C contents in waste (FCF)	0.4	0.9
Oxidation factor (OX)	100%	100%

N_2O emissions from Waste incineration are calculated according to 2006 IPCC Guidelines, Volume 5 Table 5.6. Factor 100 (g N_2O/ t waste) is used. This factor is determined for Industrial waste in wet weight. Latvia's incinerated hazardous waste are used oils, solvents and other liquids. Clinical waste is not dried before burning. The same factor also is used for N_2O emission calculation from clinical waste.

Table 7.12 Incinerated waste amounts without energy recovery

Year	Hazardous waste (kt)	Clinical waste (kt)	Animal waste (kt)	Total (kt)
1990	0.429082	0.116729	-	0.545812
1991	0.404964	0.110168	-	0.515131
1992	0.380845	0.103606	-	0.484451
1993	0.356726	0.097045	-	0.453771
1994	0.332607	0.090484	-	0.423091
1995	0.308488	0.083922	-	0.39241
1996	0.321434	0.087444	-	0.408878
1997	0.341924	0.093018	-	0.434942
1998	0.362414	0.098592	-	0.461006
1999	0.34721	0.20142	-	0.54863
2000	0.69028	0.05641	-	0.74669
2001	1.31927	0.21331	-	1.53258
2002	0.165643	0.032247	-	0.19789
2003	0.201813	0.040607	-	0.24242
2004	0.210125	0.112325	-	0.32245
2005	0.215127	0.102127	-	0.317254
2006	0.78616	0.26189	-	1.04805
2007	0.5405	0.350861	-	0.891361
2008	0.29975	0.012361	-	0.312111
2009	0.200	0.011663	-	0.211663
2010	0.200	0.012843	-	0.212843
2011	0.0063	0.012738	0.366092	0.38513
2012	NO	0.018049	0.348861	0.36691
2013	NO	0.005887	0.479833	0.48572
2014	0.166927	0.010341	0.3166033	0.493301

Indirect GHGs (NMVOC, CO, SO_2, NOx) are calculated from waste incineration according to EMEP/EEA 2013 (Table 7.13).

Table 7.13 Emission factors for indirect GHGs

	Clinical waste (kg/Mg)	Hazardous waste (kg/Mg)
NMVOC	0.7	7.4
CO	0.19	0.07
SO_2	0.24	0.047
NOx	2.3	0.87

Cremation

Indirect GHG emissions from cremation were calculated by multiplying the number of bodies burned with the corresponding emission factor. Calculations were based on emission factors given in the EMEP/EEA 2013 (Table 7.14).

Table 7.14 Emission factors for indirect GHGs from cremation

Indirect GHG	Emission factor (kg/body)
NMVOC	0.013
CO	0.140
SO_2	0.113
NOx	0.825

7.4.1.3 Uncertainties and times-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

CO_2 emission factor uncertainty is estimated as 40%, according 2006 IPCC Guidelines, because no correct information on carbon content in incinerated waste is known. Uncertainty for N_2O emission factor is 100%.

Activity data uncertainty for waste incineration is estimated as 44%.

Uncertainty assessment of activity data for waste incineration is done using the proportion between incinerated amount and population (years 2002-2014). Uncertainty is calculated as the standard medium of the average from linear trend line.

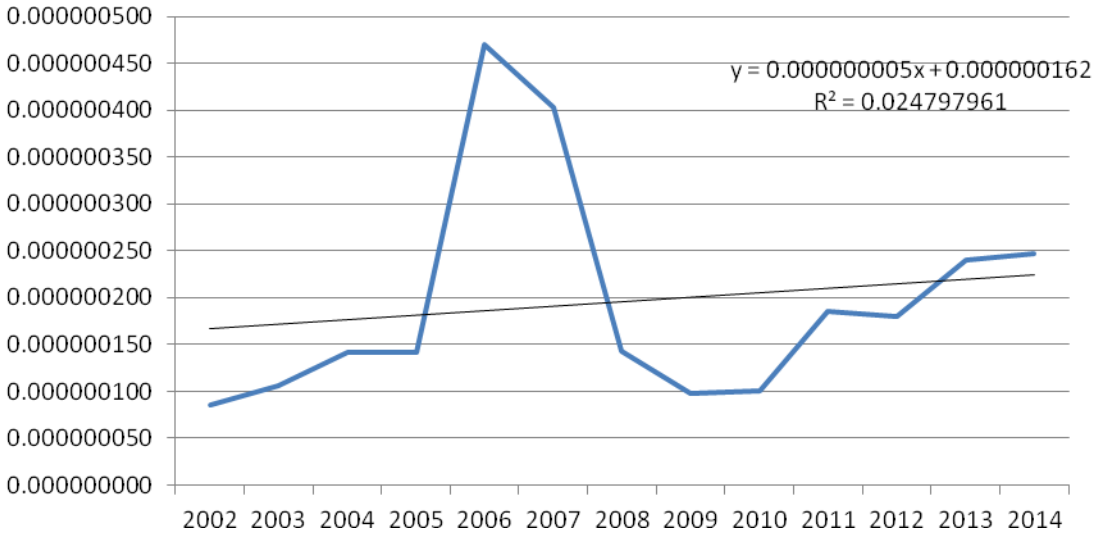

Figure 7.11 Trendline and proportion waste-to-population for waste incineration

7.4.1.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the waste sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

QA/QC procedures for waste incineration are done. Incinerated waste amounts are taken from "3-Waste" data base. Data in this data bases are checked and approved by Regional Environmental Boards.

7.4.1.5 Category-specific recalculations

No recalculations are done.

7.4.1.6 Category-specific planned improvements

No planned improvements.

7.4.2 Open Burning of Waste (CRF 5.C.2)

Open burning of waste is reported as NO (Not occuring). Open burning is not allowed in Latvia according to Waste Management Law.

7.5 WASTEWATER TREATMENT AND DISCHARGE (CRF 5.D)

7.5.1 Domestic Wastewater (CRF 5.D.1)

7.5.1.1 Category description

The emission sources cover handling of collected and uncollected domestic waste water for CH_4 from both waste water and sewage sludge and N_2O emissions from human sewage.

In most cases urban waste water is treated in aerobic systems in Latvia. However, the accurate breakdown of amount aerobic and anaerobic processes during treatment of municipal waste water is unknown.

Therefore, data on type of treatment plant and its treatment level is available within national database "2-Water", and all the treatment plants and number of population they serve is distributed by their type and level of treatment.

Totally, taking into account of recovered CH_4 as well, emissions from Domestic Waste Water Handling sector made 126.0 kt CO_2 eq. in 2014, what makes decrease of 45.8% in comparison to 1990 and decrease of 4.1% in comparison to emissions of 2013 (Figure 7.12).

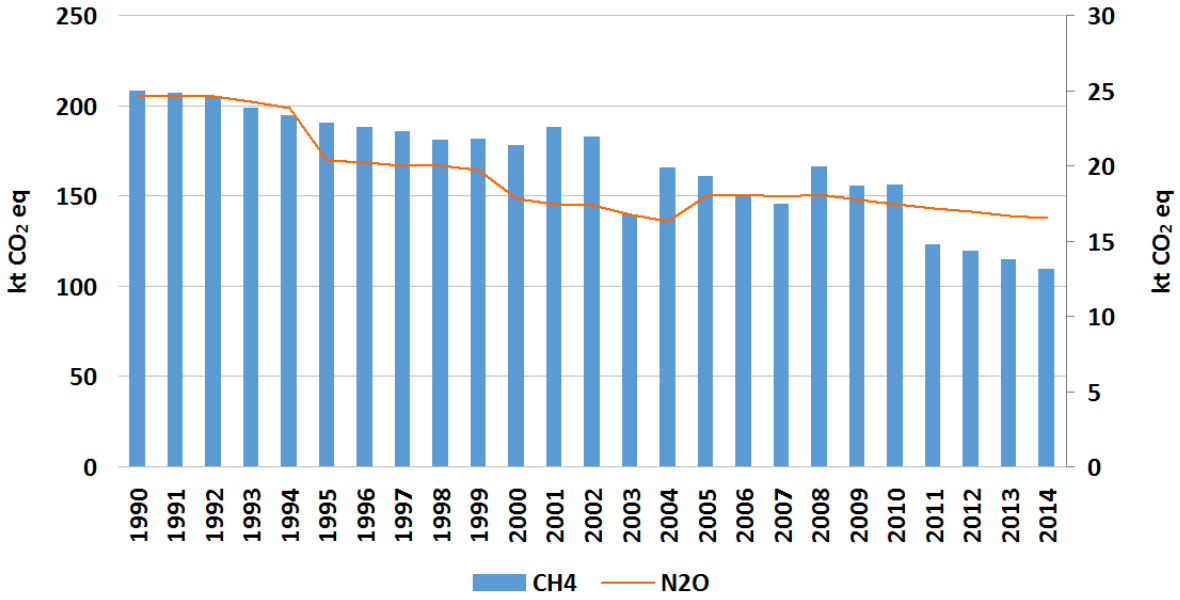

Figure 7.12 Emissions from Domestic Waste Water Handling sector[242] (kt CO_2 eq.)

7.5.1.2 Methodological issues

Calculation of CH_4 emission from Domestic Waste Water Handling is based on amount of BOD_5 (biochemical oxygen demand, 5-day test) produced by national population. However, different methane conversion factors (MCFs) are applied depending of type and level of treatment of certain treatment plant. Data on treatment type and level of certain waste water treatment plant serving certain number of population is available in national data base "2-Water"[243], collecting treatment plant-level data on water abstraction and use, treatment and discharge. Distribution of national population by type and level of waste water treatment was extrapolated for period, uncovered by water statistics (1990-1999).

Default formula from 2006 IPCC Guidelines, chapter 6.2.2 „Domestic Wastewater" was used for calculation of CH_4 emission from Domestic Waste Water Handling sector. However, distribution of national population by treatment type and level is used instead of distribution of national population by income level.

$$CH_4 Emissions = \left[\sum_i (U_i \bullet EF_i)\right] \bullet (TOW - S) - R$$

where
CH_4Emissions – CH_4 emissions in the inventory year, kg CH_4/yr
TOW – total organics in waste water in inventory year, kg BOD/yr
S – organic component removed as sludge in inventory year, kg BOD/yr
U_i – degree of national population receiving certain waste water treatment type and level, %
i –waste water treatment type and level (well-managed biological, poor-managed biological, non-biological and no collection and no treatment)
EFi – emission factor for each treatment type fraction, kg CH_4/kg BOD

[242] *N_2O on secundary axis*
[243] http://parissrv.lvgmc.lv/public_reports/#viewType=water2reports

R – amount of CH_4 recovered in inventory year, kg CH_4/yr

$$EF_i = B_o \bullet MCF_i$$

where:
EFi – emission factor for each treatment type fraction, kg CH_4/kg BOD
i –waste water treatment type and level (well-managed biological, poor-managed biological, non-biological and no collection and no treatment)
B_o – maximum CH_4 producing capacity, kg CH_4/kg BOD
MCF_i – methane correction factor for each treatment type and level

$$TOW = P \bullet BOD * 0.001 \bullet I \bullet 365$$

where
TOW – total organics in waste water in inventory year, kg BOD/yr
P – country population in inventory year, persons
BOD – country-specific per capita BOD in inventory year, g/person/day
I – correction factor for additional industrial BOD discharged into sewers

CH_4 emissions from anaerobic sewage sludge were calculated using default formula from „Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual"; chapter 6.3.5 „Methodology for Estimating Emissions from Wastewater Handling". In this case IPCC 1996 were used because 2006 IPCC Guidelines do not provide methodology to estimate emissions from anaerobic sewage sludge.

$$SM = TOS \bullet EF$$

where:
SM – total CH_4 emission from sewage sludge, kg CH_4
TOS – total organic content of sludge, kg COD/yr
EF – emission factor for sludge, kg CH_4/kg COD

$$EF = B_o \bullet MCF$$

where:
EF – emission factor for anaerobic sewage sludge, kg CH_4/kg COD
Bo – maximum CH_4 producing capacity, kg CH_4/kg COD
MCF – methane correction factor

Methane Conversion Factors (MCFs) were applied depending of treatment type and level. 2006 IPCC Guidelines were used as source of MCF values; however, expert judgment was performed to choose values applicable for Latvian conditions (Table 7.15).

Table 7.15 MCF values applied depending on type and level of treatment

Treatment type and level	MCF
Biological treatment with secondary or higher treatment level	0
Biological treatment with treatment level lower than secondary	0.3
Mechanical and chemical treatment	0.3
Not connected to waste water treatment plants	0.5 (septic tanks) 0.7 (latrines)

Although normally mechanical and chemical treatment is not a source of methane emissions, there are still rather large number of mechanical treatment plants in Latvia,

where domestic waste water is treated; therefore it is considered that conditions in the mechanical treatment plants similar to those in the poorly managed biological treatment plants and, as result, the same value of MCF is applied. It was agreed as well in the discussion with Technical Expert Review Team (TERT) during the EU ESD voluntary review in 2015.

Typical mechanical and/or chemical treatment plants in Latvia mostly serves specific industrial waste water flows, where number of population connected and served is low or not at all, so this assumption does not affect calculations of emissions from human produced organic products in the waste water.

Organic load – so called "population equivalent" or 60 g of BOD per person per day – is determined by national legislation (Cabinet Regulation No. 34 "Regulations regarding Discharge of Polluting Substances into Water" (22.01.2002)).

Activity data, used for calculation of CH_4 emissions from domestic waste water are summarized in the following Table 7.16.

Table 7.16 Activity data for calculation CH_4 emissions from Domestic Waste Water Handling sector

Year	Population receiving well-managed biological treatment	Population receiving poor-managed biological treatment	Population receiving non-biological treatment	Population receiving no treatment	Amount of anaerobic sludge, t/y (dry solids)	Amount of recovered CH_4, kt/y
1990	1 459 034	410 363	69 301	729 442	9 029	0
1995	1 367 407	384 592	64 949	683 633	6 424	0.344
2000	1 300 038	366 587	61 524	649 234	4 559	0.764
2001	1 270 656	279 768	48 911	754 049	5 788	0.948
2002	1 289 321	278 673	49 642	703 320	5 367	1.252
2003	1 575 982	95 457	44 481	583 470	6 416	0.801
2004	1 467 919	76 138	44 931	687 532	9 569	1.453
2005	1 448 202	81 977	45 164	674 381	8 479	1.683
2006	1 442 124	89 970	44 086	651 694	6 337	1.423
2007	1 454 319	76 998	40 059	637 464	5 853	1.489
2008	1 234 969	168 147	37 556	751 138	2 761	1.469
2009	1 362 273	125 021	20 145	655 395	7 019	1.860
2010	1 263 185	141 101	29 430	686 788	4 277	2.133
2011	1 464 581	91 294	26 178	488 318	6 914	1.870
2012	1 406 665	106 529	32 942	498 677	4 186	1.957
2013	1 417 448	94 034	28 559	483 784	4 275	1.806
2014	1 460 824	50 607	23 502	466 535	5 381	1.704

Some assumptions are made to calculate emissions from domestic waste water handling:

- Total organically degradable carbon, removed from domestic waste water with sludge, is divided proportionally between types of treatment. Type of treatment "not connected" removes no carbon in sludge.
- Only temporal storage of sewage sludge with dry solid content less then 20% could be considered as anaerobic conditions, since all other ways or conditions of sewage sludge (for example, storage after dewatering procedures, what results in content of dry solids 20% and more) does not allow to use MCF value for "deep anaerobic lagoons", as it was recommended by TERT during 2015 trial review under the EU ESD,

especially, if dewatered sewage sludge is being stored in the piles. An expert judgment was performed and documented to establish the 20% solid content threshold value to divide sudge in anaerobic/aerobic [244].

Figure 7.13 Dewatered sewage sludge storage shed. Considered to be no source of CH_4 emissions

Figure 7.14 Liquid sewage sludge storage basin. Considered to be source of CH_4 emissions (deep anaerobic lagoon)

[244] *Expert judgment protocol EJ_Waste_5D_2016_001*

Example of methane emission calculation for 2014 is shown in a following Table 7.17.

Table 7.17 Calculation of CH_4 emission from Domestic Waste Water Handling sector (2014)

Treatment type	Population persons	Total DC (kt BOD/yr)	DC WW w/o sludge (kt BOD/yr)	Correction factor for additional industrial discharges of BOD into a sewer	Maximum CH_4 producing capacity B_o, kg CH_4/kg BOD	MCF	Emission factor	Emission (kt of CH_4)
Well managed biological	1 460 824	31.992	28.644	1.25	0.6	0	0	0
Poor managed biological	50 607	1.108	0.993	1.25	0.6	0.3	0.18	0.223
Non-biological	23 502	0.515	0.461	1.25	0.6	0.3	0.18	0.104
Not connected to treatment plants	466 535	10.217	10.217	1				
Total:	2 001 468	43.832	4.335					**0.327**

Assumptions regarding sewage sludge are shown in Table 7.18.

Table 7.18 Characteristics of sewage sludge in Latvia

Characteristic	Value
Average content of dry solids in sludge, %[245]	14[246]
Average content of COD in dry solids, %	65[247]
Average content of N in dry solids, %	5.2[248]

Extrapolation was used to estimate amount of sewage sludge produced and treated anaerobically for period 1990 – 1997, where statistic data were not available. Based on statistics available (1998 – 2008), assumption was made the part of anaerobically stored sludge is 25% of all sludge produced. Emissions from sludge, used as fertilizer in agriculture or disposed in landfills, are reported under according sectors in different chapters of this NIR.

Data on recovery of CH_4 from waste water handling are plant specific data from treatment plant *"Daugavgrīva"*, operated by largest Latvian water supply and waste water Treatment Company *"Rīgas ūdens"*. Recovery of CH_4 is also performed by its daughter company *"Rigens"*, starting from 2002. 1.704 kt of CH_4 was recovered from waste water handling in 2014. Recovered amount of CH_4 is being used as fuel in the cogeneration plant, and emissions from it are reported under the Energy sector. It is assumed, that content of the CH_4 in the recovered biogas by volume is 70%, and density of CH_4 is 0.6687 kg/m^3.

[245] *Is used to estimate content of dry solids for years where statistic data are not available (1998-2002)*

[246] *"Notekūdeņu dūņas un to izmantošana" („Sewage Sludge and Disposal of it"), Gemste I., Vucāns A., Jelgava, 2002.*

[247] *Average data of 1996*

[248] *"Notekūdeņu dūņas" ("Sewage Sludge"), Gemste I., Vucāns A., Jelgava, 2007.*

According to 2006 IPCC Guidelines, there are emissions of recovered CH_4 in the form of leakage from the recovery. Default value of 5% of leakage was used to estimate amount of CH_4 emissions of this source, thus giving emission of 5% of 1.704 kt CH_4 = 0.085 kt CH_4 in 2014.

Example of CH_4 emission calculation from sewage sludge is shown in Table 7.19.

Table 7.19 Calculation of CH_4 emission from sewage sludge (2014)

Total DC sludge (kt COD/yr)	Maximum CH_4 producing capacity Bo, kg CH_4/kg COD	MCF for deep anaerobic lagoons	Emission factor for sludge (kg CH_4/ kg COD)	Emission of sludge (kt CH_4)
6.737	0.25	0.8	0.2	**0.699**

To estimate emission from part of national population, not connected to waste water treatment plants, recommendations from Technical Expert Review Team (TERT) during EU Effort Sharing Decision (EU ESD) voluntary review in 2015 was followed and estimation of use of septic tanks and latrines among national population was performed.

Proportion of urban and rural population was taken from The World Bank data[249], default "suggested values for urbanisation and degree of utilization of treatment, pathway or method" from 2006 IPCC Guidelines were used (since there wasn't Latvia in the list, values for neighbour country Russia were used).

It was estimated, that 83.4% from national population, not connected to waste water treatment, are served by septic tanks, while 16.6% - with latrines (2014). Corresponding default, MCF values from 2006 IPCC Guidelines were chosen to estimate emissions of CH_4 from this source (Table 7.20).

Table 7.20 Estimation of CH_4 emissions from national population, not connected to waste water treatment plants (2014)

Type of treatment or discharge pathway	Part of not connected national population, using treatment or discharge pathway	MCF	Emission factor, kg CH_4/kg BOD	Emissions of CH_4, kt/y
Septic tanks	83.4%	0.5	0.3	2.557
Latrines	16.6%	0.7	0.42	0.712
			Total:	**3.269**

Thus, total CH_4 emission from domestic waste water handling and sewage sludge in 2014 is 4.380 kt of CH_4 (Table 7.21).

Table 7.21 Total CH_4 emissions from domestic waste water handling sector (2014)

Source of CH_4 emissions	Emissions of CH_4, kt/y
Emissions from waste water, treated in waste water treatment plants	0.327
Emissions from leakage from recovered CH_4	0.085
Emissions from anaerobic sewage sludge	0.699
Emissions from national population, not connected to treatment plant	3.269
Total:	4.380

[249] http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS

Calculation of emissions of N_2O from Domestic Waste Water handling is based on amount of nitrogen, generated from the protein consumption by national population. Number of national population is taken from national statistics (CSB) while country specific values of protein consumption are obtained from web site http://chartsbin.com/view/1155 (Table 7.22).

Table 7.22 Consumption of protein in Latvia per capita (1990 - 2014)

Time period	g/person/day	kg/person/yr
1990 - 1994	102	37.23
1995 - 1999	89	32.485
2000 - 2004	81	29.565
2005 - 2014	88	32.12

When compared with similar data from Latvian neighbour countries (Lithuania and Estonia), Latvian data shows consistent value (Table 7.23).

Table 7.23 Comparison of Latvian protein consumption data with data from neighbour countries (Lithuania and Estonia)

Country	g/person/day	kg/person/yr
Latvia	81…102	29.565…37.23
Lithuania	77.4…78.1*	28.251…28.507**
Estonia	101*	36.865**

**Data taken from Lithuanian and Estonian NIRs (2010)*
***Recalculated for comparison*

Amount of N_2O emission from Domestic Waste Water Handling is calculated according to 2006 IPCC Guidelines; Chapter 6.3.1 „Methodological issues".

$$N_2O_{Emissions} = N_{Effluent} \bullet EF_{Effluent} \bullet \frac{44}{28}$$

where:
$N_2O_{Emissions}$ – N_2O emission in inventory year, kg N_2O/yr
$N_{Effluent}$ – Nitrogen in the effluent discharged to aquatic environment
$EF_{Effluent}$ – Emission factor for N_2O emissions from discharged waste water, kg N_2O-N/kg N

$$N_{Effluent} = (P \bullet \Pr otein \bullet F_{NPR} \bullet F_{NON-CON} \bullet F_{IND-COM}) - N_{Sludge}$$

where:
$N_{Effluent}$ – Total annual amount of nitrogen in waste water effluent, kg N/yr
P – National population
Protein – Annual per capita protein consumption, kg/pers/y
F_{NPR} – Fraction of nitrogen in protein, kg N/kg protein
$F_{NON-COM}$ – Factor for non-consumed protein added to waste water
$F_{IND-COM}$ – Factor for industrial and commercial co-discharged protein into a sewer system
N_{Sludge} – Nitrogen removed with sludge, kg N/y

Default value for nitrogen fraction in protein – 0.16 kg N/kg protein – is used in calculation. Default emission factor – 0.005 kg N_2O-N/kg N – was used as well. Both values were taken

from 2006 IPCC Guidelines, as well as factors for non-consumed (for countries with garbage disposals) and industrial and commercial protein co-discharged in the sewer system.

Content of Nitrogen in the dry solids of sewage sludge was already shown in the table with characteristics of sewage sludge in Latvia (Table 7.18).

A small amount of N_2O is emitted during the release from the sewage system. The calculations give emission 0.054 kt N_2O (2014).

N_2O emissions from centralized waste water treatment processes are estimated as well.

$$N_2O_{Plants} = P \bullet T_{Plant} \bullet F_{IND-COM} \bullet EF_{Plant}$$

where:
N_2O_{Plants} – Total N_2O emissions from plants in the inventory year, kg N_2O/y
P – Human population
T_{Plant} – Degree of utilization of modern, centralized treatment plants, %
$F_{IND-COM}$ – Fraction of industrial and commercial co-discharged protein
EF_{Plant} – Emission factor, g N_2O/pers/y

Waste water treatment plants, providing tertiary treatment (i.e. removal of nitrogen of phosphorus), are considered to be in compliance with requirements for "modern, centralized treatment plants". Degree of their utilization is estimated based on number of national population, provided with such treatment. National waste water database "2-Water" provides according statistical data (starting from 2000). Constant value of 3% was used for years, previous to 2000.

Activity data for estimation emissions of N_2O from Domestic Waste Water Handling sector are shown in the following Table 7.24.

Table 7.24 Activity data for estimation emissions of N_2O from Domestic Waste Water Handling sector

Year	Population	Amount of sludge produced, t/y	Degree of utilization of modern, centralized treatment plants, %
1990	2 668 140	36 115	3.0
1995	2 500 580	25 695	3.0
2000	2 377 383	18 234	1.0
2001	2 353 384	23 153	4.9
2002	2 320 956	21 467	7.6
2003	2 299 390	29 278	4.3
2004	2 276 520	36 164	8.9
2005	2 249 724	28 877	8.4
2006	2 227 874	23 942	9.2
2007	2 208 840	23 259	9.3
2008	2 191 810	19 263	12.0
2009	2 162 834	22 346	14.5
2010	2 120 504	21 395	16.4
2011	2 070 371	19 728	18.2
2012	2 044 813	18 064	17.8
2013	2 023 825	20 733	17.4
2014	2 001 468	22 078	23.4

Default values from 2006 IPCC Guidelines are used for fraction of industrial and commercial co-discharged protein and emission factor (correspondingly, 1.25 and 3.2 g N_2O/pers/y). Estimation gives emission of 0.001871 kt of N_2O from this subsector in 2014. Thus, total emission of N_2O from Domestic Waste Water Handling was 0.054 + 0.002 = 0.056 kt N_2O, what makes decrease of 38.4% in comparison with emissions of 1990 and decrease of 0.9% in comparison with emissions of 2013.

7.5.1.3 Uncertainties and times-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

The following uncertainties were used for Domestic Waste Water Handling sector for activity data and emission factors (Table 7.25).

Table 7.25 Uncertainties for Domestic Waste Water Handling sector

Emission	Activity data	Emission factor
CH_4	45%	30%*
N_2O	140%	30%*

**30% - default uncertainty from 2006 IPCC Guidelines*

Uncertainties for activity data of each subsector are estimated using similar methodology. To estimate an uncertainty for certain subsector, its activity data are drawn on chart for each year, then the mathematical relationship of activity data timeline is found as equation of the trend line. Then "theoretical values" of activity data is calculated for each year, using the equation of the trend line, and uncertainty being calculated as deviation (in %) of "actual" value from the "theoretical" one (Figure 7.15).

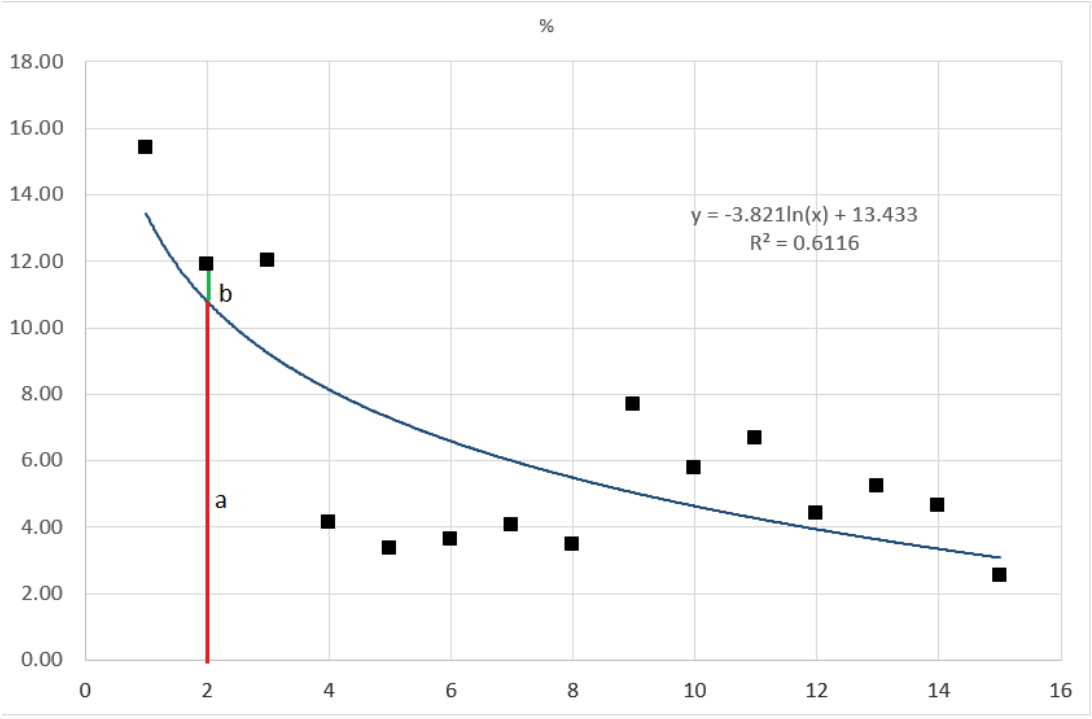

Figure 7.15 Example of estimation of uncertainties in Waste Water Handling sector

Each deviance is calculated as:

$$Uncertainty,\% = \frac{100 \bullet |b|}{a}$$

where:
a – "theoretical" value of activity data, calculated through equation of the trend line
b – difference between "theoretical" and "actual" value of activity data for certain year

Total uncertainty for certain type of activity data is calculated as average for entire timeline. Then total uncertainty for subsector is being calculated, using following formula:

$$X = \sqrt{x_1^2 + x_2^2 + \ldots + x_i^2}$$

where:
X – total uncertainty for subsector
x_1, x_2, x_i – uncertainties for each type of activity data for certain subsector

Time series show continuous decrease of emissions in the entire timeline. Main reason of this decrease is recovery of CH_4 and implementation of more and better treatment plants also can be observed.

Inconsistencies in data (for example, potential outlier in 2003) can be explained with quality of activity data. Although data collection system on population, receiving certain grade of waste water treatment is generally well-designed and allows to collect data on plant level, the actual data quality still largely depends on competence of person in enterprise, responsible for reporting these data, as well as inspector of regional environmental board, who assesses and accepts the survey with plant level data.

7.5.1.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the 2.G. sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

Following procedures of quality assurance and quality control were carried out:

- Statistic data of national population, served by certain treatment type and level, as well as amount of sludge produced and disposed are collected through annual state statistical survey "2-Water". In frames of this survey, enterprises, performing collection and treatment of waste water, submit their data using online database. Reported data are checked by Latvian State Environment Service, whose environment inspectors approve reports or return them to submitters for correcting of data;
- Units of measurement were checked during comparison with results of previous reports;
- Number of national population was cross-checked with activity data, used in others sectors (solvents and waste disposal);

- Amount of CH_4 recovery from sewage sludge was checked by comparing data from Energetic sector on amount of sludge gas burned in waste water treatment facility;
- Protein consumption data were compared with values from neighbour countries of Latvia – Lithuania and Estonia (see Table 7.23);
- Comments in CRF tables were checked in process of entering data of calculation and recalculation results in CRF tables.

7.5.1.5 Category-specific recalculations

CH_4 emission data were recalculated in Domestic Waste Water Handling sector due to adjustment of methodology and activity data for period 1993 – 2013.

N_2O emission data were recalculated for entire timeline due to correction of mistake in the assessment of emission factor and applying of dynamic values of protein consumption or entire reporting period.

7.5.1.6 Category-specific planned improvements

It is planned to continue studies regarding sewage sludge storage conditions and characteristics in the country.

7.5.2 Industrial Wastewater (CRF 5.D.2)

7.5.2.1 Category description

Industrial Waste Water Handling is responsible for CH_4 and N_2O emissions. Fluctuations of methane emission from Industrial Waste Water Handling are connected with fluctuations of amount of production produced, which is activity data for this sector. Significant decrease in methane emission in period 1993 – 1999 is due to decrease of economic activity after collapse of Soviet Union. Emission of N_2O, produced by Industrial Waste Water Handling, is negligible, giving approximately 0.1% of emission in this sector in 2014.

Totally, emissions from Industrial Waste Water Handling sector made 138.6 kt CO_2 eq. in 2014, what makes decrease of 0.5% in comparison to emissions of 1990 and increase of 1.6% in comparison to emissions of 2013 (Figure 7.16).

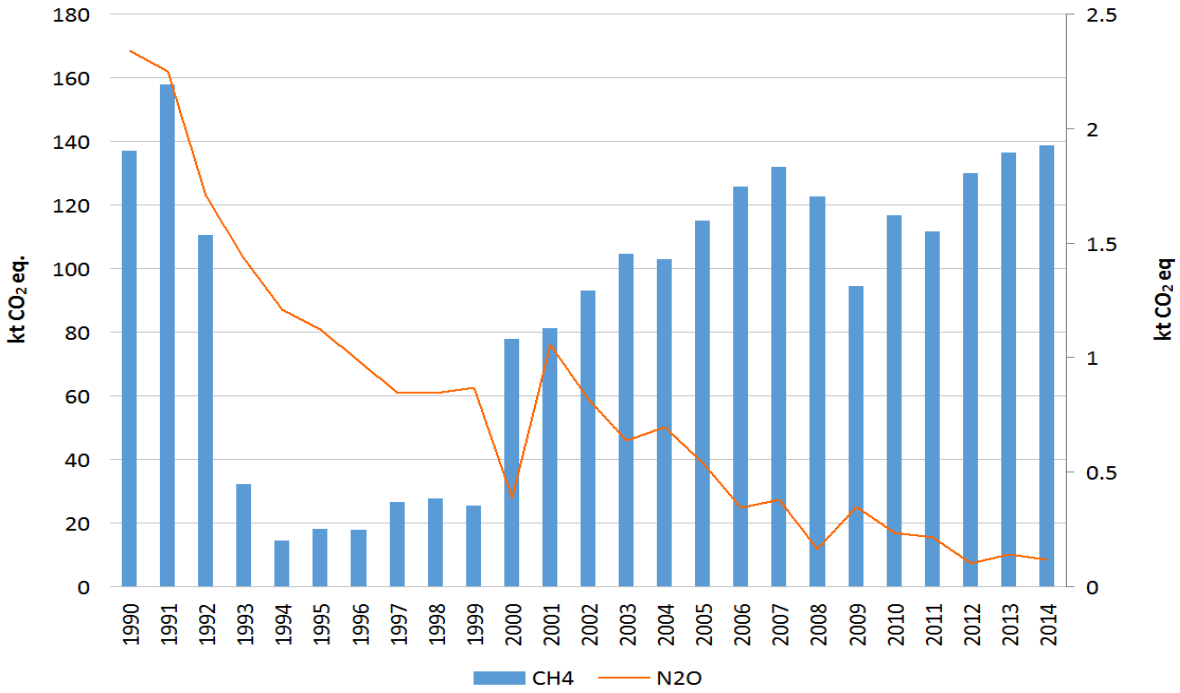

Figure 7.16 Emissions from Industrial Waste Water Handling sector[250] (kt CO_2 eq.)

7.5.2.2 Methodological issues

Emissions of CH_4 from Industrial Waste Water Handling is calculated from amount of total organic product (expressed as COD – chemical oxygen demand) and total nitrogen in waste water, generated in certain branches of industry (mostly food-processing industry).

2006 IPCC Guidelines default formula from chapter 6.2.3 „Industrial Wastewater" was used for calculation of CH_4 emission from Industrial Waste Water Handling sector.

$$CH_4 = \sum_i \left[(TOW_i - S_i) \bullet EF_i - R_i \right]$$

where:
CH_4– CH_4 emissions in inventory year, kg CH_4/yr
TOW_i – total organically degradable material in industrial waste water from industry i in inventory year, kg COD/yr
i – industrial sector
S_i – organic component removed with sludge in the inventory year, kg COD/yr
EF_i – emission factor for industry i, kg CH_4/kg COD
R_i – amount of CH_4 recovered in inventory year, kg CH_4

$$EF_i = B_o \bullet MCF_i$$

where:
EFi – emission factor for each industry i, kg CH_4/kg COD

[250] *N_2O on secundary axis*

i – each type of industry
B_o – maximum CH_4 producing capacity, kg CH_4/kg COD
MCFi – methane correction factor for each type of industry

$$TOW_i = P_i \bullet W_i \bullet COD_i$$

where:
TOW_i – total organically degradable material for industry i, kg COD/yr
i – industrial sector
P_i – total industrial product for industry i, t/yr
W_i – waste water generated for each type of industry, m^3/t product
COD_i – industrial degradable organic component in waste water, kg COD/m^3

Activity data (amount of certain industrial products) was taken from national statistics – CSB data base. Default IPCC value 0.25 kg CH_4/kg COD was used for maximum methane producing capacity, as it is recommended in 2006 IPCC Guidelines. Amount on generation of waste water per certain type of product and organic component in that waste water were taken as default values from 2006 IPCC Guidelines.

Plant specific survey was performed during 2012, to obtain MCF values for certain industries. The average weighted MCF for each industry were estimated depending of level of contribution of said industry in terms of amount of waste water generated and its fate (level of treatment or transfer to certain urban waste water treatment plant).

Assumptions for all relevant industries are summarized in Table 7.26.

Table 7.26 Assumptions used for calculation of CH_4 emissions from Industrial Waste Water Handling

Industry type	Generation of waste water, m^3/t of product*	Organic component in waste water, kg COD/m^3*	Weighted MCF value**
Milk	7	2.7	0.10
Meat	13	4.1	0.15
Fish	13	2.5	0.05
Beer	6.3	2.9	0.04
Fruits and vegetables	20	5	0.13
Sugar	11	3.2	0.50
Paper and pulp	162	9	0.30
Plastics	0.6	3.7	0.14
Organic chemicals	67	3	0.03

**Assumptions used from 2006 IPCC Guidelines*
***rounded to 2 decimal positions*

Organic component removed with sludge and amount of recovered CH_4 under this sector is assumed to be 0 – both values are estimated and taken into account under the Domestic Waste Water Handling sector.

Activity data, used for calculation of CH_4 emissions from domestic waste water are summarized in the following Table 7.27.

Table 7.27 Activity data for calculation CH_4 emissions from Industrial Waste Water Handling sector (amount of products, th. t/yr)

Year	Milk	Meat	Fish	Beer	Fruits and vegetables	Sugar	Paper and pulp	Plastics	Organic chemicals
1990	1 188	324	335	9	0	31	37	0	0
1995	353	99	114	66	0	29	1.5	0	0
2000	175	65	82	95	35	63	22	19	12
2001	184	70	107	101	41	56	23	24	14
2002	171	87	102	122	46	77	27	30	15
2003	177	103	83	139	43	75	31	38	16
2004	192	116	76	134	42	67	30	27	16
2005	207	123	88	131	42	71	34	29	4
2006	230	143	86	143	38	60	38	30	5
2007	240	148	76	143	32	0	43	33	25
2008	224	145	85	136	37	0	39	25	25
2009	195	121	55	130	27	0	30	16	51
2010	197	120	56	150	27	0	38	19	51
2011	183	121	60	150	18	0	37	20	4
2012	192	126	73	140	18	0	43	23	5
2013	211	122	73	134	19	0	46	26	5
2014	206	116	64	83	19	0	47	24	9

Example of CH_4 emission calculation from Industrial Waste Water Handling is provided in a Table 7.28.

Table 7.28 Calculation example of emission of CH_4 from Industrial Waste Water Handling (2014)

Product name	Amount of production,1000 t/yr	Amount of waste water per production unit, m^3/t	Amount of waste water, 1000 m^3/yr	Conc.of COD in waste water, kg/m^3	Load of COD, t/yr	Max.CH_4 prod. capacity, kg CH_4/ kg COD	MCF	Emission of CH_4, t/yr or Mg/yr
	a	b	c = a*b	d	e = c*d	f	g	h = e*f*g
Milk	206	7	1 443	2.7	3 897	0.25	0.10	98
Meat	116	13	1 507	4.1	6 177	0.25	0.15	230
Fish	64	13	833	2.5	2 083	0.25	0.05	26
Sugar	0	11	0	3.2	0	0.25	0.5	0
Beer	83	6.3	525	2.9	1 522	0.25	0.04	15
Fruits and vegetables	19	20	389	5	1 945	0.25	0.13	61
Paper and pulp	47	162	7 549	9	67 943	0.25	0.30	5 096
Plastics	24	0.6	14	3.7	53	0.25	0.14	2
Organic chemicals	9	67	612	3	1 837	0.25	0.03	13

Thus, total emission of CH_4 from Industrial Waste Water treatment in 2014 was 5.541 kt of CH_4, what makes 1.1% increase if compared to emission of 1990 and 1.6% increase if compared with emission of 2013.

N_2O emission from Industrial Waste Water Handling was calculated, using Tier 1 method from 2006 IPCC Guidelines, chapter 6.3.1 "Nitrous Oxide Emissions from Wastewater". Calculation is based on load of nitrogen in the industrial waste water:

$$WM = N_{ef} \bullet EF \bullet \frac{44}{28} \bullet 10^{-6}$$

where:
WM – total emission of N_2O from industrial waste water handling in kt N_2O
N_{ef} – load of nitrogen, kg/yr
EF – emission factor, kg N_2O-N/kg N

Default value (0.005 kg N_2O-N/kg N) from 2006 IPCC Guidelines was used for calculation.

Activity data, used for calculation of N_2O emissions from Industrial Waste Water Handling, are summarized in Table 7.29:

Table 7.29 Activity data for calculation N_2O emissions from Industrial Waste Water Handling sector

Year	Load of N in industrial waste water, t/yr
1990	1 000
1995	480
2000	165
2001	452
2002	350
2003	272
2004	297
2005	230
2006	147
2007	162
2008	70
2009	149
2010	101
2011	92
2012	43
2013	60
2014	49

N_2O emission from Industrial Waste Water Handling is negligible – 0.0004 kt/yr (2014), what makes decrease of 95.1% if compared to emissions of 1990 and decrease of 18.2% if compared to emission of 2013.

7.5.2.3 Uncertainties and times-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6.

The following uncertainties were used for Industrial Wastewater Handling sector for activity data and emission factors (Table 7.30).

Table 7.30 Uncertainties for Industrial Waste Water Handling sector

Emission	Activity data	Emission factor
CH_4	64%*	30%**
N_2O	23%	30%**

**frame uncertainty of CSB*
***default uncertainty from 2006 IPCC Guidelines*

Uncertainties for activity data in Industrial Waste Water Handling) are estimated similarly as uncertainties for activity data for Domestic Waste Water subsector (see Chapter 7.5.1.3).

Time series of emissions are fluctuating since Industrial Waste Water Handling is significant source of CH_4 emissions and amount of production, which is activity data for it, varies a lot from year to year. Decrease of emissions from Industrial Waste Water Handling in period 1992 – 2001 can also be explained by decrease of national economic activity after collapse of Soviet Union in 1991.

N_2O emission activity data and emissions from Industrial Waste Water are also fluctuating , however its effect on total emissions from this sector is not significant, because of small amount of N_2O emitted.

7.5.2.4 Source-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the 2.G. sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

Following procedures of quality assurance and quality control were carried out:

- Statistic data of nitrogen load in waste water (including industrial waste water) are collected through annual state statistical survey "2-Water". In frames of this survey, enterprises, performing collection and treatment of waste water, submit their data using online database. Reported data are checked by Latvian State Environment Service, whose environment inspectors approve reports or return them to submitters for correcting of data;
- Units of measurement were checked during comparison with results of previous reports;
- Comments in CRF tables were checked in process of entering data of calculation and recalculation results in CRF tables.

7.5.2.5 Source-specific recalculations

Emissions of CH_4 were recalculated for period 2000 – 2013 due to adjustment of activity data.

7.5.2.6 Source-specific planned improvements

No improvements are planned.

7.5.3 Other (CRF 5.D.3)

7.5.3.1 Category description

Data of LEGMC shows there were 182 mio m^3 of waste water discharged in Latvia (2014). Most of national population (76.7%, 2014) is served by urban waste water collecting and treatment. Certain amount of NMVOC is produced from Waste Water Handling sector.

7.5.3.2 Methodological issues

Emissions of NMVOC was calculated and using default EMEP emission factor from EMEP/EEA 2013 was used for this calculation – 15 mg of NMVOC per m^3 of waste water produced, what gives 0.00273 kt/yr of NMVOC (2014). It makes decrease of 69.7% if compared to emission of 1990 and decrease of 23.5% if compared to emission of 2013.

Activity data, used for this calculation, are summarized in the following Table 7.31.

Table 7.31 Activity data for calculation NMVOC emissions from Waste Water Handling sector

Year	Amount of waste water produced, mio m^3
1990	600
1995	357
2000	257
2001	244
2002	243
2003	229
2004	211
2005	226
2006	196
2007	210
2008	191
2009	226
2010	222
2011	241
2012	234
2013	238
2014	182

7.5.3.3 Source-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in the 2.G. sector in order to achieve these quality objectives. Quality meetings are held annually between experts.

- Statistic data of amount of waste water produced and discharged are collected through annual state statistical survey "2-Water". In frames of this survey, enterprises, performing collection and treatment of waste water, submit their data using online database. Reported data are checked by Latvian State Environment Service, whose environment inspectors approve reports or return them to submitters for correcting of data;
- Units of measurement were checked during comparison with results of previous reports.

7.5.3.4 Uncertainties and time-series consistency

Uncertainty for activity data regarding NMVOC emissions is 10%. It is calculated the same way as uncertainties for Domestic and Industrial Waste Water Handling (See Chapter 7.5.1.3 for description). EMEP/EEA 2013 does not provide uncertainty for emission factors or methodology to estimate it.

7.5.3.5 Source-specific recalculations

No recalculations were performed.

7.5.3.6 Source-specific planned improvements

No planned improvements.

8 OTHER (CRF 6)

Latvia does not report emissions under CRF 6 Other.

9 INDIRECT CO_2 AND NITROUS OXIDE EMISSIONS

9.1.1 Category description

In accordance with UNFCCC Annex I GHG inventory reporting guidelines Annex I Parties may report indirect CO_2 from the atmospheric oxidation of CH_4, CO and NMVOCs.

Sources of indirect CO_2 emissions in Latvian inventory are indirect CO_2 from the atmospheric oxidation of CH_4 and NMVOCs under Energy and IPPU sectors.

The estimation of indirect CO_2 emissions is based on the official Latvian inventories reported under the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP).

9.1.2 Methodological issues

Indirect CO_2 emissions are generally calculated using the methodology described in the 2006 IPCC Guidelines.

In order for consistency with the reporting done by Latvia under the first commitment period of the Kyoto Protocol, the indirect CO_2 emissions from NMVOCs in solvent use, road paving with asphalt, asphalt roofing and glass fibre production are reported under CRF 2.D.3 Other in accordance with UNFCCC Annex I GHG inventory reporting guidelines. For submission 2016, first time other sources of indirect CO_2 emissions occurring in Energy and Transport sectors are calculated and reported in CRF Table 6.

According to the 2006 IPCC Guidelines, there are sources in Energy that produce indirect CO_2 emissions from CH_4 and NMVOCs. Those sources in case of Latvia are NMVOC emissions from road traffic evaporation from cars, CH_4 and NMVOC emissions from natural gas leakages, as well as NMVOC emissions from gasoline distribution. The general formulas to calculate indirect CO_2 emissions are provided below:

$$from\ CH_4: \quad inputs_{CO_2} = emissions_{CH_4} \times \frac{44}{16}$$

$$from\ NMVOC: \quad inputs_{CO_2} = emissions_{NMVOC} \times C \times \frac{44}{12}$$

where:
c – fraction of carbon

2006 IPCC Guidelines provide a default factor – 0.6 – for the fraction of carbon in NMVOC, and Latvia uses this particular value in 2016 Submission.

Separate sources and emissions are presented in Table 9.1.

Table 9.1 Indirect CO_2 emissions from Energy (kt)

	Indirect CO_2 from gas leakage (NMVOC)	Indirect CO_2 from gas leakage (CH_4)	Indirect CO_2 from gasoline distribution (NMVOC)	Indirect CO_2 from gasoline evaporation (NMVOC)
1990	6.52	27.23	2.68	6.99
1991	6.28	26.23	2.26	6.27
1992	5.73	23.92	2.17	6.44

	Indirect CO_2 from gas leakage (NMVOC)	Indirect CO_2 from gas leakage (CH_4)	Indirect CO_2 from gasoline distribution (NMVOC)	Indirect CO_2 from gasoline evaporation (NMVOC)
1993	5.48	22.87	2.10	5.73
1994	5.35	22.35	2.01	5.75
1995	5.21	21.77	1.81	5.38
1996	5.02	20.97	1.79	4.66
1997	4.69	19.58	1.65	4.57
1998	4.50	18.78	1.54	4.10
1999	4.29	17.91	1.49	4.30
2000	3.97	16.57	1.48	4.37
2001	3.87	16.07	1.55	4.44
2002	4.02	16.78	1.52	4.02
2003	3.14	13.10	1.52	3.30
2004	3.11	12.97	1.54	2.71
2005	3.51	14.65	1.51	1.96
2006	2.52	10.51	1.68	1.75
2007	4.16	10.79	1.83	1.17
2008	3.82	11.08	1.67	0.65
2009	3.98	10.46	1.40	0.50
2010	3.90	10.08	1.27	0.41
2011	1.89	6.93	1.19	0.40
2012	2.16	8.76	1.02	0.38
2013	2.83	11.11	0.93	0.29
2014	4.24	14.88	0.90	0.17

As it can be seen in the Table 9.1, the largest part of indirect CO_2 emissions contributes to natural gas leakage (94.7%).

9.1.3 Uncertainties and times-series consistency

Uncertainty analysis for 2016 submission is carried out by using Approach 1. Quantitative estimates of uncertainties are provided in Annex 2. Overall description of uncertainty analysis is included in Section 1.6

Information regarding uncertainties for 2.D.3 sector can be found under chapter 4.5.3.3.

9.1.4 Category-specific QA/QC and verification

The quality objectives and the QA/QC plan for the Latvia's greenhouse gas inventory at the national inventory level are presented in Section 1.2.3. The QC procedures are performed according to the QA/QC plan in order to achieve these quality objectives. Quality meetings are held annually between experts.

9.1.5 Category-specific recalculations

In 2015 submission indirect CO_2 emissions occuring in CRF 2.D.3 were reported outside of IPPU sector and reflected in Table 6. But in order to ensure compliance with the reporting done by Latvia under the first commitment period of the Kyoto Protocol, it was decided the indirect CO_2 emissions from NMVOCs in solvent use, road paving with asphalt, asphalt roofing and glass fibre production to report under CRF 2.D.3.

9.1.6 Category-specific improvements

No improvements are planned for this sector.

10 RECALCULATIONS AND IMPROVEMENTS

10.1 Explanations and justifications for recalculations, including KP-LULUCF inventory

10.1.1 GHG inventory

The changes in inventory since the previous submission to the UNFCCC were done according to:

- Recommendations by Technical expert review team (TERT) during European Union Effort sharing decision (EU ESD)[251] voluntary review in 2015[252] and EU ESD review in 2016;
- Recommendations by Expert review team (ERT) according to Report on the individual review of the annual submission of Latvia submitted in 2014[253];
- Suggestions from the third part experts not directly involved in the preparation of national inventory (LULUCF, KP-LULUCF sector);
- Corrections of activity data by CSB and corrections of input mistakes.

Overall impacts of recalculations since 1990 are summarized in Table 10.1.

Table 10.1 Impacts of recalculations on national emissions

		Previous submission	Latest submission	Difference	Difference
		CO_2 equivalent (kt)			(%)
1990	Total CO_2 Eq Emissions with LULUCF	17284.87	17834.80	549.93	3.18
	Total CO_2 Eq Emissions without LULUCF	26184.37	26256.43	72.06	0.28
1991	Total CO_2 Eq Emissions with LULUCF	15063.89	15587.93	524.04	3.48
	Total CO_2 Eq Emissions without LULUCF	24214.61	24269.68	55.07	0.23
1992	Total CO_2 Eq Emissions with LULUCF	8975.77	9508.84	533.07	5.94
	Total CO_2 Eq Emissions without LULUCF	19460.45	19524.00	63.55	0.33
1993	Total CO_2 Eq Emissions with LULUCF	6171.63	6865.72	694.09	11.25
	Total CO_2 Eq Emissions without LULUCF	15873.39	16108.10	234.70	1.48
1994	Total CO_2 Eq Emissions with LULUCF	3479.14	4148.37	669.22	19.24
	Total CO_2 Eq Emissions without LULUCF	14020.70	14209.92	189.22	1.35
1995	Total CO_2 Eq Emissions with LULUCF	3111.38	3761.25	649.87	20.89
	Total CO_2 Eq Emissions without LULUCF	12617.28	12799.16	181.88	1.44

[251] *http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009D0406&from=EN*
[252] *https://emrt.eea.europa.eu/*
[253] *http://unfccc.int/resource/docs/2015/arr/lva.pdf*

		Previous submission	Latest submission	Difference	Difference
		CO_2 equivalent (kt)			(%)
1996	Total CO_2 Eq Emissions with LULUCF	2479.16	3125.77	646.61	26.08
	Total CO_2 Eq Emissions without LULUCF	12632.97	12849.42	216.45	1.71
1997	Total CO_2 Eq Emissions with LULUCF	3576.33	4242.03	665.69	18.61
	Total CO_2 Eq Emissions without LULUCF	12064.06	12296.11	232.05	1.92
1998	Total CO_2 Eq Emissions with LULUCF	3940.57	4608.63	668.05	16.95
	Total CO_2 Eq Emissions without LULUCF	11549.00	11788.17	239.17	2.07
1999	Total CO_2 Eq Emissions with LULUCF	6461.99	7149.43	687.45	10.64
	Total CO_2 Eq Emissions without LULUCF	10750.18	11003.11	252.93	2.35
2000	Total CO_2 Eq Emissions with LULUCF	3016.55	3738.30	721.75	23.93
	Total CO_2 Eq Emissions without LULUCF	10147.24	10434.07	286.83	2.83
2001	Total CO_2 Eq Emissions with LULUCF	2826.03	3528.68	702.65	24.86
	Total CO_2 Eq Emissions without LULUCF	10754.33	11038.46	284.13	2.64
2002	Total CO_2 Eq Emissions with LULUCF	4286.98	4973.87	686.89	16.02
	Total CO_2 Eq Emissions without LULUCF	10729.39	11010.57	281.18	2.62
2003	Total CO_2 Eq Emissions with LULUCF	4933.33	5609.57	676.24	13.71
	Total CO_2 Eq Emissions without LULUCF	10890.64	11171.32	280.68	2.58
2004	Total CO_2 Eq Emissions with LULUCF	6399.79	7089.66	689.87	10.78
	Total CO_2 Eq Emissions without LULUCF	10850.90	11166.82	315.93	2.91
2005	Total CO_2 Eq Emissions with LULUCF	6941.58	7651.48	709.90	10.23
	Total CO_2 Eq Emissions without LULUCF	11039.79	11380.36	340.57	3.08
2006	Total CO_2 Eq Emissions with LULUCF	6453.24	7182.55	729.31	11.30
	Total CO_2 Eq Emissions without LULUCF	11543.31	11899.29	355.97	3.08
2007	Total CO_2 Eq Emissions with LULUCF	7567.40	8313.44	746.05	9.86
	Total CO_2 Eq Emissions without LULUCF	11991.85	12364.87	373.02	3.11
2008	Total CO_2 Eq Emissions with LULUCF	6759.39	7511.32	751.94	11.12
	Total CO_2 Eq Emissions without LULUCF	11562.85	11940.64	377.79	3.27

		Previous submission	Latest submission	Difference	Difference
		CO_2 equivalent (kt)			(%)
2009	Total CO_2 Eq Emissions with LULUCF	9625.27	10577.28	952.01	9.89
	Total CO_2 Eq Emissions without LULUCF	10803.02	11217.68	414.66	3.84
2010	Total CO_2 Eq Emissions with LULUCF	12778.46	13936.31	1157.85	9.06
	Total CO_2 Eq Emissions without LULUCF	11896.94	12361.52	464.58	3.91
2011	Total CO_2 Eq Emissions with LULUCF	11642.50	12967.06	1324.55	11.38
	Total CO_2 Eq Emissions without LULUCF	11130.56	11601.95	471.39	4.24
2012	Total CO_2 Eq Emissions with LULUCF	10549.81	12152.61	1602.81	15.19
	Total CO_2 Eq Emissions without LULUCF	10966.65	11493.46	526.81	4.80
2013	Total CO_2 Eq Emissions with LULUCF	10765.95	12623.30	1857.35	17.25
	Total CO_2 Eq Emissions without LULUCF	10913.73	11414.54	500.82	4.59

Recalculations made for the 2016 inventory submission by CRF category and gas and their implications to the emission level in 1990 and 2013 as well as explanations for recalculations are provided in following Table 10.2, Table 10.3, Table 10.4 and Table 10.5.

Table 10.2 Recalculations made in 2016 submission (recalculated year 2013)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
1. Energy	CO_2	6705.77	6700.17	-5.60	-0.08	-0.08	-0.07	
A. Fuel combustion activities	CO_2	6705.76	6700.16	-5.60	-0.08	-0.08	-0.07	
2. Manufacturing industries and construction	CO_2	761.10	755.52	-5.58	-0.73	-0.08	-0.07	Precised amounts of anthracite and other biogas; excluded amounts of coke in 1A2a sector (allocated to 2C1 sector) recalculated waste amounts and emissions in 2013.
3. Transport	CO_2	2772.11	2772.10	-0.02	0.00	0.00	0.00	Recalculations have been done due to improvement of activity data and corrected gasoline consumption in road transport.
2. Industrial processes and product use	CO_2	551.98	613.55	61.57	11.15	0.84	0.82	
A. Mineral industry	CO_2	549.95	550.26	0.32	0.06	0.00	0.00	Recalculations have been done for years 2012-2014 in sector 2.A.3 due to data of soda ash used in direct glass production are available and indirect CO_2 emissions from glass fibre production are reported under this sector.
C. Metal industry	CO_2	0.96	13.90	12.94	1354.94	0.18	0.17	Recalculations have been done in all time series in sector 2.C.1 due to data of used carburizators (coke, coke fine etc.) are taken into account and allocated from Energy sector to IPPU.
D. Non-energy products from fuels and solvent use	CO_2	1.08	49.39	48.31	4482.32	0.66	0.65	In 2015 submission indirect CO_2 emissions occuring in CRF 2.D.3 were reported outside of IPPU sector and reflected in Table 6. But in order to ensure compliance with the reporting done by Latvia under the first commitment period of the

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
								Kyoto Protocol, it was decided the indirect CO_2 emissions from NMVOCs in solvent use, road paving with asphalt, asphalt roofing and glass fibre production to report under CRF 2.D.3. In 2015/2016 recalculations for period 1990-2014 have been carried out under Solvent Use sector due the corrected list of NMVOCs substances and change of method for all time series in accordance with EMEP/EEA 2013 for all time series (see Chapter 4.5.3.2.). Also recalculations were made in 2.D.1 and 2.D.2 sectors due to correction of mistake in calculation which affects CO_2 emissions in all time series.
4. Land use, land-use change and forestry (net)	CO_2	-1195.27	151.51	1346.79	-112.68		17.98	
A. Forestland	CO_2	-3952.38	-3178.15	774.24	-19.59		10.34	Revision of land use category due to manual check of land use categories entered in the NFI database.
B. Cropland	CO_2	2700.97	2901.49	200.52	7.42		2.68	Revision of land use category due to manual check of land use categories entered in the NFI database.
C. Grassland	CO_2	188.32	387.35	199.03	105.68		2.66	Revision of land use category due to manual check of land use categories entered in the NFI database.
D. Wetlands	CO_2	1003.23	1003.23	0.00	0.00		0.00	Revision of land use category due to manual check of land use categories entered in the NFI database.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
E. Settlements	CO_2	1006.11	901.75	-104.36	-10.37		-1.39	Revision of land use category due to manual check of land use categories entered in the NFI database.
G. Harvested wood products	CO_2	-2141.52	-1864.16	277.36	-12.95		3.70	More accurate activity data.
International bunkers	CO_2	1118.11	1116.53	-1.57	-0.14	-0.02	-0.02	
Aviation	CO_2	375.15	373.58	-1.57	-0.42	-0.02	-0.02	Recalculations have been done due to corrected number of LTO and fuel consumption for representative aircraft type in LTO cycle.
CO_2 emissions from biomass	CO_2	5992.02	5978.02	-14.00	-0.23	-0.19	-0.19	Precised activity data by CSB.
Indirect CO_2	CO_2	111.70	15.16	-96.55	-86.43	-1.32	-1.29	In 2015 submission indirect CO_2 emissions occuring in CRF 2.D.3 were reported outside of IPPU sector (under Indirect CO_2) and reflected in Table 6. But in order to ensure compliance with the reporting done by Latvia under the first commitment period of the Kyoto Protocol, it was decided the indirect CO_2 emissions from NMVOCs in solvent use, road paving with asphalt, asphalt roofing and glass fibre production to report under CRF 2.D.3.
1. Energy	CH_4	359.11	279.55	-79.56	-22.16	-3.96	-3.35	
A. Fuel combustion activities	CH_4	258.11	178.55	-79.56	-30.83	-3.96	-3.35	

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
2. Manufacturing industries and construction	CH_4	12.09	12.20	0.11	0.92	0.01	0.00	Precised amounts of anthracite and other biogas; excluded amounts of coke in 1A2a sector (allocated to 2C1 sector) recalculated waste amounts and emissions in 2013.
3. Transport	CH_4	4.77	5.04	0.27	5.69	0.01	0.01	Recalculations have been done due to improvement of activity data and corrected gasoline consumption in road transport
4. Other sectors	CH_4	233.18	153.24	-79.95	-34.28	-3.98	-3.36	Methodology change for biomass use in 1A4b sector (Tier 1 to Tier 2, using CS methane EFs), precised data for wood in 1A4a. Diesel used for stationary and offroad installations were splitted in 1A4ci and 1A4cii.
3. Agriculture	CH_4	940.52	937.41	-3.11	-0.33	-0.15	-0.13	
A. Enteric fermentation	CH_4	803.51	843.06	39.55	4.92	1.97	1.66	The number of non-dairy cattle is split down in new 7 sub-groups by characterizing specifics of dairy and beef production. Reporting in CRF is performed for 3 cattle groups below Option: B. New sub-groups are defined by implementing research results under 2009 - 2014 EEA Grants Programme National Climate Policy Pre-Defined Project "Development of the National System for Greenhouse Gas Inventory and Reporting on Policies, Measures and Projections". Distribution of MMS is recalculated for all livestock groups due to application of new methodology developed under research results mentioned above. As share of pasture for cattle is changed, also feeding situation is described differently,

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
								comparing to the previous submission. Cattle weight data are updated by national expert judgment based on Animal Breeders Association of Latvia Breeding Program results. Amount of milk production per day is adjusted to 305 lactation days. Deer is included in the inventory as a new animal category.
B. Manure management	CH_4	137.01	94.36	-42.65	-31.13	-2.12	-1.79	For emissions calculation from manure management, also the number of swine is split down in 3 sub-groups and Tier 2 methodology is implemented to calculate methane emissions. Distribution of MMS is recalculated for all livestock groups due to application of new methodology developed under research results mentioned above. Also a new animal category as deer is included in the inventory. MCF value 2 for anaerobic digester is implemented in the inventory, according to TERT recommendations after the EU ESD voluntary review in 2015.
4. Land use, land-use change and forestry (net) (4)	CH_4	348.65	366.63	17.98	5.16		0.76	
A. Forestland	CH_4	141.81	146.61	4.80	3.39		0.20	Revision of land use category due to manual check of land use categories entered in the NFI database.
B. Cropland	CH_4	117.66	118.42	0.76	0.65		0.03	Revision of land use category due to manual check of land use categories entered in the NFI database.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
C. Grassland	CH_4	60.65	73.06	12.41	20.47		0.52	Revision of land use category due to manual check of land use categories entered in the NFI database.
5. Waste	CH_4	736.76	793.26	56.50	7.67	2.81	2.38	
A. Solid waste disposal	CH_4	532.90	522.65	-10.26	-1.92	-0.51	-0.43	CH_4 emissions from Solid waste disposal were recalculated due to change of emission factor k and DOCf according to 2006 IPCC Guidelines.
B. Biological treatment of solid waste	CH_4	1.44	19.57	18.14	1262.30	0.90	0.76	Recalculation is done due to new activity data estimation become available. Emissions from household composting are added to submission. For household composting emission factors for CH_4 were applied as for industrial composting.
D. Waste water treatment and discharge	CH_4	202.43	251.04	48.62	24.02	2.42	2.04	Recalculated due to adjusted activity data both of Domestic and Industrial Waste Water Handling.
International bunkers	CH_4	1.38	1.26	-0.12	-8.48	-0.01	0.00	
Aviation	CH_4	0.23	0.12	-0.12	-49.98	-0.01	0.00	Recalculations have been done due to corrected number of LTO and fuel consumption for representative aircraft type in LTO cycle
1. Energy	N_2O	120.22	137.91	17.70	14.72	0.95	0.69	
A. Fuel combustion activities	N_2O	120.22	137.91	17.70	14.72	0.95	0.69	

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
2. Manufacturing industries and construction	N_2O	19.78	19.93	0.15	0.78	0.01	0.01	Precised amounts of anthracite and other biogas, recalculated waste amounts and emissions in 2013.
3. Transport	N_2O	49.69	53.42	3.73	7.50	0.20	0.15	Recalculations have been done due to improvement of activity data and corrected gasoline consumption in road transport
4. Other sectors	N_2O	38.03	51.84	13.81	36.32	0.74	0.54	EF change for biomass use in 1A4b sector (lowest values from N_2O default EF range taken from 2006 IPCC Guidelines), precised data for wood in 1A4a. Diesel used for stationary and offroad installations were splitted in 1A4ci and 1A4cii.
2. Industrial processes and product use	N_2O	0.01	1.95	1.95	36344.44	0.11	0.08	
G. Other product manufacture and use	N_2O	0.01	1.95	1.95	36344.44	0.11	0.08	During quality control procedures mistakes in N_2O emission calculation were found.
3. Agriculture	N_2O	1351.75	1684.47	332.73	24.61	18.27	13.25	
B. Manure management	N_2O	111.28	101.90	-9.38	-8.43	-0.52	-0.37	Nitrogen excretion values are changed for poultry and swine as well as the amount of manure nitrogen that is lost due to volatilization of NH_3 and NOx is assigned to Tier 2 according to TERT recommendation after EU ESD voluntary review in 2015. A new animal category as deer is included in the inventory.
D. Agricultural soils	N_2O	1240.47	1582.58	342.11	27.58	18.78	13.62	Recalculations are done due to the implementation of new emission factor for emission estimation from organic soils defined by

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
								2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement) methodological issues. This is done to reach consistent reporting of emissions with LULUCF sector. Updated organic soil areas are including in the inventory, based on information from LULUCF sector. Values of organic soils area are updated for 2009-2013. Dry matter fraction values and grassland area was updated for emission calculations from crop residue, based on the revision of current estimation and suggested technical corrections. Recalculations also are affected by implementation of new methodology to determine MMS and the share of grazing animals.
4. Land use, land-use change and forestry (net)	N_2O	698.84	690.61	-8.23	-1.18		-0.33	
A. Forestland	N_2O	591.37	639.41	48.04	8.12		1.91	Revision of land use category due to manual check of land use categories entered in the NFI database.
B. Cropland	N_2O	22.57	5.19	-17.38	-77.00		-0.69	Revision of land use category due to manual check of land use categories entered in the NFI database.
C. Grassland	N_2O	25.57	0.18	-25.39	-99.28		-1.01	Revision of land use category due to manual check of land use categories entered in the NFI database.
D. Wetlands	N_2O	3.79	3.79	0.00	0.00		0.00	Revision of land use category due to manual check of land use categories entered in the NFI

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
								database.
E. Settlements	N_2O	52.56	38.98	-13.58	-25.84		-0.54	Revision of land use category due to manual check of land use categories entered in the NFI database.
5. Waste	N_2O	12.35	35.11	22.76	184.25	1.22	0.89	
B. Biological treatment of solid waste	N_2O	1.28	14.00	12.71	989.84	0.68	0.50	Recalculation is done due to new activity data estimation become available. Emissions from household composting are added to submission. For household composting emission factors for N_2O were applied as for industrial composting.
D. Waste water treatment and discharge	N_2O	6.75	16.80	10.04	148.72	0.55	0.40	Recalculated due to correction of mistake in applying emission factors
International bunkers	N_2O	36.52	36.14	-0.38	-1.04	-0.02	-0.02	
Aviation	N_2O	4.40	4.03	-0.38	-8.61	-0.02	-0.02	Recalculations have been done due to corrected number of LTO and fuel consumption for representative aircraft type in LTO cycle

Table 10.3 Recalculations made in 2016 submission (recalculated year 1990)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
1. Energy	CO_2	18556.81	18610.70	53.89	0.29	0.27	0.52	

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
A. Fuel combustion activities	CO_2	18556.80	18610.69	53.89	0.29	0.27	0.52	
2. Manufacturing industries and construction	CO_2	3889.62	3883.95	-5.67	-0.15	-0.03	-0.05	Amounts of coke previously reported in 1A2a sector are allocated to 2C1 sector.
4. Other Sectors	CO_2	5535.58	5595.15	59.56	1.08	0.30	0.57	Recalculations have been done in CRF 1.A.4.a sector due to activity data corrections.
2. Industrial processes and product use	CO_2	602.59	706.12	103.53	17.18	0.53	1.00	
C. Metal industry	CO_2	12.82	52.60	39.78	310.39	0.20	0.39	Recalculations have been done in all time series in sector 2.C.1 due to data of used carburizators (coke, coke fine etc.) are taken into account and allocated from Energy sector to IPPU.
D. Non-energy products from fuels and solvent use	CO_2	0.58	64.32	63.74	11071.60	0.32	0.61	In 2015 submission indirect CO_2 emissions occuring in CRF 2.D.3 were reported outside of IPPU sector and reflected in Table 6. But in order to ensure compliance with the reporting done by Latvia under the first commitment period of the Kyoto Protocol, it was decided the indirect CO_2 emissions from NMVOCs in solvent use, road paving with asphalt, asphalt roofing and glass fibre production to report under CRF 2.D.3. In 2015/2016 recalculations for period 1990-2014 have been carried out under Solvent Use sector due the corrected list of NMVOCs substances and change of method for all time series in accordance with EMEP/EEA 2013 for all time series (see Chapter 4.5.3.2.). Also recalculations were made in 2.D.1 and 2.D.2

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
								sectors due to correction of mistake in calculation which affects CO_2 emissions in all time series.
4. Land use, land-use change and forestry (net) (4)	CO_2	-9782.42	-9305.34	477.08	-4.88		4.62	
A. Forestland	CO_2	-15040.33	-14661.36	378.97	-2.52		3.67	Revision of land use category due to manual check of land use categories entered in the NFI database.
B. Cropland	CO_2	3249.06	3293.67	44.61	1.37		0.43	Revision of land use category due to manual check of land use categories entered in the NFI database.
C. Grassland	CO_2	851.29	901.37	50.08	5.88		0.48	Revision of land use category due to manual check of land use categories entered in the NFI database.
D. Wetlands	CO_2	1215.01	1215.01	0.00	0.00		0.00	Revision of land use category due to manual check of land use categories entered in the NFI database.
E. Settlements	CO_2	108.91	112.33	3.42	3.14		0.03	Revision of land use category due to manual check of land use categories entered in the NFI database.
Indirect CO_2	CO_2	142.11	43.43	-98.68	-69.44	-0.50	-0.96	In 2015 submission indirect CO_2 emissions occuring in CRF 2.D.3 were reported outside of IPPU sector (under Indirect CO_2) and reflected in Table 6. But in order to ensure compliance with the reporting done by Latvia under the first commitment period of the Kyoto Protocol, it was decided the indirect CO_2 emissions from NMVOCs in solvent use, road paving with asphalt, asphalt roofing and glass fibre production to report under CRF 2.D.3.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
1. Energy	CH_4	552.72	498.50	-54.22	-9.81	-1.48	-1.36	
A. Fuel combustion activities	CH_4	305.14	250.92	-54.22	-17.77	-1.48	-1.36	
2.Manufacturing industries and construction	CH_4	5.48	5.48	0.00	-0.02	0.00	0.00	Amounts of coke previously reported in 1A2a sector are allocated to 2C1 sector.
4. Other sectors	CH_4	275.07	220.85	-54.22	-19.71	-1.48	-1.36	Methodology change for biomass use in 1A4b sector (Tier 1 to Tier 2, using CS methane EFs), precised data for wood in 1A4a. Recalculations have been done in CRF 1.A.4.a sector due to activity data corrections. Diesel used for stationary and offroad installations were splitted in 1A4ci and 1A4cii.
3. Agriculture	CH_4	2690.49	2411.15	-279.33	-10.38	-7.63	-7.04	
A. Enteric fermentation	CH_4	2281.89	2221.54	-60.35	-2.64	-1.65	-1.52	The number of non-dairy cattle is split down in new 7 sub-groups by characterizing specifics of dairy and beef production. Reporting in CRF is performed for 3 cattle groups below Option: B. New sub-groups are defined by implementing research results under 2009 - 2014 EEA Grants Programme National Climate Policy Pre-Defined Project "Development of the National System for Greenhouse Gas Inventory and Reporting on Policies, Measures and Projections". Distribution of MMS is recalculated for all livestock groups due to application of new methodology developed under research results

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
								mentioned above. As share of pasture for cattle is changed, also feeding situation is described differently, comparing to the previous submission. Cattle weight data are updated by national expert judgment based on Animal Breeders Association of Latvia Breeding Program results. Amount of milk production per day is adjusted to 305 lactation days. Deer is included in the inventory as new animal category.
B. Manure management	CH_4	408.59	189.61	-218.98	-53.59	-5.98	-5.52	For emissions calculation from manure management, also the number of swine is split down in 3 sub-groups and Tier 2 methodology is implemented to calculate methane emissions. Distribution of MMS is recalculated for all livestock groups due to application of new methodology developed under research results mentioned above. Also a new animal category as deer is included in the inventory. MCF value 2 for anaerobic digester is implemented in the inventory, according to TERT recommendations after EU ESD voluntary review in 2015.
4. Land use, land-use change and forestry (net) (4)	CH_4	303.72	307.53	3.81	1.25		0.10	
A. Forestland	CH_4	83.84	83.86	0.01	0.01		0.00	Revision of land use category due to manual check of land use categories entered in the NFI database.
B. Cropland	CH_4	125.09	125.10	0.00	0.00		0.00	Revision of land use category due to manual check of land use categories entered in the NFI database.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
C. Grassland	CH_4	66.25	70.04	3.79	5.72		0.10	Revision of land use category due to manual check of land use categories entered in the NFI database.
5. Waste	CH_4	752.66	761.54	8.88	1.18	0.24	0.22	
B. Biological treatment of solid waste	CH_4	NO,NE	23.91	23.91	100.00	0.65	0.60	Recalculation is done due to new activity data estimation become available. Emissions from household composting are added to submission. For household composting emission factors for CH_4 were applied as for industrial composting.
D. Waste water treatment and discharge	CH_4	359.83	344.80	-15.03	-4.18	-0.41	-0.38	Recalculation due to changed methodology and adjustment of assumptions and MCFs for Domestic Waste Water Handling.
1. Energy	N_2O	148.93	174.39	25.46	17.10	0.88	0.73	
A. Fuel combustion activities	N_2O	148.93	174.39	25.46	17.10	0.88	0.73	
2.Manufacturing industries and construction	N_2O	8.79	8.77	-0.02	-0.27	0.00	0.00	Amounts of coke previously reported in 1A2a sector are allocated to 2C1 sector.
4. Other sectors	N_2O	48.49	73.98	25.49	52.55	0.88	0.74	EF change for biomass use in 1A4b sector (lowest values from N2O default EF range taken from 2006 IPCC Guidelines), precised data for wood in 1A4a. Recalculations have been done in CRF 1.A.4.a sector due to activity data corrections. Diesel used for stationary and offroad installations were splitted in 1A4ci and 1A4cii.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
2. Industrial processes and product use	N_2O	0.00	1.30	1.30	27212.50	0.05	0.04	
G. Other product manufacture and use	N_2O	0.00	1.30	1.30	27212.50	0.05	0.04	During quality control procedures mistakes in N_2O emission calculation were found.
3. Agriculture	N_2O	2489.05	2663.75	174.70	7.02	6.15	5.11	
B. Manure management	N_2O	305.42	323.75	18.33	6.00	0.65	0.54	Nitrogen excretion values are changed for poultry and swine according to ERT review results. The amount of manure nitrogen that is lost due to volatilization of NH_3 and NOx is assigned to Tier 2 approach, according to TERT suggestion after EU ESD voluntary review in 2015. A new animal category as deer is included in the inventory.
D. Agricultural soils	N_2O	2183.63	2340.00	156.37	7.16	5.51	4.58	Recalculations are done due to the implementation of new emission factor for emission estimation from organic soils defined by 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement) methodological issues. This is done to reach consistent reporting of emissions with LULUCF sector. Updated organic soil areas are including in the inventory, based on information from LULUCF sector. Values of organic soils area are updated for 2009-2013. Dry matter fraction values and grassland area was updated for emission calculations from crop residue, based on the revision of current estimation and suggested technical corrections. Recalculations also are affected by

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
								implementation of new methodology to determine MMS and the share of grazing animals.
4. Land use, land-use change and forestry (net)	N_2O	579.20	576.18	-3.02	-0.52		-0.09	
A. Forestland	N_2O	571.13	570.67	-0.46	-0.08		-0.01	Revision of land use category due to manual check of land use categories entered in the NFI database.
B. Cropland	N_2O	3.15	0.59	-2.56	-81.26		-0.07	Revision of land use category due to manual check of land use categories entered in the NFI database.
C. Grassland	N_2O	0.05	0.05	0.00	-0.27		0.00	Revision of land use category due to manual check of land use categories entered in the NFI database.
D. Wetlands	N_2O	3.79	3.79	0.00	0.00		0.00	Revision of land use category due to manual check of land use categories entered in the NFI database.
E. Settlements	N_2O	0.91	0.91	0.00	0.00		0.00	Revision of land use category due to manual check of land use categories entered in the NFI database.
5. Waste	N_2O	11.12	48.98	37.86	340.50	1.31	1.09	
B. Biological treatment of solid waste	N_2O	NO,NE	17.10	17.10	100.00	0.59	0.49	Recalculation is done due to new activity data estimation become available. Emissions from household composting are added to submission. For household composting emission factors for N_2O were applied as for industrial composting.
D. Waste water treatment and discharge	N_2O	6.27	27.03	20.76	331.00	0.73	0.61	Recalculated due to correction of mistake in applying emission factors.

Table 10.4 Recalculations made in 2016 submission (F-gases) (recalculated year 2013)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
F-gases: Total actual Emissions	HFCs	108.46	204.35	95.90	88.42	46.93	46.93	
2.F.1. Refrigeration and air conditioning	HFCs	102.86	198.93	96.07	93.40	47.01	47.01	Recalculations were made in all 2.F. subcategories due to implementation of F-gases research (2016) results. According to the research, activity data taken from annual reports by F-gases operators were split between the subcategories and the time series was recalculated at a level of 2006 IPCC Guidelines subcategories (Commercial, Industrial, Transport refrigeration and Stationary air conditioning). Emission factors were elaborated based on consultations with Latvian Freezing Equipment Engineers` Association. Recalculations were made also for mobile air conditioners as more precise data regarding population of cars and distribution by vehicle types (passenger cars, LDV, HDV), age and vehicle categories according to emission control system (EURO classes) were obtained. Refrigerant stocks and emissions from operating systems in 2.F.1 were recalculated due to recommendation by TERT during EU ESD review in 2016.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF %	Explanation for recalculations
2.F.2. Foam blowing agents	HFCs	0.00	1.84	1.84	128441.47	1.41	1.41	Emissions from foaming of polyether (for shoe soles) were added to 2.F.2 Closed cell foams after recommendation by TERT during EU ESD voluntary review in 2015. Consequently emissions from 2.F.2 Foam Blowing Products increased.
2.F.3. Fire protection	HFCs	0.24	0.06	-0.17	-73.83	-0.13	-0.13	Emissions have decreased due to decrease of activity data reported in annual reports by companies using F gases in Fire protection equipment.
2.G.4. Other	HFCs	1.84	NO	-1.84	-100.00	-1.41	-1.41	Emissions from foaming of polyether (for shoe soles) previously wrongly reported under 2.G.4 Other. After recommendation by TERT during EU ESD voluntary review in 2015, these emissions included under 2.F.2 Foam Blowing Products.

Table 10.5 Recalculations made in 2016 submission (F-gases) (recalculated year 1995)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF(3) %	Explanation for recalculations
F-gases: Total actual Emissions	HFC	0.67	11.50	10.83	1617.59	94.18	94.18	
2.F.1. Refrigeration and air conditioning	HFCs	0.27	11.10	10.83	4022.43	94.18	94.18	Recalculations were made in all 2.F. subcategories due to implementation of F-gases research (2016) results. According to the research, activity data taken from annual reports by F-gases operators were split between the

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Gas	Previous submission (CO_2-eq, kt)	Latest submission (CO_2-eq, kt)	Difference (CO_2-eq, kt)	Difference %	Impact of recalculation on total emissions excluding LULUCF %	Impact of recalculation on total emissions including LULUCF(3) %	Explanation for recalculations
								subcategories and the time series was recalculated at a level of 2006 IPCC Guidelines subcategories (Commercial, Industrial, Transport refrigeration and Stationary air conditioning). Emission factors were elaborated based on consultations with Latvian Freezing Equipment Engineers` Association. Recalculations were made also for mobile air conditioners as more precise data regarding population of cars and distribution by vehicle types (passenger cars, LDV, HDV), age and vehicle categories according to emission control system (EURO classes) were obtained.
2.F.2. Foam blowing agents	HFC	NO,NE	0.40	0.40	100.00	3.48	3.48	Emissions from foaming of polyether (for shoe soles) was added to 2.F.2 Closed cell foams after recommendation by TRT during EU ESD voluntary review in 2015. Consequently emissions from 2.F.2 Foam Blowing Products increased.
2.G.4. Other	HFC	0.40	NO	-0.40	-100.00	-3.48	-3.48	Emissions from foaming of polyether (for shoe soles) previously wrongly reported under 2.G.4 Other. After recommendation by TERT during EU ESD voluntary review in 2015, these emissions included under 2.F.2 Foam Blowing Products.

Changes in methodological descriptions for 2016 submission are summarized in Table 10.6 below.

Table 10.6 Changes in methodological descriptions

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please mark the relevant cell where the latest NIR includes major changes in methodological descriptions compared to the NIR of the previous year	**Please mark the relevant cell where this is also reflected in recalculations compared to the previous years' CRF**	**If the cell is marked please provide a reference to the relevant section or pages in the NIR and if applicable some more detailed information such as the sub-category or gas concerned for which the description was changed.**
Total (Net Emissions)	-	-	-
1. Energy	-	-	-
A. Fuel Combustion (sectoral approach)	-	-	-
1. Energy industries	-	-	-
2. Manufacturing industries and construction	-	-	-
3. Transport	-	-	-
4. Other sector	**+**	**+**	Change from Tier 1 to Tier 2 in 1.A.4.b. (for CH_4). More information available on NIR chapter 3.2.7.2.
5. Other	-	-	-
B. Fugitive emissions from fuels	-	-	-
1. Solid fuels	-	-	-
2. Oil and natural gas and other emissions from energy production	-	-	-
C. CO_2 transport and storage	-	-	-
2. Industrial processes and product use	-	-	-
A. Mineral industry	-	-	-
B. Chemical industry	-	-	-
C. Metal industry	-	-	-
D. Non-energy products from fuels and solvent use	**+**	**+**	2.D.3, Solvent Use, see Chapter 4.5.3.6.
E. Electronic industry	-	-	-
F. Product uses as substitutes for ODS	**+**	**+**	2.F.1 Refrigeration and Air Conditioning, see Chapter 4.7.1.
G. Other product manufacture and use	**+**	**+**	2.G.3, N_2O From Product Uses, see Chapter 4.8.2.6.
H. Other	-	-	-

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please mark the relevant cell where the latest NIR includes major changes in methodological descriptions compared to the NIR of the previous year	**Please mark the relevant cell where this is also reflected in recalculations compared to the previous years' CRF**	**If the cell is marked please provide a reference to the relevant section or pages in the NIR and if applicable some more detailed information such as the sub-category or gas concerned for which the description was changed.**
3. Agriculture	-	-	-
A. Enteric fermentation	-	-	-
B. Manure management	-	-	-
C. Rice cultivation	-	-	-
D. Agricultural soils	-	-	-
E. Prescribed burning of savannahs	-	-	-
F. Field burning of agricultural residues	-	-	-
G. Liming	-	-	-
H. Urea application	-	-	-
I. Other carbon containing fertilisers	-	-	-
J. Other	-	-	-
4. Land use, land-use change and forestry	-	-	-
A. Forest land	-	**+**	Described in the NIR section 7.6 Forest land, sub-section 7.6.7 Category-specific recalculations
B. Cropland	-	**+**	Described in the NIR section 7.7 Cropland, sub-section 7.7.1.7 and 7.7.2.7 Category-specific recalculations
C. Grassland	-	**+**	Described in the NIR section 7.8 Grassland, sub-section 7.8.1.6 and 7.8.2.6 Category-specific recalculations
D. Wetlands	-	**+**	Described in the NIR section 7.9 Wetland, sub-section 7.9.7 Category-specific recalculations
E. Settlements	-	**+**	Described in the NIR section 7.10 Settlements, sub-section 7.10.8 Category-specific recalculations
F. Other land	-	**-**	-
G. Harvested wood products	-	**+**	Described in the NIR section 7.13 Harvested wood products, sub-section 7.13.7 Category-specific recalculations

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please mark the relevant cell where the latest NIR includes major changes in methodological descriptions compared to the NIR of the previous year	**Please mark the relevant cell where this is also reflected in recalculations compared to the previous years' CRF**	**If the cell is marked please provide a reference to the relevant section or pages in the NIR and if applicable some more detailed information such as the sub-category or gas concerned for which the description was changed.**
H. Other	-	-	-
5. Waste	-	-	-
A. Solid waste disposal	-	-	-
B. Biological treatment of solid waste	**+**	**+**	Changes in composting activity data. Amount if compotsed amounts from households are firstly estimated from year 1990.
C. Incineration and open burning of waste	-	-	-
D. Wastewater treatment and discharge		**+**	NIR Chapter 7.5.1.5. and 7.5.2.5. N2O emissions from Domestic Waste Water Handling recalculated for entire period due to correction of mistake with Efs; CH_4 emissions from Domestic Waste Water Handling recalculated for period 2000 - 2013 due to adjustment of activity data; CH_4 emissions from Industrial Waste Water Handling recalculated for period 2000 - 2013 due to adjustment of activity data.
E. Other	-	-	-
6. Other (as specified in Summary 1.A)	-	-	-
KP LULUCF	-	-	-
Article 3.3 activities	--	-	-
Afforestation/reforestation	**+**	**+**	Described in the NIR section 12.KP-LULUCF, sub-section 12.3.1.4 Changes in data and methods since the previous submission (recalculations)
Deforestation	**+**	**+**	Described in the NIR section 12.KP-LULUCF, sub-section 12.3.1.4 Changes in data and methods since the previous submission (recalculations)
Article 3.4 activities	-	**-**	-

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please mark the relevant cell where the latest NIR includes major changes in methodological descriptions compared to the NIR of the previous year	**Please mark the relevant cell where this is also reflected in recalculations compared to the previous years' CRF**	**If the cell is marked please provide a reference to the relevant section or pages in the NIR and if applicable some more detailed information such as the sub-category or gas concerned for which the description was changed.**
Forest management	**+**	**+**	Described in the NIR section 12.KP-LULUCF, sub-section 12.3.1.4 Changes in data and methods since the previous submission (recalculations)
Cropland management (if elected)	-	**-**	-
Grazing land management (if elected)	-	**-**	-
Revegetation (if elected)	-	**-**	-
Wetland drainage and rewetting (if elected)	-	-	-
NIR Chapter	**DESCRIPTION**		**REFERENCE**
	Please mark the cell where the latest NIR includes major changes in descriptions compared to the previous year NIR		**If the cell is marked please provide some more detailed information for example reference to pages in the NIR**
Chapter 1.2 Description of national inventory arrangements	-	-	-

10.1.2 KP-LULUCF inventory

Deforestation in 2009-2013 is recalculated by application of updated land use data provided by the NFI after spatial analysis of the NFI plots. In previous inventory reports extrapolation of historical data and results of remote sensing analysis were used. This recalculation considerably increased emissions due to deforestation and from organic soils.

10.2 Implication for emission levels

10.2.1 GHG inventory

See section 10.1.

10.2.2 KP-LULUCF inventory

Recalculations reduced net removals in 1990-2013 in the KP-LULUCF inventory by 5%; however, the most of the impact applies to period from 2009 to 2013 for which new data on deforestation are applied.

10.3 Implications for emission trends, including time series' consistency

10.3.1 GHG inventory

See section 10.1.

10.3.2 KP-LULUCF inventory

See section 10.1

10.4 Recalculations, including in response to the review process, and planned improvements to the inventory

10.4.1 GHG inventory

The development of the GHG inventory aims to improve the calculation and reporting of the inventory. The improvement plan is discussed and approved by all experts and organizations involved in GHG inventory preparation process.

Many improvements of next and future GHG inventories are planned within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy ":

-) development of an integrated database for climate change and air quality data aggregation. The development of the database will result in enhanced data quality, workflow optimization and facilitation of report submissions;

-) preparation of research studies for GHG inventory improving (for example, Promoting sustainable land management through creation of a digital soil database; analyze bovine intestinal fermentation processes (methane release); evaluate agricultural fertilizer-related processes and activities; estimation of soil carbon stock in cropland and grassland);

Table 10.7 shows the sector specific improvements needs for the forthcoming inventories. More detailed information about planned improvements can be found under sectoral chapters.

Table 10.7 Sector specific planned improvements for Latvia`s national GHG inventory

	Planned improvement	Tentative time schedule	Progress
General	Develop an integrated database for climate change and air quality data aggregation and preparation of GHG inventory (NIR) and other reports to different international institutions.	From 2017	Implementation of integrated database is ongowing in 2016. Launching of system is planned in 2017.
General	Improve uncertainty of the inventory	2016	Experience sharing seminar regarding uncertainty

	Planned improvement	Tentative time schedule	Progress
			evaluation already took place at the end of 2015 within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy ". As a result uncertainty evaluation was improved and overall uncertainty of the 2016 submission has significantly reduced compared to previous submissions. Implementation of final results is ongoing.
IPPU/F-gases	Elaborate F-gases reporting – improve AD obtaining, develop country specific emission factors, improve QA/QC procedures of F-gases inventory	2015-2017	Started in 2015 within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy ". Results implemented into this submission. Additional cross-checks with data reported under Regulation EU 517/2014 are planned for the next submission.
2.D.3 Solvent Use	Electronic reporting for importers and producers in the Chemicals Register.	2016-2017	It is planned to implement electronic reporting for importers and producers in the Chemicals Register. According to that, possible changes in activity data are expected. It is planned to get more accurate division by subcategories taking into account that previously it was done by expert judgment.
Agriculture 3.A.1 Enteric fermentation	Updating of digestible energy as percent of gross energy for cattle, according to feeding situation research	2017	Improvement planned within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy ".

	Planned improvement	Tentative time schedule	Progress
Agriculture 3.A.2. Manure management	Implementation of country specific nitrogen excretion values for all livestock groups based on latest research activities. Revision of MCF value for anaerobic digester, based on data collection and proceeding required by ERT in 2015.	2017	Improvement planned within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy".
Agriculture 3.A.2. Manure management	Strengthening Tier 2 methodology for indirect emissions calculations from manure management to force development of national ammonia model. Straitening the consistency of GHG and ammonia emissions reporting.	2017-2018	Improvement planned within activities supported by funding of Ministry of Environmental Protection and Regional Development.
Agriculture 3.D	Future development of the country specific value for FracLEACH-(H) and FRACGASM to estimate N losses by leaching/runoff and volatilization.	2017-2018	Improvement planned within activities of GHG research group of Latvia University of Agriculture.
LULUCF - overview	Evaluation of carbon stock changes in croplands and grasslands.	2016	Improvement planned within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy ". Field data collection and analyses are done, scientific publication is under preparation. After publishing the results will be implemented in the GHG calculations.
LULUCF Direct and Indirect N_2O emissions from managed soils	N_2O emissions might be considerable part of emissions from wetlands, therefore, it is necessary to develop method for estimation impact of drainage on N_2O emissions, and it is important to be able to separate wetlands on nutrients rich organic soils (high N_2O emissions) and poor organic	2016-2020	Demonstration project application for LIFE+ program "LIFE Restore - Support tools for sustainable and responsible management and re-use of degraded peatlands in Latvia" proposed in 2015. The project is started in September, 2015 and

	Planned improvement	Tentative time schedule	Progress
	soils (low N_2O emissions). Information on land use changes, particularly, distribution of nutrients rich and poor organic and losses of organic carbon due to land use changes should be updated. Country specific C/N ratio will be introduced for calculation of N_2O emissions from forest land, cropland and grassland in 2017.		the outputs (emission factors) will be available in 2019.
LULUCF 4.A Forest Land	Estimation of decay period for dead wood (harvesting residues and below-ground biomass, planned to complete until report 1990-2014);	2016	Research project on this issue is completed, implementation stage is proposed in 2015. The results will be used in the GHG calculations after publishing results.
	Estimation of carbon stock changes in drained organic soils in forest lands (2015);	2016	The research completed for fertile organic soils and emission factors are elaborated; scientific publication is under preparation and will be delivered to peer reviewed magazine.
	Development of production version of EPIM tool, including broader representation of land use change, integration of land use change and GHG calculation modules and integration of Kyoto protocol and the UNFCCC reporting modules.	2016	Technical work and quality assurance still ongoing in 2016.
LULUCF 4.B.1 Cropland remaining cropland	Updated area of organic soil in cropland according to the NFI study started in 2012 and soil mapping project.	2016-2020	Temporary results will be available in 2016 after completion of soil mapping project, all NFI plots on former and currently used cropland and grassland on organic soils will be visited until 2017, and final reporting will be done in 2017.
	Updated CO_2 emissions from organic soil considering area changes and recent findings in Nordic and Baltic countries, particularly, doctoral thesis by Jüri-Ott Salm "Emission of greenhouse gases CO_2, CH_4, and N_2O from Estonian transitional fens and ombrotrophic bogs: the impact of different land-use practice".	2016-2020	Demonstration project application for LIFE+ program "LIFE Restore - Support tools for sustainable and responsible management and re-use of degraded peatlands in Latvia" is started in 2015, updated emission factors will be available in 2019.
	Tier 3 methodology to estimate carbon	2017	It is proposed to implement

	Planned improvement	Tentative time schedule	Progress
	stock changes in cropland considering changes of cropping practices since 1970.		Yasso model in forest land and cropland to obtain information on carbon stock changes in soil, the implementation is planned in 2017, forest lands on dry mineral soils, cropland and grassland will be covered by the estimation. Results should be prepared for publication until the end of 2017.
LULUCF 4.B.2 Land converted to cropland	Area of organic soil might be overestimated in land converted to cropland. Field measurement based information on organic soils is necessary to improve accuracy of estimates of the emissions.	2016	The new estimates will be based on soil mapping project, which has to be completed in 2016, and GIS analysis of land use changes in the NFI plots. The work is ongoing; however, due to limited capacity, it will be implemented in the GHG inventory in 2017.
LULUCF 4.C Grasslands	Improvement of reporting for ditch area in organic soil. Now the estimates are based on limited knowledge about organic soils and drainage ditches in grasslands. The updated information will be based on NFI data, soil mapping data and digital GIS information on drainage systems.	2016	Soil mapping project has to be completed to start estimation of area of drainage ditches on organic soils.
LULUCF 4.B., 4.C. Land, Aggregate Sources and Non-CO_2 EmissionsSources on Land	Create a digital database of soils digitalising available soil maps.	2016	Is under implementation within the scope of the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy ".
LULUCF 4.B.5. Settlements	Utilization of high resolution satellite images to evaluate dynamics of carbon stock in living biomass in certain pilot areas since 1990 and to extrapolate obtained results to all NFI plots to avoid potential overestimation of removals of CO_2 in living biomass.	2016-2020	Planned to implement in following submissions.
LULUCF 4 (V) Biomass Burning	A new methodology on estimation of incineration efficiency in forest fires will be elaborated and different types of forest fires will be separated to account the GHG emissions more accurate. Information provided by the State forest service will be used with	2017	The work plan is elaborated for implementation to obtain data for the following inventories.

	Planned improvement	Tentative time schedule	Progress
	higher level of accuracy by splitting different types of forest fires and following activities in the forest stands to avoid double reporting of harvested wood extracted in sanitary felling after forest fires. Burning of harvesting residues will be evaluated by forest owner's questionnaires.		
Waste 5.A Solid Waste Disposal	Estimation of MCF will be done for Latvia landfills for all time series.	2015-2016	It is planned to make an efforts within the programme "European Economic Area Financial Mechanism 2009-2014 – "National Climate Policy" to improve MCF uses. Research about MCF and CH_4 content in landfill gas was done in year 2015. Results of the research are in the evaluation stage. Emission calculation improvement will be undertaken for next submission.
Waste 5.B.1 Composting	New waste recovery classification in Latvia comes in force in 2013. Determination of composting will be more precise, because special R code will be used for composting. It is planned to make an efforts within the programme "European Economic Area Financial Mechanism 2009-2014 – "National Climate Policy" to improve this section. Research about composted amounts in households and country specific emissions factors for composting will be realized in year 2015.	2015-2016	It is planned to organize the pilot project within the programme "European Economic Area Financial Mechanism 2009-2014 – "National Climate Policy". Improvement will be undertaken for next submission.
Waste 5.D Waste Water Handling	Further assessment of sewage sludge properties depending of content of dry solids to distinct anaerobic sewage sludge from dry sewage sludge, stored in piles.	2016-2017	On-site visits to sewage sludge treatment plants are planned.

Response to the review (Table 10.8) includes:

- recommendations related to Supplementary Information required under Article 7, Paragraph 1 of the Kyoto Protocol listed in Report on the individual review of the annual submission of Latvia submitted in 2014[254];

[254] *http://unfccc.int/resource/docs/2015/arr/lva.pdf*

- recommendations in LULUCF and KP-LULUCF sectors during the international third part review in 2015;

Table 10.8 Response to the review process

Sector	CRF Category/ Issue	Review Recommendation	Review Report/ Paragraph	LV Response (status of implementation)	Chapter/Section in the NIR
Article 3, paragraphs 3 and 4, of the Kyoto Protocol	General	Use updated data from the second cycle of the NFI to calculate more reliable estimates of the areas converted to forest land in the period 2008–2012	FCCC/ARR/ 2014/LV, para 95	Recalculation of areas is done according to recommendations of ERT; however, more accurate estimation of area of afforested lands is targeted in the improvement plan to consider also natural regeneration as a forest management method	Chapter 11, Section 11.3.
KP-LULUCF	Afforestation and reforestation – CO_2	Provide figures that demonstrate no statistically significant difference in the carbon stock in mineral soils in historical grassland and afforested land	FCCC/ARR/ 2014/LV, para 100	Field data collection and analyses are done. Preliminary data on carbon stock in grassland and forest land are published by: Lazdiņš, A., Bārdule, A. & Butlers, A. (2015). Preliminary results of comparison of carbon stock in soil in grassland, cropland and forest land. *Proceedings of Adaptation and mitigation: strategies for management of forest ecosystems*, Airport hotel ABC, 2015. pp 54–57. Lazdiņš, A., Bārdule, A. & Stola, J. (2013). Preliminary results of evaluation of carbon stock in historical cropland and grassland. *Proceedings of Interdisciplinary Research for Higher Socioeconomic Value of Forests*, Riga, 2013. pp 56–57. LSFRI Silava. Scientific publication that highlight final conclusions is under preparation. After publishing the results will be implemented in the GHG calculations.	Chapter 11, Section 11.3.
KP-LULUCF	Afforestation and reforestation – CO_2	Include the explanation provided to the ERT on the reasons for reporting the carbon stock changes in above- and below-ground biomass as "NO"	FCCC/ARR/ 2014/LV, para 101	Carbon stock changes in above and below-ground biomass are recalculated according to updated information provided by the NFI. NO is not any more used for carbon stock changes in living biomass in afforested land	Chapter 11, Section 11.3

Sector	CRF Category/ Issue	Review Recommendation	Review Report/ Paragraph	LV Response (status of implementation)	Chapter/Section in the NIR
KP-LULUCF	Deforestation – CO_2	Include the specific exclusions in the definition of forest and any other criteria provided in the NIR	FCCC/ARR/ 2014/LV, para 104	Information about principles of estimation of land use changes are provided in relevant chapters of forest land, cropland and grassland with following cross-references to this information in KP 3.3 activities related chapters	Chapter 11, Section 13.2
KP-LULUCF	Deforestation – CO_2	Provide adequate documentation to support the expert judgement applied to separate emissions from living biomass due to commercial harvesting following deforestation	FCCC/ARR/ 2014/LV, para 105	Emissions due to commercial felling before deforestation are accounted as losses of living biomass due to deforestation	Chapter 13, Section 11.2
KP-LULUCF	Forest management – CO_2	Include the information provided in the annex to the response from Latvia "Afforestation study_SP" that justifies the recalculated areas meet the requirements of definitions in decision 16/CMP.1 in the NIR	FCCC/ARR/ 2014/LV, para 106	Detailed information on reporting of land under afforestation is provided in relevant sections of NIR (land converted to forest and relevant sections in the National inventory report on reporting of KP 3.3 activities	Chapter 11, Section 11.2 and 11.3
KP-LULUCF	Forest management – CO_2	Report the carbon losses due to harvesting that took place on afforested/reforested areas and on forest management separately and report this issue transparently	FCCC/ARR/ 2014/LV, para 108	As it is noted in the NIR, there is no evidences of commercial felling in afforested lands according to NFI data. Losses of biomass due to pre-commercial thinning are reported under natural mortality and carbon stock changes in dead biomass	Chapter 11, Section 11.3
KP-LULUCF	Biomass burning – CO_2	Include the explanation regarding the use of the notation key "IE" to report CO_2 emissions from controlled burning	FCCC/ARR/ 2014/LV, para 109	Detailed explanation is provided in sub-chapter of methodologic issues under chapter Biomass burning	Chapter 6, Section 6.10

Sector	CRF Category/ Issue	Review Recommendation	Review Report/ Paragraph	LV Response (status of implementation)	Chapter/Section in the NIR
Standard electronic format and reports from the national registry	National Registry	Address the recommendations contained in the SIAR.	FCCC/ARR/ 2014/LV, para 110	Recommendations contained in the SIAR addressed in this submission.	Chapter 14
	National Registry	Clarify what changes have been made to the national registry.	FCCC/ARR/ 2014/LV, para 119	Information regarding changes in national registry provided in this submission.	Chapter 14
	National Registry	Include all other additional information in response to the SIAR findings in the NIR in accordance with decision 15/CMP.1	FCCC/ARR/ 2014/LV, para 120	All information in response to the SIAR findings are included in the NIR in accordance with decision 15/CMP.1	Chapter 14
Cross-sectoral	General	Clarify all reporting requirements and identify best data available in the country or internationally (e.g. Joint Research Centre, Food and Alimentation Organization, etc.), while having in mind low cost solutions. International data can be used as surrogate until national better data is achieved	LULUCF, KP-LULUCF third part review[255]	Latvian State Forest Research Institute Silava is continuously involved in several international and national scientific projects to develop and evaluate country specific emission factors and more accurate activity data. Several scientific publication is under preparation. After publishing the results will be implemented in the GHG calculations. There is good cooperation practice with NFI, State forest service and other organization that provide the most updated data used in GHG calculations.	Chapter 6 and Chapter 11

[255] *Third part review of Latvia's GHG inventory from Land use, land use change and forestry for 1990 – 2013 under UNFCCC, Kyoto Protocol and decision No. 529/2013/EU of the European Parliament*

Sector	CRF Category/ Issue	Review Recommendation	Review Report/ Paragraph	LV Response (status of implementation)	Chapter/Section in the NIR
Cross-sectoral	General	Link asap to The Land Parcel Identification System (LPIS) agency and identify solutions for transfer of agricultural soil management information to LULUCF group. Because of LPIS data peculiarity annual data has to be provided from since records started. This information has to be geo-referenced, either provided as polygons or as exact information for NFI plots, or in a different manner national experts have to agree upon	LULUCF, KP-LULUCF third part review	Discussions about cooperation with The Land Parcel Identification System agency are started; data are transferred to LSFRI Silava and status of land use is compared with the NFI data. About 10 % difference is found between identification of cropland and grassland due to rapid changes in land management approaches, but detailed analyse is not yet done due to insufficient resources for georeferencing the NFI plots and sectors within plots. Detailed analysis is planned for 2016.	Will be implemented into next submissions.
Cross-sectoral	General	Add English headings in excel spreadsheets in order to ensure readability and proper external QAQC of calculations, whenever that is possible or required	LULUCF, KP-LULUCF third part review	EPIM tool is in development stage. Technical work and quality assurance continued in 2015 and will be completed in 2016. The delay is associated with implementation of the CRF Reporter tool.	Chapter 6 and Chapter 11
LULUCF	4.B Cropland, 4.C Grassland	Updated geo-referenced soil map, with focus on organic soil mapping and association to land use	LULUCF, KP-LULUCF third part review	Temporary results will be available in 2016 after completion of soil mapping project, all NFI plots on former and currently used cropland and grassland on organic soils will be visited until 2017, and final reporting will be done in 2017.	Chapter 6, Section 6.5.1, 6.6.1

Sector	CRF Category/ Issue	Review Recommendation	Review Report/ Paragraph	LV Response (status of implementation)	Chapter/Section in the NIR
LULUCF	4.B Cropland4.C Grassland	Updated drainage mapping for cropland and grassland. Because of high level of emissions associated to these lands, there is need for a split on 'actively managed' and 'abandoned' drainage systems areas. An adequate assumption is that all such lands were actively drained in 1990. In order to derive the current actively managed areas, using actual crop cultivation data reported by farmers in LPIS as a proxy may be an adequate economically solution (to be tested)	LULUCF, KP-LULUCF third part review	Estimation of area of drainage ditches on organic soils in cropland and grassland will starts in 2016 when soil mapping project will be completed and temporary results will be available. Discussions about cooperation with The Land Parcel Identification System agency are started however NFI will be kept as a main source of data for the inventory to maintain integrity of land use accounting.	Chapter 6, Section 6.5 and 6.6
LULUCF	4.A Forest land, 4.B Cropland, 4.C Grassland,4.D Wetland, 4.E Settlements	Development of data to ensure time series back to 1970. If major changes in land use have occurred over the period 1970-1990, e.g. major drainage and extension of arable croplands, conversions from forests, etc then development of this time series based on existing spatial information would respond adequately to reporting guidelines. Otherwise, simple /arithmetical extrapolation of post-1990 conversions rates and use of any actual data on conversions (e.g. from/to forests) back in time can provide picture. For guidance on extrapolation see Ch.5 of Vol.1 of 2006 IPCC Guidelines.	LULUCF, KP-LULUCF third part review	The work on this issue is ongoing. Development of data of area of forest land and deforested land, carbon stock changes in living biomass and dead wood as well as harvesting stock are done to ensure time series back to 1970.	Chapter 6, Section 6.2

Sector	CRF Category/ Issue	Review Recommendation	Review Report/ Paragraph	LV Response (status of implementation)	Chapter/Section in the NIR
LULUCF	4.A Forest land, 4.B Cropland, 4.C Grassland	-Development of capacity to estimate SOC change in mineral soils for both agricultural and forest soils. For forest data on decomposition may be needed, although Finland data may be appropriate (to be discussed with finish colleagues in the bilateral activities). An alternative to be studied is to check for the existence of more detailed historical data regarding for soil C or humus content (%) at soil science or agro-pedology institute. Such data should have metadata, including soil management and land use. It can be used to derive country specific 'C stock change factors.....'. Another alternative is to wait for EU LUCAS to produce such factors.	LULUCF, KP-LULUCF third part review	Improvement (evaluation of carbon stock changes in croplands and grasslands) planned within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy". Field data collection and analyses are done, scientific publication is under preparation. After publishing the results will be implemented in the GHG calculations. It is proposed to implement Yasso model in forest land, cropland and grassland on dry mineral soils to obtain information on carbon stock changes in soil. Results of our research show that EU LUCAS data are not suitable for calculation of carbon stock changes in soils for preparation of GHG inventory or other reports related to Climate Convention or the Kyoto Protocol.	Chapter 6, Section 6.4, 6.5 and 6.6
	4.A Forest land	Develop age dependent BEFs for major forest types/species. This is crucial for GHG inventory and projections, e.g. for FMRL (both for CP2, CP3) insofar as a model would be used for that. Majority of empiric forest models work with commercial or stem volume and BEFs as main inputs. This is feasible as long as tree biomass equations are under development in the country, while volume of commercial wood (or any other wood volume based parameter) are available. BEFs for stand age can be derived both for	LULUCF, KP-LULUCF third part review	Country specific BEFs for coniferous and deciduous trees are implement, but development of more accurate and growing stock dependent coefficients and equations for biomass calculation is in final stage.	Chapter 6, Section 6.4

Sector	CRF Category/ Issue	Review Recommendation	Review Report/ Paragraph	LV Response (status of implementation)	Chapter/Section in the NIR
		standing stock between volume and total biomass, or for annual increment by arithmetic in successive NFIs measurements for all ages and species.			

PART 2: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

11 KP-LULUCF

In 2015 Latvia made an inventory submission under UNFCCC, but not under Kyoto Protocol because the CRF Reporter could not deliver CRF tables for Kyoto Protocol LULUCF activities without errors. Even if minor inconsistencies may still exist in the reporting tables the present report is the official inventory submission of Latvia for the year 2016 under the UNFCCC and for the years 2015 and 2016 under the Kyoto Protocol.

11.1 GENERAL INFORMATION

11.1.1 Definition of forest and any other criteria

The applied forest definition for the reporting is harmonized with the definition used within the NFI. The same forest definition is used in relevant chapters of the LULUCF sector reporting. The selected parameters are presented in Table 11.1. Additional criteria defined by the Forest Law of Latvia[256] are width of rows of trees of artificial or natural origin – they should be at least 20 m wide to be accounted as a forest. The whole country is considered as one sub-division in the reporting.

Table 11.1 Selected parameters defining forest in Latvia for the reporting

Parameter	Range in FAO definition	Value
Minimum land area	0.05-1 ha	0.1 ha
Minimum crown cover	10-30 %	20 %
Minimum height	2-5 m	5 m

Forest roads, cleared tracts, fire-breaks, seed orchards and other forest infrastructure with permanently removed vegetation and/or fertile soil layer are excluded from forest and are accounted under settlements; respectively, building of the forest road or drainage system is accounted as deforestation. Forest definition for the 2nd commitment period is not changed since the 1st commitment period.

11.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

Latvia reported Forest management in the 1st commitment period and all lands reported under forest management in the 1st commitment are included in the Forest management accounting in 2nd commitment period, except deforested lands reported under activities of Article 3, paragraph 3, of the Kyoto Protocol. All afforested and deforested lands reported in the 1st commitment periods are represented in the 2nd commitment period as afforestation, deforestation or forest management. The latest category consists of naturally afforested lands, which are reported as land converted to forest land under the UNFCCC and forest management under the KP reporting. Afforested lands, where natural forest regeneration methods are applied, active forest management takes place and forest owner completed

[256] *Latvijas Republikas Saeima, "Meža likums, 2000. (Forest law)", published in 24.02.2000.*

legal procedure of the land use change, are reported under the Afforestation activities. Activity data for this category is delivered by the State forest service (stand wise forest register) and National forest inventory (land use history).

Latvia reports mandatory land activities of ARDFM. It elected to report forest management under the KP 3.4 activities for the 2nd commitment period.

11.1.3 Application of natural disturbance provision on Article 3.3 activities and Forest Management

Latvia is not reporting natural disturbances; therefore, accounting of lands reported under natural disturbances is not necessary, neither for AR nor for FM.

11.1.4 Description of how the definitions of each activity under Article 3.3 and each mandatory and elected activity under Article 3.4 have been implemented and applied consistently over time

On the basis of the definitions provided in the Decision 19/CMP.136, afforestation and reforestation that take place on agricultural land have to be included in the Article 3.3: a common forest management approach in Latvia is exploitation of natural re-growth by seeds of adjacent trees in forest regeneration and afforestation. In addition these transitions are essentially due to political decisions under the EEC Regulations 2080/92 and 1257/99 (art.10.1 and 31.1). However, only planted trees and managed forest stands, where natural regeneration is applied as the afforestation method, are reported under afforestation. The information is provided by the NFI and State forest service. The rest of afforested lands are reported under forest management in the KP reporting.

Concerning deforestation activities, as mentioned above, in Latvia land use changes from forest to other land use categories are allowed in very limited circumstances; however, due to large share of forest lands the most of economic activities associated with building of new infrastructure takes place on forest lands. The most common type of land use change in this reporting is construction of forest roads which is not considered as land use change according to national legislation but from the point of view of emissions it is land use change. Conversion to agricultural land occurs to less extent and generally is associated with removal of woody vegetation from abandoned farmlands and it was more common in 1990s.

Latvia does not apply carbon equivalent forest conversion (CEFC).

11.1.5 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

Under Article 3.4 activities Latvia reports only forest management; respectively, there is no need to build up a hierarchy between forest management and other Article 3.4 activities (i.e. forest has anyway higher hierarchical position in classification of activities on land).

11.2 LAND-RELATED INFORMATION

11.2.1 Spatial assessment unit used for determining the area of the units of land under Article 3.3

Latvia implements spatial explicit approach (Reporting approach 3 according to the 2006 IPCC Guidelines Chapter 3.3.1 and Reporting method 1 according to 2013 KP supplement) in reporting of lands subject to Article 3.3. and Article 3.4 activities. The approach is consistent with calculations of land use changes under the LULUCF sector reporting. The spatial assessment units for the submission of the Kyoto Protocol and LULUCF sector report cover the entire territory of Latvia. Latvia is mapping land use to 0.1 ha for afforestation, reforestation and deforestation.

11.2.2 Methodology used to develop the land transition matrix

The land use matrix is based on the results of land use changes to forest derived from the NFI of the period 2004-2008 and 2009-2013 and 2010-2014. Methodology for estimation of earlier land use changes, including deforestation activities is under development in the LSFRI Silava as a part of National Forest inventory (NFI). The assessment methods at the NFI grid points are described above. Estimation of afforested and deforested area in 2014 is based on extrapolation of the NFI data and the research results.

Historical figures of deforestation were estimated using remote sensing methods. LANDSAT satellite image series from 1990, 1995 and 2000 were geographically referenced to fit to the actual location of sample plots before satellite image analysis and non-guided classification of vegetation types was done using ERDAS Imagine software.

Cumulative information on area accounted under forest management, deforestation, afforestation and reforestation is provided in Table 11.2.

Table 11.2 Summary of area under forest management, afforestation & reforestation and deforestation accounting (kha)

[7. KP LULUCF][NIR-2]	Remaining afforestation and reforestation	Remaining deforestation	Remaining forest management
1990	0.23	2.5	3123.99
1991	0.96	5	3127.6
1992	2.91	7.5	3132.38
1993	5.29	10	3138.2
1994	6.83	12.5	3142.85
1995	8.79	14.99	3151.47
1996	11.33	16.26	3162.06
1997	13.74	17.52	3171.5
1998	15.25	18.78	3182.7
1999	15.93	20.04	3193.26
2000	17.53	21.3	3204.6
2001	18.92	22.88	3217.74
2002	19.57	24.46	3229.16
2003	21.57	26.04	3236.33
2004	23.06	27.62	3247.89
2005	24.66	29.19	3257.19
2006	26.52	30.77	3263.13

[7. KP LULUCF][NIR-2]	Remaining afforestation and reforestation	Remaining deforestation	Remaining forest management
2007	27.4	32.35	3269.86
2008	32.36	33.93	3274.7
2009	34.58	36.23	3271.21
2010	37.38	38.52	3267.12
2011	39.98	40.82	3263.24
2012	40.94	43.12	3261
2013	40.94	45.41	3259.72
2014	40.94	50.57	3258.44

11.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

Since the geographical location of NFI sample plots is known, the results can be computed for geographically referenced areas. Geographical locations are identified by the coordinates of centres of the NFI sample plots.

The methodology for reporting is based on the NFI which uses a permanently below ground marked 4 x 4 km grid across all of Latvia with four permanent sample plots of 500 m^2 size at each grid point. Sample plots are split into up to 10 sectors if different land use categories or vegetation type in the same category are presented in a single plot. In total, 23583 sectors in 16383 sample plots (Figure 11.1) were used for calculations of land use and carbon stock changes in living and dead biomass. Number of sectors may change from cycle to cycle, because of land use changes. Borders of sample plots are constant all the time. Each sector in average represents about 400 ha of the country area including internal water bodies. ARD activities are accounted as long as the forest definition is met (minimum assessment unit 0.1 ha), except AR in extensively managed grassland and cropland, if the trees do not reach at least 2 m height, because growth of trees in such areas usually do not mean afforestation, but delayed grass cutting, as well as AR, if human induced afforestation cannot be approved (the main criteria are planting of trees or other early management activities targeted on increase of growing potential of the forest stand, afforestation is also considered in areas, where legal procedure of land use change is completed). The sizes of the sub-areas with different land use at the permanent sample plots need to be larger than 1/10 (> 30 m^2) of the total sample plot area to be assessed. If this precondition is met the polygon that divides the different areas of land uses within the sub-plot is measured using polar-coordinates. At a site, sketches are drawn and the polygon data are entered into the geographic information system of the portable input device. If the former border line can be recognized in the follow-up NFI cycle, it is kept.

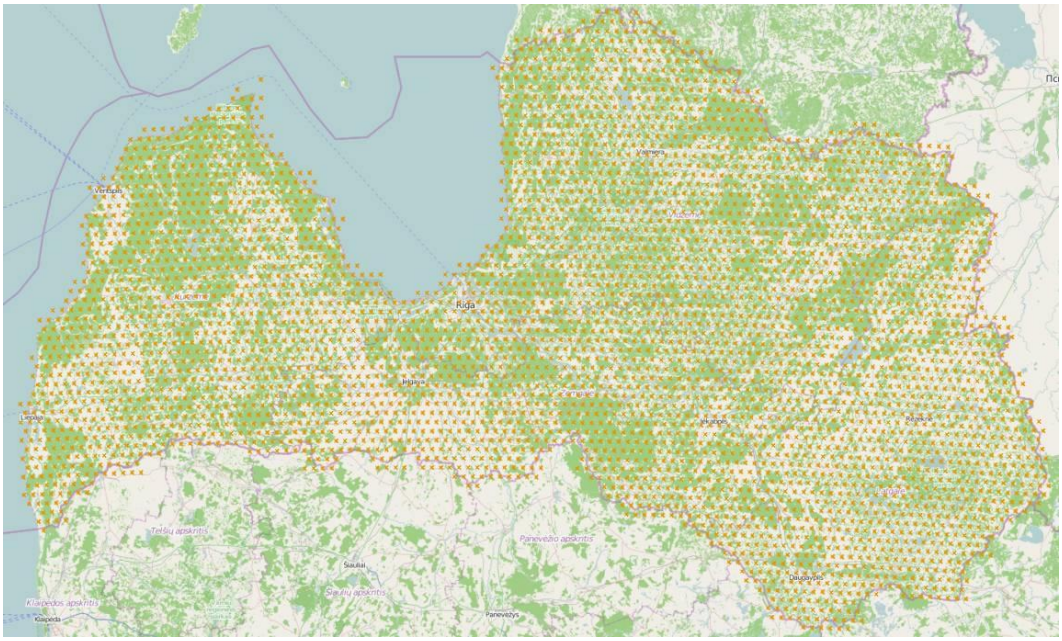

Figure 11.1 Permanent grid of the forest inventory plots

During the 2nd NFI cycle the fact of afforestation and deforestation is fixed mathematically by accounting area of sectors, where land use category is changed from one type to another and multiplying by area (in ha) represented by 1 m^2 of sample plots. Uncertainty is determined as error of proportion. The method is not fully implemented and in many cases land use changes should be determined manually (when 2 or more sectors representing different land uses are merged into new sector). GIS tools will be used in further inventories to process land use information as well as information on destiny of every single tree – if it is cut due to deforestation or just accounted under another land use category. So the calculation will be done in 2 levels – land use and destiny of trees.

Changes in forest area were detected on the basis of the NFI data. The following afforestation/reforestation activities that occurred or could have occurred on or after 1990 are included in the reporting of these activities:

- planted or seeded grassland;
- abandoned grassland which are afforested and converted to forest lands.

In Latvia all land use categories (cropland, grassland, forest, settlements and wetlands) are considered managed; therefore any land use change occurs between in lands and, consequently, is direct human-induced.

Afforested/reforested areas are to be considered legally bound by national legislation. Usually these activities have resulted from a decision to change the land use by planting or seeding or managing of afforested lands.

11.3 ACTIVITY-SPECIFIC INFORMATION

11.3.1 Methods for carbon stock change and GHG emission and removal estimates

The National Forest Inventory (NFI) of Latvia is the main data provider for the GHG reporting in LULUCF sector and Kyoto protocol Article 3, paragraph 3 and Article 3, paragraph 4 activities.

Soil properties (carbon stock in litter and mineral soil) in forest lands was determined in permanent 16 x 16 km grid of 95 sample plots of the 1st level forest monitoring programme (Figure 11.2). The results of forest soil monitoring demonstrate that mineral soils in forest lands are not a source of emissions, but can be a net sink. However, number of plots is insufficient to finalize conclusions about carbon stock change in forest lands. The increase of number of plots to 210 is proposed in the Forest monitoring programme providing more accurate data on soil carbon stock changes in forest lands. No soil carbon stock changes are considered in afforested lands, according to research data demonstrating insignificant carbon stock differences in forest land and grassland.

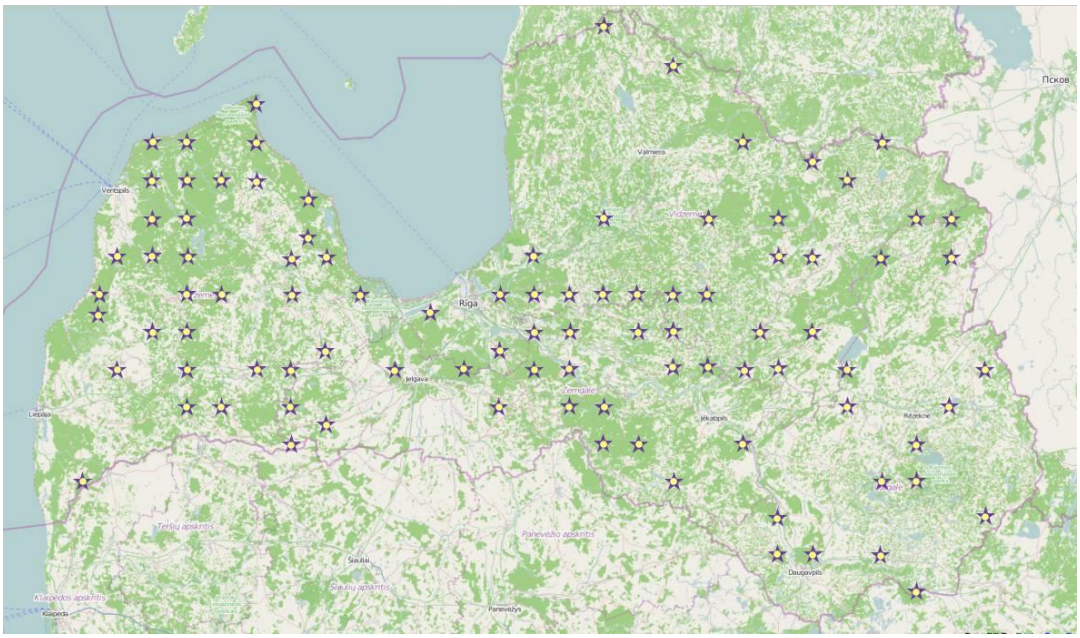

Figure 11.2 Permanent grid of the Level 1 forest monitoring plots

11.3.1.1 Description of the methodologies and the underlying assumptions used

Methods for estimating carbon stock changes in forests (for Article 3.3 afforestation, reforestation, deforestation and Article 3.4 forest management) are the same as those used for the LULUCF inventory reported under the UNFCCC. Estimations of carbon stock changes in living biomass on forest land remaining forest in the 1st cycle of the NFI are based on measurements of radial increment of growing trees and calculation of actual potential increment of timber volume of all living trees; in the second period, increment is calculated as stock difference of living trees; mortality is accounted as the stock of trees changing status (destiny) from living trees to dead and left in the stand; harvesting stock is accounted as stock of trees changing status (destiny) to dead and extracted. The NFI data are harmonized with the State forest service data provided information by application of linear

factor (+26 %) to the whole accounting period, because the basics of the methodology used for calculation of harvesting stock in SFS is not changed for several decades.

The destiny of trees or change of status of tree is classified as follows:

- Living trees:
    - Still growing (trees remaining alive since the previous NFI cycle),
    - Ingrowth (new trees appearing in the NFI plot, measured first time),
- Commercial harvesting:
    - Harvested and extracted (living trees in previous NFI cycle, removed from the plot between previous and current measurement),
    - Diseased and extracted (mostly dead standing or laying trees in previous NFI cycle, removed from the plot between previous and current measurement),
- Mortality:
    - Harvested and left (living trees in previous NFI cycle, cut but left in the plot between previous and current measurement, mostly undergrowth trees),
    - Diseased (dry) and left (living trees in previous NFI cycle),
    - Thrown out (by wind) and left (living trees in previous NFI cycle, uprooted by wind),
    - Broken, dead (living trees in previous NFI cycle),
    - Eaten by beavers (living trees in previous NFI cycle, specific and common type of damages),
    - Broken top, living tree (such trees are accounted as 2 pieces – as living tree and dead wood).

There are 3 categories of dead trees, including dead standing trees, which might change their destiny to dead laying trees or rotten parts of trees. This conversion is excluded from mortality accounting.

Since research data are available, historical figures on mortality are recalculated and provided in the inventory considering 20 years decay period for dead biomass, respectively; calculations are done for the period 1970-2013. Removals of CO_2 in living biomass on afforested areas are calculated on the base of weighted average of timber stock changes in 1-25 years old forest stands on non-forest lands.

The difference between the SFS and NFI is not due to illegal felling. The permissions for timber extraction are given for area and the area of final felling is the same in NFI and SFS reports. There is considerably higher growing stock reported under the NFI and, respectively, extracted volumes. Additional timber, which does not appear in statistics of production of sawn products, is generally used as firewood in households and other small scale applications. The findings of NFI on additional harvested volumes fully comply with energy sector statistics considered overestimated in utilization of solid biofuel.

No harvesting takes place in lands converted to forests; therefore no artificial emissions in living biomass are reported in this category. However if by some reasons (for instance, thinning) harvesting took place on afforested area it is also reported in national statistics and is included in Forest management related carbon stock changes. Therefore there is no risk of underestimation of emissions from living biomass.

Losses in living and dead biomass due to deforestation are reported based on average growing stock in forest land. The method as well as the values used in calculations is explained in details in previous sections. All biomass, including stem, branches and below-ground biomass is considered instantly oxidized.

Carbon stock changes in dead wood, litter and soils are reported under deforestation assuming that average carbon stock on forest lands remaining forest in dead biomass pools is instantly oxidizing during conversion, but carbon soil in mineral soils stabilizes in 20 years. For conversion to settlements it is assumed that 20 % of carbon in 0-30 cm deep soil layer turns into emissions in 20 years. The methods are described in previous sections under Croplands and Settlements categories.

The most important changes due to implementation of the 2006 IPCC Guidelines and IPCC Wetlands Supplement are changes in emission factors for CO_2, N_2O and CH_4 for drained organic soils, updates in calculation of harvested wood products and carbon losses in soil due to disturbances caused by land use conversion from forest land to settlements and cropland.

11.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected and mandatory activities under Article 3.4

According to the NFI conversions to forestland that can be classified as afforestation/reforestation take place only on grasslands. The soil monitoring study initiated in 2012 by the Joint stock company "Latvia state forests" and Ministry of Agriculture demonstrates no statistically significant difference in carbon stock in mineral soil in grassland, forest land remaining forest in fertile stand types and in afforested lands, i.e. no changes appear in soil organic matter (SOM) due to afforestation. The results are based on 95 plots in forest, 34 plots in afforested lands and 40 plots in grassland; for each plot 4 repetitions have been taken.

It is assumed in calculation of carbon stock changes in afforested lands, that dead wood and litter will reach values characteristic for the forest lands (average figures of the 1st cycle of the NFI and 2nd round of forest soil monitoring, representing the same time period) in 150 years, which is twice average rotation of the most common tree species in afforested lands (birch and spruce). The rationale behind selection of 150 long transition period is decomposition of dead wood, which reach equality with forest lands at the end of the second rotation; however, this expert judgement will be evaluated in future using field measurement data.

Data from the BioSoil net (95 plots) have been elaborated for the years 2006 and 2012 putting together the mineral soil and litter pools and then analyzing the trend in changes of the total carbon stock and its significance. The result shows that there is no statistically significant difference in total carbon stock between 2006 and 2012, respectively no carbon

stock changes in these pools can be reported. This represents a quantitative demonstration that soil is neither sink nor a source of CO_2 on short term.

The litter and soil pools have been analyzed altogether since the separation of humic layers in the year 2006 and in the year 2012 have not been done following the same methodology, so that data on litter and data on soil cannot be compared among those 2 years. However, the accumulation of litter is always associated with increase of humic layer, and, vice versa, a decrease or a removal of litter causes a decrease of humic layers and therefore of soil carbon stocks in the soil carbon pool, as defined in the 2006 IPCC Guidelines. Consequently, whether the litter stock increases also the soil stock increases and vice versa, to a decrease in litter stock a decrease in soil stocks (humic layers) follows. Therefore, the analysis conducted on the sum of both pools giving information on the total trends gives also the needed information on the trend of both pools i.e. if the sum of litter and soil is not a source then both, the litter and the soil are not a source.

Emissions from natural and controlled biomass burning due to are estimated according to methodology described in section Biomass Burning.

11.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

It is recognized that:

- for Article 3, paragraph 4 activities, the issue of "factoring out" was solved during negotiations with the cap for Forest Management and with the net-net accounting for the other Article 3, paragraph 4 activities;
- for Article 3, paragraph 3 activities, the dynamic effect of age is not relevant since all these activities have occurred after 1990;
- for the elevated CO_2 concentration and the indirect nitrogen deposition, there are no methodologies adopted by the UNFCCC.

N_2O emissions associated with conversion to cropland are reported using the methodology provided in the 2006 IPCC Guidelines and IPCC Wetlands Supplement, for organic soil. Carbon stock changes for calculation of the emission factor are taken from losses of soil organic carbon stock due to conversion for mineral soils and constant emissions factor (7.9 tonnes C ha^{-1}) is used for organic soils[257]. Also for grasslands and wetlands (accounted as rewetted non-forest lands) the default emission factors are used, respectively 6.1 and 0.5 tonnes C ha^{-1}.

11.3.1.4 Changes in data and methods since the previous submission (recalculations)

Implementation of changes due to use of 2006 IPCC Guidelines and IPCC Wetlands Supplement for certain categories and implementation of the 2nd cycle and floating cycle of the NFI for 2014 continued this year, particularly area of forest land is recalculated due to review of land use categories in the NFI plots.

[257] *According to 2013 SUPPLEMENT, TABLE 2.1 TIER 1 CO2 EMISSION/REMOVAL FACTORS FOR DRAINED ORGANIC SOILS IN ALL LAND-USE CATEGORIES (Cropland, drained, boreal and temperate).*

Methodological consistency between the reference level and reporting for forest management during the 2nd commitment period, including the area accounted for the treatment of harvested wood products is secured by implementation of the same methodological approaches for the whole accounting period and recalculation of the whole time series according to a new methodology. A technical correction to FMRL would be recalculated because of reasons highlighted above, in a consistent way.

It is planned to implement country specific method for estimation of FMRL and recalculation of historical data affecting the FMRL, This issue is under consideration currently, while new data is coming out from NFI and other sources.

11.3.1.5 Uncertainty estimates

Uncertainty estimates are described under corresponding LULUCF chapters of NIR.

11.3.1.6 Information on other methodological issues

The methodology used for reporting under the Kyoto Protocol is described in detail in previous sections.

11.3.1.7 The year of the onset of an activity, if after 2013

The starting year of the activities reported can directly be derived from the land-use change matrix (Table 6.9). The activities in the 2nd commitment period are reported starting with 2013.

11.4 ARTICLE 3.3

11.4.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

Changes in forest area were detected on the basis of the NFI data. The following afforestation/reforestation activities that occurred or could have occurred on or after 1990 are included in the reporting of these activities:

- trees planted or sown on grassland or abandoned cropland;
- afforested lands where management activities (tending, thinning, soil scarification) are identified by the NFI teams;
- grassland, where natural regeneration methods are used to proceed afforestation and human induced forest management is approved by official land use transformation in land use register.

11.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

In Latvia temporarily unstocked areas (e.g. harvested area) remain forests and are not accounted as deforestation if no other activities prohibiting forest regeneration are implemented. The NFI teams are trained to distinguish between forest management and land use changes. The legal requirements for the forest regeneration are to reach certain

dimensions and density of trees within 5-10 years, depending on forest site type. Normally these requirements will not be reached only in case of flooding or human induced prohibiting of forest regeneration, like building of asphalted road. In such cases conversion to non-forest land can be easily identified. In all other cases it is decided to use the same approach as for conversion from cropland to grassland and backward – if land use change is approved within 2 NFI cycles, the land use change is recorded. Identification of transition in such cases takes 10 years, which complies with the legally permitted forest regeneration period for the most of forest stand types. Afforested areas fulfil the criteria for the forest definition used in the Latvia's NFI, which besides other threshold values is minimum width of 20 m.

Deforested areas can be detected by two combined characteristics:

- the forest definition of Latvia's NFI does not apply (as described above within 2 NFI cycles, the identification of conversion takes 10 years);
- there are significant visible changes in soil structure or ground vegetation which do not complies with the natural succession of a forest (consequences of anthropogenic activities like ploughing, crop production, mowing or construction activities or natural abortion of the forest and its stand by e.g. landslides, the identification of conversion takes 5 years).

Deforestation includes artificial measures prohibiting regeneration of unstocked forest lands. In any natural conditions forests can regenerate, except, for instance, flooding or formation of dunes.

Deforestation and relevant land use changes (construction of forest roads) are regulated by national laws.

Restocking is assumed for forest areas that have lost forest cover through harvesting or forest disturbance, unless there is deforestation as described above.

11.4.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

Information on the size and location of forest areas that have permanently lost forest cover (due to a tillage or construction) is collected on 5 years period basis by the NFI. These data can be validated by national statistics; however, no historical records since 1990 are available for statistics and only recent data can be used for the validation.

11.4.4 Information related to the natural disturbances provision under Article 3.3

Latvia is decided not to report natural disturbances, because trees diseased due to natural disturbances are usually extracted in salvage logging (sanitary clear-felling or thinning); therefore, accounting of lands reported under natural disturbances is not necessary or even possible due to salvage logging, neither for AR nor for FM.

11.4.5 Information on Harvested Wood Products under Article 3.3

The emissions from the harvested wood products pool that have been accounted during the 1st commitment period were not accounted on the basis of instantaneous oxidation;

respectively, they should not be excluded from the accounting for the 2nd commitment period.

Harvested wood products resulting from deforestation have been accounted on the basis of instantaneous oxidation using proportion approach; respectively, if the projected felling stock in deforested areas is 1 % of the total felling stock, the proportion of harvested wood products to which the instant oxidation approach is applied is 1 %.

The carbon dioxide emissions from harvested wood products in solid waste disposal sites are not accounted, and the carbon dioxide emissions from wood harvested for energy purposes have been accounted on the basis of instantaneous oxidation under carbon losses from living biomass.

11.5 ARTICLE 3.4

11.5.1 Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

The area of forest land reported for Afforestation/Reforestation and Deforestation under the Kyoto Protocol is not equal to the area reported for Land use changes from and to forests in the UNFCCC greenhouse gas inventory, because lands afforested / deforested in 1990-1993 already completed 20 years transition period and under the UNFCCC greenhouse gas inventory they are accounted under land use categories retaining their land use status, respectively, lands afforested in 1990-1993 are reported in 2010-2014 under the forest land remaining forest land category. In the Kyoto protocol reporting transition period is not considered; therefore, afforested lands will always be afforested lands, except the case if they are deforested in future. The total area of forest lands, however, is the same in the both reports. All land use changes from and to forests take place on managed lands and therefore are considered to be human induced.

All forests are considered as managed land. Forest management activity is practised on the forest area as defined above.

The Forest law lays down provisions on management and utilisation of forest. Afforested lands are also considered as subjects of forest law apart from reason of afforestation. Therefore all afforested lands are also considered managed.

11.5.2 Information relating to Forest Management

According to the Forest law[258] forest management in Latvia is sustainable utilization and management of forests and forest resources to preserve biodiversity, productivity and vitality of forests as well as ability to regenerate, while providing economic, social and cultural opportunities for the benefit of present and future generations. Consequently, all forests, as well as all forest lands according to national definitions are considered as managed land. Forest management activity is practiced on the forest area (forest stands) as defined above. The area of forest land and the area under forest management (forest land remaining forest) in the end of 2014 decreased in comparison to 1989 because of

[258] *Latvijas Republikas Saeima, "Meža likums, 2000."*

deforestation; however, total area reported under forest management is increasing due to reporting of naturally lands, where no commercial activities takes place, under forest management.

The Forest law lays down provisions on management and utilization of forest. Afforested lands are also considered as subjects of forest law apart from reason of afforestation. Therefore all afforested lands are also considered managed. The purpose of the Law is to promote economically, ecologically and socially sustainable management and utilization of the forests in such a way that forests provide a sustainable satisfactory yield while biological diversity is being maintained.

11.5.2.1 Conversion of natural forest to planted forest

No emissions arising from the conversion of natural forests to planted forests are accounted for, because no such kind of activities takes place in Latvia in accordance with any supplementary methodological guidance developed by the IPCC.

11.5.2.2 Forest Management Reference Level (FMRL)

Latvia's forest management reference level is -16.302 Mt CO_2 eq. and -14.255 Mt CO_2 eq. (including harvested wood products) as inscribed in the appendix to the annex to decision 2/CMP.7. Latvia will make technical corrections for the forest management reference level according the requirements of decision 2/CMP.7 and 2/CMP.8.

11.5.2.3 Technical Corrections of FMRL

The need for Technical Correction is determined by following reasons:

- The method used for GHG reporting changed after the adoption of FMRL as part of improving inventory quality and due to conversion of calculations from the IPCC GPG LULUCF 2003 to 2006 IPCC Guidelines and IPCC Wetlands Supplement. For instance, emission factors for organic soil (CO_2 and N_2O) are changed. Emission factors for biomass burning are also changed due to implement of the new guidelines. The inconsistency in calculation of the dead wood stock is found in the previous inventory report during the quality assurance procedures, leading to considerable overestimation of carbon stock changes in dead wood due to deforestation and afforestation, as well as biomass burning. These changes lead to a recalculated time series that also lead to an inconsistency between FMRL and reporting of FM in the second commitment period;
- New non-CO_2 GHG sources are included in reporting for FM in the second commitment period. For instance, calculation of CH_4 emissions from drained organic soils, drainage systems and rewetted soils are introduced in the current inventory;
- Recalculated historical data was done for the most important parameters, like increment of living biomass, mortality and commercial felling due to availability of data from the NFI 2nd cycle. Commercial felling stock was increased by 26 %, mortality – by 21 %, increment of living biomass was reduced by 0.1 %. The NFI data are compiled once in a 5 year period. Since the data on land use changes from the 2nd NFI cycle is available in this inventory, deforested area for the last 5 years period, as

well as distribution of drained and rewetted soils is recalculated and Technical Correction is necessary to include new information in the FMRL;

- The accounting of HWP has been also improved since estimation of the FMRL which was submitted before Decision 2/CMP.7 and Technical Correction related to HWP are also necessary.

In 2014 the Technical Correction of Latvia`s FMRL was calculated by European Commission's Joint Research Centre (JRC) and constituted 9.922 Mt CO_2 eq.

Technical Correction is done on the basis of the FMRL considering instantaneous oxidation for HWP. Tehnical Correction was calculated based on a model re-calibration. A full re-run of the model will be carried in the future to allow Latvia to implement a complete Technical Correction.

11.5.2.4 Information related to the natural disturbances provision under Article 3.4

Latvia does not intend to apply the Natural Disturbance provision, respectively, annual emissions resulting from natural disturbances and the subsequent removals during the commitment period in those areas are not estimated and not excluded from the accounting for forest management under Article 3, paragraph 4, of the Kyoto Protocol during the second commitment period.

11.5.2.5 Information on Harvested Wood Products under Article 3.4

Current forest management reference level (FMRL) is based on a projection; the emissions from harvested wood products originating from forests prior to the start of the second commitment period have been included in the accounting.

The emissions and removals resulting from changes in the harvested wood products pool do not include imported harvested wood products, irrespective of their origin. FAOSTAT data are used to identify share of imported harvested wood products. Calculations are done according to IPCC KP Supplement and scientifically verified methodology[259].

Emissions from harvested wood products originating from forests prior to the start of the 2nd commitment period have been calculated in the reference level in accordance with decision 2/CMP.7, annex, paragraph 16. The methodology for calculation of harvested wood products is based on IPCC KP Supplement[260] and earlier studies on the forest management reference level[261]. Half-lives are based on table 3a.1.3 of the IPCC GPG LULUCF 2003 of two years for paper, 25 years for wood panels and 35 years for sawn wood. Instant oxidation is considered for biomass originated in deforested areas.

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[259] T. Hiraishi et al., eds., "Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol" (IPCC, Switzerland, 2013), http://www.ipcc-nggip.iges.or.jp/public/kpsg/pdf/KP_Supplement_Entire_Report.pdf; Andis Lazdiņš and Līga Strūve, "Contribution of Harvested Wood Products to Greenhouse Gas Emissions due to Forest Management in Latvia," in Mežzinātne. Special Issue. Abstracts for International Conferences Organized by LSFRI Silava in Cooperation with SNS and IUFRO, vol. 25 (58) (presented at the OSCAR 2012, Riga: LSFRI Silava, 2012), 79–82; Sebastian Rüter, Projection of Net-Emissions from Harvested Wood Products in European Countries (Hamburg, 2011), Hamburg.

[260] T. Hiraishi et al., eds., "Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol" (IPCC, Switzerland, 2013), http://www.ipcc-nggip.iges.or.jp/public/kpsg/pdf/KP_Supplement_Entire_Report.pdf.

[261] Sebastian Rüter, Projection of Net-Emissions from Harvested Wood Products in European Countries (Hamburg, 2011), Hamburg; Andis Lazdiņš and Līga Strūve, "Contribution of Harvested Wood Products to Greenhouse Gas Emissions due to Forest Management in Latvia," in Mežzinātne. Special Issue. Abstracts for International Conferences Organized by LSFRI Silava in Cooperation with SNS and IUFRO, vol. 25 (58) (presented at the OSCAR 2012, Riga: LSFRI Silava, 2012), 79–82.

Activity data for the harvested wood products categories used for estimating the harvested wood products pool removed from domestic forests, for domestic consumption and for export are obtained in FAOSTAT and verified by internal research data and expert judgements.

Half-lives used in estimation of the emissions and removals for these categories are in accordance with decision 2/CMP.7, annex; respectively 2 years for pulp-wood, 15 years for plate-wood and 25 years for sawn-wood.

11.5.3 Information relating to Cropland Management, Grazing Land Management, Revegetation and Wetland Drainage and Rewetting if elected, for the base year

Not relevant.

11.6 OTHER INFORMATION

11.6.1 Key category analysis for Article 3.3 activities, forest management and any elected activities under Article 3.4

In 2014, net annual emissions from forest management, afforestation, reforestation and deforestation activities were 886.78 kilotons of CO_2 eq. This value is the total of all emissions and removals from activities under Article 3.3 (Figure 11.3 and Figure 11.4) and forest management activity under Article 3.4 of the Kyoto Protocol and includes: removals from the growth of forest and emissions from the conversion of land to forest after 1989; emissions from harvesting of forest remaining forest since 1990; emissions and removals from harvested wood products from forest land; emissions from deforestation; emissions from biomass burning due to natural forest fires and incineration of harvesting residues, mineralization of soil nitrogen associated with afforestation or deforestation since 1990 and management of organic soils in forest land, afforested or reforested land and deforested land.

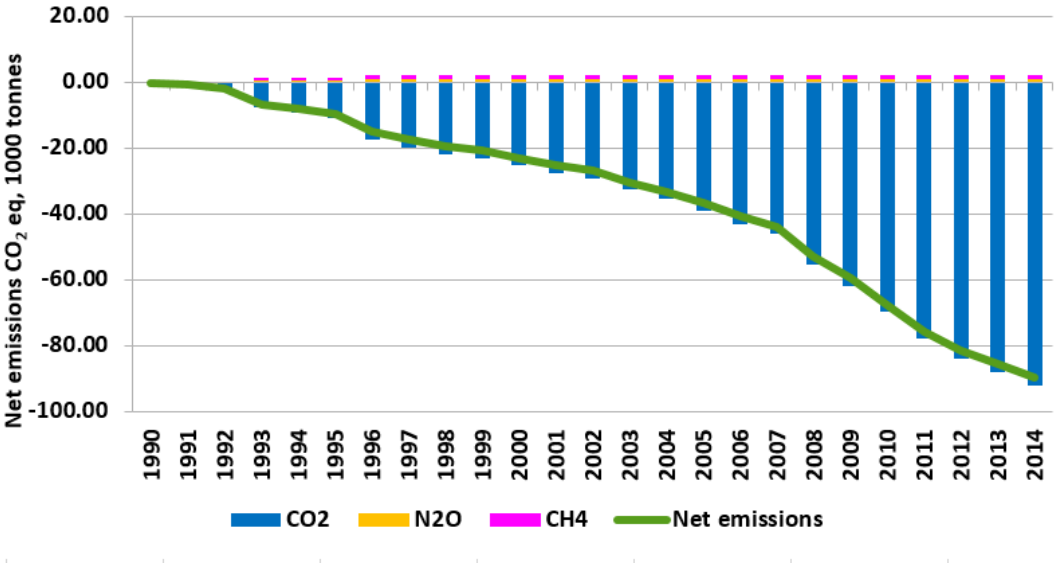

Figure 11.3 GHG emissions due to afforestation

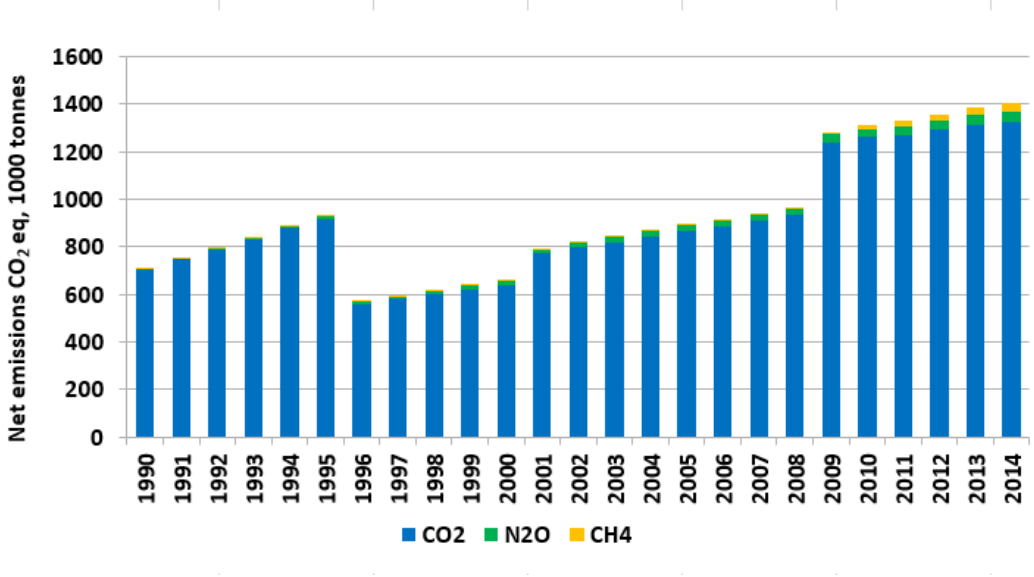

Figure 11.4 GHG emissions due to deforestation

Removals of CO_2 in living biomass is the most significant driver to have negative balance of the net GHG emissions during the reporting period; however, with reduction of CO_2 removals the role of other GHGs increases, particularly, N_2O emissions from organic soil is a key source of emissions (Figure 11.5).

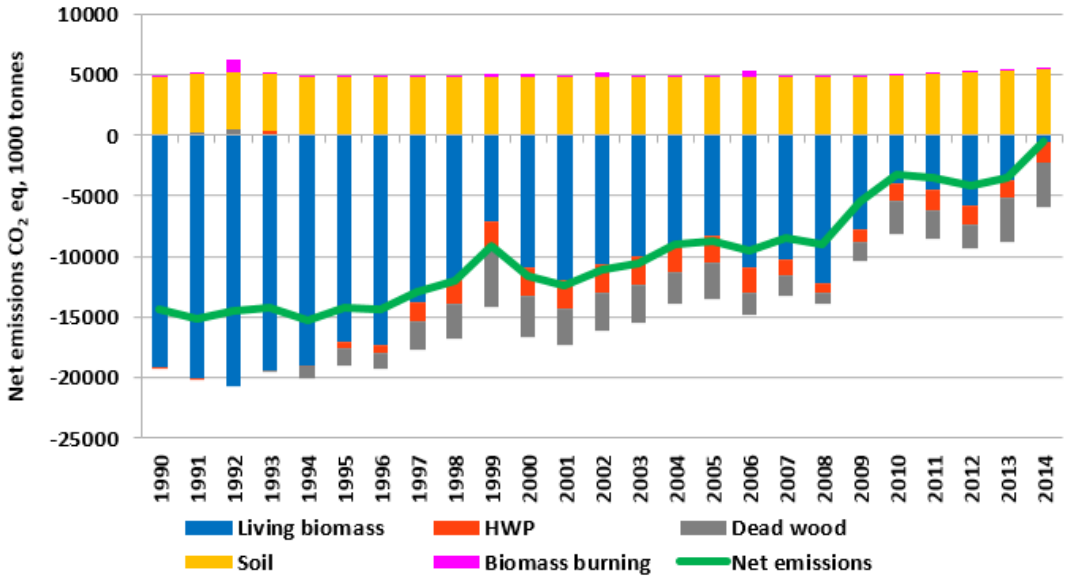

Figure 11.5 GHG emissions due to forest management

11.7 INFORMATION RELATING TO ARTICLE 6

There are no lands subject to Article 3.3 and Article 3.4 activities which are also subject to projects under Article 6.

12 INFORMATION ON ACCOUNTING OF KYOTO UNITS

12.1 Background information

Chapter 12 and 14 include information on the Latvia's emission trading registry. The accounting on Kyoto units and the public available information is described in chapter 12. Any significant changes in the national registry are reported in chapter 14.

The standard electronic format tables are included in the submission (see "RREG1_LV_2015.xlsx" attached to the submission). The SEF tables include information on the AAU, ERU, CER, t-CER, l-CER and RMU in the Latvia's registry on 31.12.2015 as well as information on transfers of the units in 2015 to and from other Parties of the Kyoto Protocol.

12.2 Summary of information reported in the SEF tables

According to decision 15/CMP.1, annex, part 1, section E each Party must include information on its aggregate holdings and transactions of Kyoto units in its annual report. The information has to be reported in the Standard Electronic Format (SEF), which is an agreed format, embodied in a special report, for reporting on Kyoto units.

The SEF for 2015 was generated on 7 January 2016 with the Union registry in version 6.7.3, provided by the EU commission on 03.08.2015 and the SEF application version 3.6.1, provided by the secretariat at 23.11.2015.

At the beginning of the 2015 there were 66 332 433 AAUs, 418 607 ERUs, 322 904 CERs in the Party holding accounts and 5 317 ERUs, 21 550 CERs were held in entity holding accounts. At the beginning of 2015 10 499 146 EUAs, 848 191 CERs and 49 013 ERUs were stored in Retirement account.

At the end of 2015 28 249 726 AAUs were left in National holding accounts and 21 550 CERs and 5 317 ERUs were held in the entity holding accounts.

48 478 397 EUAs_AAUs, 490 531 ERUs, 6 233 333 RMUs and 1 251 640 CERs were left in Latvia's national retirement account during compliance period at the beginning of 2015 and therefore these allowances are also stored in Retirement account.

The registry did not contain any RMUs, t-CERs or l-CERs and no units were in the Article

3.3/3.4 net source cancellation accounts and the t-CER and l-CER replacement accounts.

Total of Kyoto protocol units 76 728 123 AAUs, 495 848 ERUs, 12 457 753 RMUs and 1 273 190 CERs were stored in the ETR accounts at the end of 2015.

Latvia's CP1 assigned amount is 119 182 130 tonnes CO_2 eq.

Full details are available in the SEF tables.

In year 2015 there were received the SEF comparison report "CR_RREG1_LV_2014" prepared by the international transaction log (ITL) administrator that provides information on the outcome of the comparison of data contained in the LV SEF tables with corresponding records contained in the ITL. There were not provided reports R2-R5 as there were no discrepancies in this report in 2014.

12.3 Discrepancies and notifications

12.3.1 List of discrepant transactions

No discrepant transactions rejected and / or terminated with the response codes that are considered to be a discrepancy for the purpose of the reporting occurred in 2015 in Latvia's ETR.

No transactions in Latvia's ETR were cancelled or terminated.

12.3.2 List of CDM notifications

CDM notifications – reversal of storage notifications, non-certification notifications were not received in the reporting period 2015.

12.3.3 List of non-replacements

No non-replacement occurred during reporting period 2015.

12.3.4 List of invalid units

There weren't any invalid units in Latvia's ETR in the reporting period from 1st January 2015 to 31st December 2015.

12.3.5 Actions and changes to address discrepancies

There weren't any discrepant transactions that were not terminated and / or cancelled in Latvia's ETR during reporting period 2015.

12.4 Publicly accessible information

The information required to be publicly accessible by the decisions 13/CMP/1 is available on the national administrator of Emission registry web page: http://www.meteo.lv/en/lapas/submission-under-unframework-of-climate-change-convention-conference-?id=1476&nid=646

As well as on the Emission Registry of Latvia public webpage:

https://ets-registry.webgate.ec.europa.eu/euregistry/LV/public/reports/publicReports.xhtml

The information on the accounts is also available on the European Commission webpage: http://ec.europa.eu/environment/ets/account.do;EUROPA_JSESSIONID=zyE_PpHqLkqmy0rOOeWALmfWfvpML4wVYw-l5j2-LwzuDy-fQcAX!-198553537?languageCode=lv&account.registryCodes=LV&accountHolder=&search=Search&searchType=account&currentSortSettings=

According to Article 44-48 of the decision 13CMP.1 Annex E the following information has to be publicly available:

Article 45 – Information about the accounts opened in Latvia's Emission trading registry, account types, account holders and contact persons has been published in file "Latvia's registry".

Article 46 – Information about Article 6 project against which the Party has issued ERUs.

Article 47 – Information of the Kyoto Protocol units in the Latvia's Emission Trading registry opened accounts as well as transactions of Kyoto Protocol units is submitted in Standard Electronic Format.

Article 48 - Legal entities authorized to participate in the mechanisms under Articles 6, 12 and 17 of the Kyoto Protocol.

12.5 Calculation of the commitment period reserve (CPR)

Parties are required by decision 11/CMP.1 under the Kyoto Protocol and paragraph 18 of Decision 1/CMP.8 to establish and maintain a commitment period reserve as part of their responsibility to manage and account for their assigned amount. The commitment period reserve equals the lower of either 90% of a Party's assigned amount pursuant to Article 3(7bis), (8) and (8bis) or 100% of its most recently reviewed inventory, multiplied by 8.

Both methods are used for calculation of commitment period reserve.

1) 100% of most recently reviewed inventory, multiplied by 8:

CPR = 10,979,650 tonnes CO_2 eq * 8 = 87,837,200 tonnes CO_2 eq.

2) 90% of a Latvia`s assigned amount pursuant to Article 3(7bis), (8) and (8bis):

CPR = 76,633,439 tonnes CO_2 eq * 90% = 68,970,095 tonnes CO_2 eq

The commitment period reserve equals the lower figure from both calculated, therefore Latvia`s commitment period reserve is 68,970,095 tonnes CO_2 eq.

12.6 KP-LULUCF accounting

Latvia has chosen accounting of all KP-LULUCF activities regarding Articles 3.3. (Aforestation, Reforestation and deforestation) and 3.4 (Forest Management) at the end of commitment period. Latvia has not elected any voluntary Kyoto Protocol LULUCF activities for the second commitment period.

Additions to the assigned amount resulting from forest management under Article 3, paragraph 4 (FM cap) in the second commitment shall not exceed 3.5 per of the base year emissions.

Latvias FM cap is calculated following:

26256.4348313065 tonnes CO_2 eq without LULUCF * 3,5 /100 = 918.975219095727 kt CO_2 eq = 918975.219095727 t CO_2 eq.

For the whole second commitment period the additions to the assigned amount resulting from Forest management can be 7351801.75276582 tonnes CO_2 eq.

13 INFORMATION ON CHANGES IN NATIONAL SYSTEM

According to the Cabinet of Ministers Regulation No. 217 "Regulations regarding the National Inventory System of Greenhouse Gas Emission Units" Latvian State Forest Research Institute "Silava" is responsible for GHG emissions from LULUCF and KP-LULUCF sectors at national level. For GHG inventory preparation regarding LULUCF and KP-LULUCF sectors the expert capacity has increased.

Capacity of expert`s knowledge in all GHG inventory sectors has also increased through experience sharing events within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy " in 2015 and 2016.

14 INFORMATION ON CHANGES IN NATIONAL REGISTRY

The following changes to the national registry of Latvia has occurred in 2015.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	No changes of name or contact information in the registry following 32(a) during the reported period and previous period.
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	There was no change to the database structure as it pertains to KP functionality in 2015. Versions of the CSEUR released after 6.3.3.2 (the production version at the time of the last Chapter 14 submission) introduced minor changes in the structure of the database. These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. The database model is provided in Annex A. No change to the capacity of the national registry occurred during the reported period. In NIR submission 2016 there are attached AnnexA_resubmission, AnnexB_resubmission and AnnexH_resubmission that contain changes referring to year 2014 and AnnexA, AnnexB that contains changes for year 2015. AnnexA_resubmission and AnnexA contain the same information as there are no changes in database structure in this reporting period comparing with previous year.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced since version 6.3.3.2 of the national registry are listed in Annex B. Each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex B). Annex H testing will be carried out in February 2016 and the test report will be submitted thereafter No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
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.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced since version 6.3.3.2 of the national registry are listed in Annex B. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex B. Annex H testing will be carried out in February 2016 and the test report will be submitted thereafter.
The previous Annual Review recommendations	See table below.

In response to the previous Annual Review recommendations and to the Standard Independent Assessment Report (IAR/2015/LVA/1/2 and IAR/2015/LVA/2/2), the following table was submitted as a second addendum to Chapter 14: 'Information on changes in national registry 'of the Annual Inventory Submission for the reporting year 2014.

Reference	Recommendation description	Response
P1.2.14	The Party didn't report the calculation of its commitment period reserve (CPR) in [NIR].	Latvia`s 2015 submission was the official submission under the UNFCCC. The 2015 submission was not an official submission under the Kyoto Protocol therefore calculation of the commitment period reserve has not been included in the 2015 NIR by Latvia. Information on CPR is included in this 2016 submission.
P1.4.1 P1.4.1.1. P1.4.1.2	The assessor was able to locate only information pertaining to operator holding accounts at the first link mentioned. No other information on Party holding accounts, retirement and cancellation accounts is included. The assessor recommends the Party include this information in the first link mentioned.	Information is updated – Account information is provided on the web pages : Article 45 – Information about the accounts opened in Latvia's registry has been published http://www.meteo.lv/en/lapas/submission-underunframework-of-climate-change-convention-conference-?id=1476&nid=646 file "Latvia' registry" According to last SIAR report and previous report findings that were reiterated referring to publicly available information, there were made updates and provided additional information in above mentioned webpage http://www.meteo.lv/en/lapas/submission-under-unframework-of-climate-change-convention-conference-?id=1476&nid=646 There is updated information under UN Framework of Climate Change Convention Conference of the Parties decision 13/CMP.1

Reference	Recommendation description	Response
		Annex E requirements Article 45- Information about the accounts opened in Latvia's Emission trading registry, account types, account holders and contacts. There is updated pdf file "Latvia's registry" that contains information according to 13/CMP.1 Annex E Article 45 (a, b and c).
P1.4.1.3	The assessor was not able to locate information on account commitment period at the first link mentioned. The assessor recommends the Party include this information in the first link mentioned	Information is updated: the commitment period with which a cancellation or retirement account is associated provided on the web pages http://www.meteo.lv/en/lapas/submission-underunframework-of-climate-change-convention-conference-?id=1476&nid=646
P1.4.1.4 P.1.4.1.5	The assessor was not able to locate information on account representatives at none of the links mentioned. The assessor suktests the Party include an explicit reference to this confidentiality in the public information webpage.	In line with the data protection requirements of Regulation (EC) No 45/2001 and Directive 95/46/EC and in accordance with Article 110 and Annex XIV of Commission Regulation (EU) no 389/2013, the information on account representatives, account holdings, account numbers, all transactions made and carbon unit identifiers, held in the EUTL, the Union Registry and any other KP registry (required by paragraph 45) is considered confidential. In accordance 13/CMP.1 Annex paragraph 45 (d and e) and taking into account Latvia's Latvia Law of Personal Data Protection all information regarding the account representatives is confidential and don't provide relevant information publically available according to national Law of Personal Data Protection.
P1.4.2.3	The Party informed that there were no projects in accordance to 13/CMP.1 Annex paragraph 46 (c) Article 6 in 2014 and that only one Joint Implementation project "The Liepaja Regional Solid Waste Management Project" is registered on 2012. The information of the project is available in the UNFCCC webpage http://ji.unfccc.int/JIITLProject/DB/JFNQLCBVKMHCWY7HVH1YC7610UVHOD/details however assessor was still unable to locate the years of ERU issuance for this project. The assessor recommends that the Party clearly provide this information even if the result is that no ERUs have been issued.	As well there are updated information according to 13/CMP.1 Annex E Article 47 and 48 requirements. There was no projects accordance to 13/CMP.1 Annex paragraph 46(c) Article 6 in 2014. Information is updated: http://www.meteo.lv/en/lapas/submission-under-unframework-of-climate-change-convention-conference-?id=1476&nid=646
P.1.5.3.2.	The assessor couldn't find the relevant information in the link provided. The assessor could find the updated information at https://etsregistry.webgate.ec.europa.eu/euregistry/LV/public/reports/publicReports.xhtml The assessor recommends the Party refers to this url in the next annual	Information about the accounts opened in Latvia's registry, has been updated and added http://www.meteo.lv/en/lapas/submission-underunframework-of-climate-change-convention-conference-?id=1476&nid=646 The Party also refers to this url https://etsregistry.webgate.ec.europa.eu/euregistry/LV/public/reports/publicReports.xhtml in

Reference	Recommendation description	Response
	submission.	this annual submission.
P.1.5.3.3	The SIAR assessor recommends Party includes information on the commitment periods of accounts as required by 13/CMP.1 Annex paragraph 45 (c)	Information is updated: the commitment period with which a cancellation or retirement account is associated provided on the web pages http://www.meteo.lv/en/lapas/submission-underunframework-of-climate-change-convention-conference-?id=1476&nid=646
P2.4.1.1	The ERT recommends that Latvia clarifies what changes have been made to the national registry (regarding the information on the registry administrators)	Latvia has clarified such information in NIR and has reported an incorrect description in the previous submission related to the changes to the information for the Registry Administrator.
P2.4.1.2	The assessor recommends the Party include a specific paragraph/reference in NIR to address ERT recommendations.	Done.
P2.4.1.3	The ERT recommends that Latvia addresses the recommendations contained in the SIAR (FCCC/ARR/2014/LVA para. 110).	Latvia has included in this NIR submission this information referring on the SEF tables and the SEF comparison report in the 12.2 point.
P2.4.2.1	The SIAR assessor recommends that Party include information on its commitment period reserve in its next annual submission.	The information on its commitment period reserve is included in this NIR
P2.4.2.6	Assessor cannot locate [Annex A, B and H] referenced in the Party's submission. There were described changes and there were reference to Annex A, B and H in chapter 14 but there were not attached these annexes to NIR submission 2015.	In NIR submission 2016 there are attached AnnexA_resubmission, AnnexB_resubmission and AnnexH_resubmission that contain changes referring to year 2014

15 INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

Latvia as Annex I country provides the following information how Latvia is striving, under Article 3, paragraph 14, minimize adverse social, environmental and economic impacts on developing countries in accordance with the guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol (Decision 15/CMP.1, paragraph 24).

Latvia is acting together with other Parties in the EU to fulfil the commitments under the Protocol.

As reported by the *Energy Development Guidelines 2016-2020*, future energetics policy will be built according to the following principles: integration of the EU energetics and climat policy's targets in the national policy, regional cooperation with the Baltic Sea countries, Energy accessibility for users with a relatively low level of income, GHG emission reduction-oriented sustainable policy.

Parties included in Annex I that are in the position to do so, shall incorporate information on how they give priority, in implementing their commitments under Article 3, paragraph 14, to the following 6 actions, based on relevant methodologies referred to in paragraph 11 of decision 31/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

Energy sector

As already mentioned in the last years' report, Latvia agreed on the long term strategy for energy until 2030 – a competitive energy for society, focusing also on sustainable energy. The main target of the Strategy is to promote competitive economy by creating balanced, effective, economically, socially and environmentally justified and market-based energy policy.

- According to Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources, Latvia has got one of the highest individual targets for the share of renewable energy by 2020, namely 40% from total gross final energy consumption. In 2013, the rate was already about 37.1 %, what positioned Latvia on number 2 in the EU after Sweden. In 2014, this rate was already 38, 65%.
- The share of renewable energy in the transport sector must reach at least 10% by 2020 of gross final energy consumption for transport (in 2010 it comprised 3.3%, in 2011 – 3.2%, in 2012 – 3.1%). One of the ways how to reach this target is the use of electric vehicules. Latvia is starting to work on the infrastructure of electric vehicule charging stations: *Electromobility development plan 2014-2016* has been approved by the Cabinet of Ministers on 26 March 2014 (order Nr. 129). Taking into account

the estimated number of registred electric vehicles in the country, it would be necessary to install about 235 such charging stations. Till 2020 Latvia has several plans also about the electrification of the public transport system, essentially in the capital Riga, including railway electrification.

- Alternative energy is a crucial source of energy for the future. Based on the consultation of stakeholders and national experts, as well as the expertise reflected in the Communication from the Commission of 24 January 2013 entitled 'Clean Power for Transport: A European alternative fuels strategy', hydrogen was identified as one of the principal alternative fuels with a potential for long-term oil substitution. The use of hydrogen could be an effective solution because of the abundant water resources in Latvia. In respect of the DIRECTIVE 2014/94/EU, the Municipality of Riga has joined the Hydrogen Fuel cells and Electro-mobility in European regions (HvER) and participates to several international projects, including the creation of a hydrogen fuel station in the capital of Riga. Several national-level programs in research on hydrogen fuel cells have been launched in cooperation with the local universities.
- On 1st January 2015, the electroenergy market was opened also for households, as it is required by the amendments of the Energy Market Law of 20 March 2014. Along with the opening of the electricity market for households, the market came to approximately 847 300 users, represneting about 90% of the total amount of users. Not all households in the price of electricity are longer subsidiesed. The reduced price of electricity is provided at the most vulnerable groups of society – poor or low income families (persons), families with disabled children, persons with disabilities, and the first group of large families (the electricity price diference is subsidized).
- Latvia has introduced a national support mechanism for renewable energies – mandatory procurement and guarenteed payement for the installed electrical capacity. Costs incurred in support of RES or high-efficiency cogeneratrion production of electricity are covered by Latvian electricity end-users in proportion to their consumption of electricity as in the price is included mandatory procurement components (OIK). It is projected that the OIK will increase till 2017 when the state support is going to expire. In order to maintain the support for producing the energy from RES or high-efficiency cogeneration installations, and to leave the OIK at the 2013 level, (26.79 EUR/MWh), Subsidized Energy Tax (SEN) is in force since 1st January 2014. It can be applied till the 31st December 2017. This tax is laid down ir 3 different rates: 15% for natural gas cogeneration plants, 10% for RES –using stations, 5% for stations that have particular conditions.

Environmental taxes

Environmental taxes are intended to grow in the years to follow: according to European Comission *Study on Environmental Fiscal Reform Potential in 14 EU Member States,* the potential revenue generated from the increase of the environmental taxes could reach 2.47% from the Latvian GDP by 2025, comparing to 2.42% in 2012.In the therms of money, it could reach 642 millions of euros by 2025 (real 2014 terms).

- Any emission of air pollutants (including CO_2) which is outside of transferred allowances is taxed according to the Natural Resources Tax Law. A number of these rates have increased steadily since 2007. CO_2 from stationary technological installations (except those covered by exemptions outlined in the Law on Pollution 405) 2014 rate: €2.85 per tonne; 2015 rate: €3.50 per tonne; PM_{10} (not containing heavy metals): 2014 rate: €51.22 per tonne; 2015 rate: €75.00 per tonne.
- Since the 1st January 2014, there is an additional tax on the sale of coal, coke and lignite. If the thermal input is known, the tax is €0.30 per GJ; and if the thermal input is unknown, the tax is €8.54 per tonne.

(b) Removing subsidies associated with the use of environmentally unsound and unsafe Technologies.

No changes in subsidies for environmentally unsound and unsafe technologies have been identified in 2014.

(c) Cooperating in the technological development of non-energy uses of fossil fuels, and supporting developing country Parties to this end

The technological development of non-energy uses of fossil fuels is not a priority for Latvia at this moment.

(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.

Each year there is a new Assitance Development Plan worked out by the Ministry of Foreign Affairs. Latvian priority countries in the development assistance for 2014 were UE East partnership countries (Belarus, Georgia, Moldova and Ukraine) and the Central Asia countries (Kyrgyzstan, Tajikistan and Uzbekistan).

In 2014, the budget funding for the bilateral development assistance was 213 813 EUR. With this budjet funding, there has been a continuation to the cooperation project between the Ministry of Environmental protection and Regional development of Latvia (MEPRD) and the Republic of Moldova (mentioned in the last year's report) in the field of regional planning. Taking into account the positive results of the Moldova's North Region development program, what is now an example program for other regions of the country, the cooperation in 2014 was financed in the same amount as in 2012 and 2013.

According to the Assitance Development Plan for 2014, there has been a call for grant project proposals to finance bilateral cooperation projects in the Latvian priority countries in the UE East partnership countries and Central Asia. In 2014, the financal support for these projects was 70 000 EUR.

2014 was also the preparation year for the Latvian Presidency in the EU Council and for the European Thematic year, which was devoted to the development assistance theme. There has been some participation of the Environmental NGO sector.

Latvia is interested to participate in the implementation of international and regional level cooperation plans in the energy sector. There is an active cooperation in the scientific sector on a regional and EU level.

- As a member of the European Union, Latvia is also taking part in the work of the Energy Community, beeing a part of its objective to improve the environmental situation in relation with the energy supply.
- Latvian partners are implicated in the European Comission supported program „Intelligent Energy Europe" (IEE) Project Transparense. Its objective is to increase the transparense of the Energy performance certificates (EPC).
- Latvia has a good cooperation with Norway. To increase "green" business competitiveness, including the competitiveness of enterprises and the "green" innovation, "a project called "Green innovation" has been implemented with the financement of the Norwegian Financial Mechanism during 2009-2014. The program was implemented by the program intermediary - Ministry of Economics of Latvia in cooperation with Investment and Development Agency of Latvia (LIAA) and a donnor-country program partner - the Royal Norwegian state-owned enterprise "Innovation Norway" (Innovation Norway).

(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.

There is no direct action taken in the context of cooperation with developing countries in the energy sector. Nevertheless, Latvia is continuing to make efforts in the increase of local origin energy fuels, strengthening its energetical independance while reducing the potential negative impact of the imported fossil resources.

In 2013 local energy provided 34.9% of the total primary energy consumption. Most of them were RES - wood biomass, hydro, wind, biogas, biofuels and local energy resources - peat, waste. There is still a potential for peat extraction energy and for waste use in the production of energy.

The rest of the part or 65.1% of energy resources in 2013, among which the most important were oil and natural gas, were imported from the Baltic region, the EU and third countries, including from Russia. Natural gas was supplied only from Russia, which accounted for 26.9%. Imported energy from other countries than Russia or EU countries is about 0,4%, and it is electricity.

(f) Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.

There have been no direct assistance projects in 2014 to diversify developing countries' economies, although, Latvia is taking part in these actions by working in connexion with such international organizations like OECD. Latvia has started its way to OECD since the invitation to start negotiations on 30 May 2013. Joining OECD will also increase Latvia's responsabilities in the field of renewable energy. OECD Environment Policy Committee and its subgroups were assessed in the context of compliance with the Latvian 44 OECD policy

instruments applicable to the broader environmental policies, like energy choice, air pollution control, energy use in households and the production sector, environmental mitigation, environmental aspects of development cooperation and others. MEPRD and other public authorities are actively involved in the OECD Environment Policy Committee subgroup of Climate, investment and development, and other subgroups. Becoming member of OECD, Latvia could also have the possibility to join the International Energy Agency.

In 2014, Latvia devoted 0.08% of the gross national income (GNI) or about ~ 18.4 million for the development assistance. Each year, Latvia accounts for the Official Development Assistance (ODA) by using OECD's Development Assistance Committee guidelines.

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ANNEXES TO THE NATIONAL INVENTORY REPORT

Annex 1: Key categories

A.1.1. Spreadsheet for the Approach 1 analysis for 1990 – level assessment with LULUCF

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
4.A.1 Forest Land remaining Forest Land – Carbon stock change, living biomass	CO_2	-19117.243	19117.243	0.337	34%
4.A.1 Forest Land remaining Forest Land – Drained organic soil	CO_2	4125.549	4125.549	0.073	41%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3049.621	3049.621	0.054	46%
4.B.1 Cropland remaining Cropland – Drained organic soil	CO_2	2761.365	2761.365	0.049	51%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2644.319	2644.319	0.047	56%
3.A.1 Enteric Fermentation - Cattle	CH_4	2117.989	2117.989	0.037	60%
3.D.1. Direct N2O emissions from managed soils	N_2O	1962.776	1962.776	0.035	63%
1.A.3.b Road Transportation - Gasoline	CO_2	1723.750	1723.750	0.030	66%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1410.785	1410.785	0.025	69%
4.D.1. Wetlands, Peat extraction from lands, organic soils	CO_2	1016.928	1016.928	0.018	70%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1007.294	1007.294	0.018	72%
4.C.1 Grassland remaining Grassland – Drained organic soil	CO_2	924.833	924.833	0.016	74%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798.206	798.206	0.014	75%
1.A.2.g Other - Liquid Fuels	CO_2	795.704	795.704	0.014	77%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778.531	778.531	0.014	78%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	695.076	695.076	0.012	79%
1.A.3.b Road Transportation - Diesel Oil	CO_2	616.136	616.136	0.011	80%
1.A.4.b Residential - Solid Fuels	CO_2	605.818	605.818	0.011	81%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	N_2O	567.422	567.422	0.010	82%
1.A.3.c Railways - Liquid Fuels	CO_2	531.380	531.380	0.009	83%
1.A.2.g Other - Gaseous Fuels	CO_2	524.169	524.169	0.009	84%
5.A.2. Unmanaged Waste Disposal	CH_4	392.831	392.831	0.007	85%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
Sites					
3.D.2 Indirect N2O Emissions from managed soils	N_2O	377.223	377.223	0.007	86%
4.B.2 Land converted to Cropland – Carbon stock change, forest land converted to cropland	CO_2	373.356	373.356	0.007	86%
3.G. Liming	CO_2	371.419	371.419	0.007	87%
2.A.1. Cement Production	CO_2	370.804	370.804	0.007	88%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	334.009	334.009	0.006	88%
1.A.4.b Residential - Liquid Fuels	CO_2	329.911	329.911	0.006	89%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	314.484	314.484	0.006	89%
4.D.1 Wetlands remaining Wetlands – Carbon stock change –organic soils	CO_2	277.200	277.200	0.005	90%
1.A.2.c Chemicals - Liquid Fuels	CO_2	276.679	276.679	0.005	90%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	273.577	273.577	0.005	91%
4.A.1 Forest land remaining forest land - Controlled burning	CO_2	256.178	256.178	0.005	91%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234.464	234.464	0.004	92%
1.A.4.b Residential - Gaseous Fuels	CO_2	219.601	219.601	0.004	92%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	218.053	218.053	0.004	92%
5.D.1 Domestic Wastewater	CH_4	207.775	207.775	0.004	93%
1.B.2.b Natural Gas	CH_4	177.238	177.238	0.003	93%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174.222	174.222	0.003	93%
4. G. Harvested wood products	CO_2	-166.356	166.356	0.003	94%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	149.415	149.415	0.003	94%
2.A.2. Lime Production	CO_2	148.857	148.857	0.003	94%
4.B.1 Land converted to Cropland – Carbon stock change – dead organic matter	CO_2	147.054	147.054	0.003	94%
1.A.1.a Public Electricity and Heat Production - Peat	CO_2	142.827	142.827	0.003	95%
3.B.5 Indirect N2O emissions from Manure Management	N_2O	137.520	137.520	0.002	95%
5.D.2 Industrial Wastewater	CH_4	137.025	137.025	0.002	95%
4.B. Cropland remaining cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	125.098	125.098	0.002	95%
3.B.2.1 Manure Management - Cattle	N_2O	120.666	120.666	0.002	96%
4.E.2 Land converted to Settlements – Carbon stock change – living biomass	CO_2	115.903	115.903	0.002	96%
3.B.1.1 Manure Management - Cattle	CH_4	110.967	110.967	0.002	96%
1.A.2.e Food Processing, Beverages	CO_2	103.071	103.071	0.002	96%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
and Tobacco - Solid Fuels					
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	102.282	102.282	0.002	96%
1.A.4.b Residential - Biomass Fuels	CH_4	96.425	96.425	0.002	97%
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	93.252	93.252	0.002	97%
4.A.1 Forest Land remaining Forest Land – Carbon stock change, dead wood	CO_2	77.311	77.311	0.001	97%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CO_2	73.839	73.839	0.001	97%
1.B.2.c Venting and Flaring	CH_4	70.344	70.344	0.001	97%
4.C. Grassland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	69.988	69.988	0.001	97%
2.A.4. Other process uses of carbonates	CO_2	69.185	69.185	0.001	97%
1.A.4.a Commercial/Institutional - Peat	CO_2	66.545	66.545	0.001	97%
3.B.1.3 Manure Management - Swaine	CH_4	65.378	65.378	0.001	98%
4.D.1 Wetlands remaining Wetlands – Carbon stock change – living biomass	CO_2	-65.311	65.311	0.001	98%
1.A.2.a Iron and Steel - Other fossil fuels	CO_2	61.352	61.352	0.001	98%
1.A.3.c Railways - Liquid Fuels	N_2O	61.201	61.201	0.001	98%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	56.126	56.126	0.001	98%
2.C.1 Iron and Steel Production	CO_2	52.596	52.596	0.001	98%
3.A.3 Enteric Fermentation - Swine	CH_4	52.541	52.541	0.001	98%
4.E.1 Settlements remaining Settlements – Carbon stock change – living biomass	CO_2	-48.284	48.284	0.001	98%
1.A.4.b Residential - Solid Fuels	CH_4	48.030	48.030	0.001	98%
4.E.2 Land converted to Settlements – Carbon stock change – dead organic matter	CO_2	45.651	45.651	0.001	98%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	44.699	44.699	0.001	98%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	43.269	43.269	0.001	99%
1.A.4.b Residential - Peat	CO_2	42.272	42.272	0.001	99%
2.D.3. Solvent Use	CO_2	41.064	41.064	0.001	99%
3.B.2.3 Manure Management - Swaine	N_2O	40.753	40.753	0.001	99%
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	39.135	39.135	0.001	99%
1.A.3.b Road Transportation - LPG	CO_2	36.957	36.957	0.001	99%
3.A.2 Enteric Fermentation - Sheep	CH_4	32.920	32.920	0.001	99%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
4.D.1. Wetlands, Peat extraction from lands, organic soils	CH_4	28.534	28.534	0.001	99%
1.A.2.g Other - Solid Fuels	CO_2	27.263	27.263	0.000	99%
4.A.1 Forest land remaining forest land - Controlled burning	CH_4	25.205	25.205	0.000	99%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	24.779	24.779	0.000	99%
5.D.1 Domestic Wastewater	N_2O	24.687	24.687	0.000	99%
5.B.1. Composting	CH_4	23.909	23.909	0.000	99%
1.A.2.c Chemicals - Gaseous Fuels	CO_2	23.424	23.424	0.000	99%
2.D.1 Lubricant Use	CO_2	23.251	23.251	0.000	99%
3.B.2.4 Manure Management - Other livestock	N_2O	22.986	22.986	0.000	99%
4.C.1 Grassland remaining Grassland – Carbon stock change – living biomass	CO_2	-19.180	19.180	0.000	99%
3.A.4 Enteric Fermentation - Other livestock	CH_4	18.091	18.091	0.000	99%
1.A.3.b Road Transportation - Gaseous Fuels	CO_2	17.617	17.617	0.000	99%
1.A.3.b Road Transportation - Gasoline	CH_4	17.155	17.155	0.000	99%
5.B.1. Composting	N_2O	17.100	17.100	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	16.429	16.429	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	15.547	15.547	0.000	100%
4.D.1 Wetlands remaining Wetlands – Carbon stock change – dead organic matter	CO_2	-13.810	13.810	0.000	100%
1.A.3.b Road Transportation - Gasoline	N_2O	13.074	13.074	0.000	100%
3.B.1.4 Manure Management - Other livestock	CH_4	12.485	12.485	0.000	100%
4.B.2 Land converted to Cropland – Drained organic soil	CO_2	12.456	12.456	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	9.150	9.150	0.000	100%
1.A.4.b Residential - Biomass Fuels	N_2O	8.944	8.944	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	8.109	8.109	0.000	100%
3.H. Urea Application	CO_2	7.709	7.709	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	7.163	7.163	0.000	100%
4.B.2 Land converted to Cropland – Mineral soil	CO_2	6.935	6.935	0.000	100%
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	6.666	6.666	0.000	100%
1.A.4.a Commercial/Institutional - Biomass Fuels	N_2O	6.220	6.220	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
4.B.1 Cropland remaining Cropland – Carbon stock change – living biomass	CO_2	-6.124	6.124	0.000	100%
4.E.1 Settlements remaining Settlements – Carbon stock change – dead organic matter	CO_2	-6.108	6.108	0.000	100%
1.A.3.b Road Transportation - Diesel Oil	N_2O	5.594	5.594	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	5.286	5.286	0.000	100%
5.C.1 Waste Incineration	N_2O	4.847	4.847	0.000	100%
4.C.1 Grassland remaining Grassland – Carbon stock change – dead organic matter	CO_2	-4.284	4.284	0.000	100%
4.D.1. Wetlands, Peat extraction from lands, organic soils	N_2O	3.793	3.793	0.000	100%
4.E.2 Land converted to Settlements – Organic soils	CO_2	3.766	3.766	0.000	100%
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	3.728	3.728	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	3.495	3.495	0.000	100%
1.A.3.b Road Transportation - Lubricants	CO_2	3.463	3.463	0.000	100%
1.A.4.b Residential - Peat	CH_4	3.188	3.188	0.000	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CO_2	3.079	3.079	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CO_2	3.023	3.023	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	3.005	3.005	0.000	100%
4.A.1 Forest land remaining forest land - Controlled burning	N_2O	2.956	2.956	0.000	100%
1.A.4.b Residential - Solid Fuels	N_2O	2.863	2.863	0.000	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO_2	2.692	2.692	0.000	100%
4.A.1 Forest land remaining forest land - wildfires	CH_4	2.525	2.525	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	2.412	2.412	0.000	100%
5.D.2 Industrial Wastewater	N_2O	2.341	2.341	0.000	100%
1.A.2.g Other - Liquid Fuels	CH_4	2.265	2.265	0.000	100%
1.A.2.g Other - Liquid Fuels	N_2O	2.150	2.150	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1.879	1.879	0.000	100%
3.B.2.2 Manure Management - Sheep	N_2O	1.824	1.824	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	1.774	1.774	0.000	100%
4.A.2 Land Converted to Forest Land – grassland converted to forest land,	CO_2	-1.612	1.612	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
carbon stock change, dead wood					
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	1.454	1.454	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	1.437	1.437	0.000	100%
4.E.2 Land converted to Settlements – Mineral soils	CO_2	1.400	1.400	0.000	100%
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, litter	CO_2	-1.382	1.382	0.000	100%
4.B.1 Cropland remaining Cropland – Carbon stock change – dead organic matter	CO_2	-1.368	1.368	0.000	100%
2.G.3. N2O from product uses	N_2O	1.302	1.302	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	1.205	1.205	0.000	100%
1.A.3.b Road Transportation - Diesel Oil	CH_4	1.108	1.108	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	1.030	1.030	0.000	100%
1.A.2.a Iron and Steel - Other fossil fuels	N_2O	0.998	0.998	0.000	100%
4.E.2 Lands converted to settlements, Direct nitrous oxide (N2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	0.911	0.911	0.000	100%
1.A.4.b Residential - Liquid Fuels	CH_4	0.868	0.868	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	0.833	0.833	0.000	100%
5.C.1 Waste Incineration	CO_2	0.811	0.811	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.789	0.789	0.000	100%
3.B.1.2 Manure Management - Sheep	CH_4	0.782	0.782	0.000	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0.761	0.761	0.000	100%
1.A.3.c Railways - Liquid Fuels	CH_4	0.745	0.745	0.000	100%
1.A.3.b Road Transportation - Gaseous Fuels	CH_4	0.702	0.702	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	N_2O	0.651	0.651	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.641	0.641	0.000	100%
1.A.2.a Iron and Steel - Other fossil fuels	CH_4	0.628	0.628	0.000	100%
1.A.1.a Public Electricity and Heat Production - Peat	N_2O	0.616	0.616	0.000	100%
4.B.2 Land converted to cropland,	N_2O	0.590	0.590	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
Direct nitrous oxide (N2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils					
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	0.520	0.520	0.000	100%
1.A.4.b Residential - Gaseous Fuels	CH_4	0.501	0.501	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.483	0.483	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0.478	0.478	0.000	100%
1.A.2.g Other - Biomass Fuels	N_2O	0.455	0.455	0.000	100%
1.A.4.b Residential - Liquid Fuels	N_2O	0.450	0.450	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.423	0.423	0.000	100%
2.A.3. Glass production	CO_2	0.356	0.356	0.000	100%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	0.327	0.327	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	N_2O	0.318	0.318	0.000	100%
4.A.1 Forest land remaining forest land - wildfires	N_2O	0.296	0.296	0.000	100%
1.A.4.a Commercial/Institutional - Peat	N_2O	0.296	0.296	0.000	100%
1.A.2.g Other - Biomass Fuels	CH_4	0.287	0.287	0.000	100%
1.A.2.g Other - Gaseous Fuels	N_2O	0.285	0.285	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.273	0.273	0.000	100%
1.A.3.b Road Transportation - Gaseous Fuels	N_2O	0.273	0.273	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.272	0.272	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.269	0.269	0.000	100%
1.A.2.g Other - Gaseous Fuels	CH_4	0.239	0.239	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CH_4	0.233	0.233	0.000	100%
1.A.2.a Iron and Steel - Liquid Fuels	N_2O	0.218	0.218	0.000	100%
1.A.4.b Residential - Peat	N_2O	0.186	0.186	0.000	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.181	0.181	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.173	0.173	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.171	0.171	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.171	0.171	0.000	100%
1.A.4.a Commercial/Institutional -	CH_4	0.168	0.168	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
Peat					
1.A.3.b Road Transportation - LPG	N_2O	0.164	0.164	0.000	100%
4.A.2 Land converted to Forest Land – Carbon stock change, grassland converted to forest land	CO_2	-0.158	0.158	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.143	0.143	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.127	0.127	0.000	100%
1.A.3.b Road Transportation - LPG	CH_4	0.125	0.125	0.000	100%
1.A.2.g Other - Solid Fuels	N_2O	0.124	0.124	0.000	100%
1.A.4.b Residential - Gaseous Fuels	N_2O	0.119	0.119	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.107	0.107	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	0.101	0.101	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.095	0.095	0.000	100%
1.A.2.a Iron and Steel - Liquid Fuels	CH_4	0.091	0.091	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.081	0.081	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.079	0.079	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	N_2O	0.076	0.076	0.000	100%
2.C.1 Iron and Steel Production	CH_4	0.069	0.069	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0.068	0.068	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.058	0.058	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CO_2	0.055	0.055	0.000	100%
4.C.1 Grassland remaining Grassland, wildfires	N_2O	0.054	0.054	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0.054	0.054	0.000	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	N_2O	0.050	0.050	0.000	100%
4.C.1 Grassland remaining Grassland, wildfires	CH_4	0.050	0.050	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.036	0.036	0.000	100%
1.A.1.a Public Electricity and Heat Production - Peat	CH_4	0.034	0.034	0.000	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CH_4	0.032	0.032	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.027	0.027	0.000	100%
1.A.3.b Road Transportation - Lubricants	CH_4	0.025	0.025	0.000	100%
1.A.1.c Manufacture of Solid Fuels and	N_2O	0.024	0.024	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
Other Energy Industries - Gaseous Fuels					
1.A.3.b Road Transportation - Lubricants	N_2O	0.024	0.024	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CH_4	0.023	0.023	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.020	0.020	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CH_4	0.018	0.018	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.015	0.015	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	N_2O	0.014	0.014	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.013	0.013	0.000	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N_2O	0.013	0.013	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.011	0.011	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0.011	0.011	0.000	100%
1.B.2.b Natural Gas	CO_2	0.009	0.009	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	0.008	0.008	0.000	100%
1.A.2.g Other - Solid Fuels	CH_4	0.007	0.007	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.005	0.005	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.004	0.004	0.000	100%
4.C.2 Land converted to Grassland – Mineral soil	CO_2	-0.003	0.003	0.000	100%
2.D.3.c Asphalt roofing	CO_2	0.003	0.003	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.003	0.003	0.000	100%
1.B.2.c Venting and Flaring	CO_2	0.003	0.003	0.000	100%
2.D.3.b Road paving with asphalt	CO_2	0.001	0.001	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.001	0.001	0.000	100%
4.C.2 Land converted to Grassland – Drained organic soil	CO_2	0.001	0.001	0.000	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH_4	0.001	0.001	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CH_4	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation	CH_4	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
Gasoline					
TOTAL		17834.80	56737.089	1.000	

A.1.2. Spreadsheet for the Approach 1 analysis for 1990 – level assessment without LULUCF

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3049.621	3049.621	0.116	12%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2644.319	2644.319	0.101	22%
3.A.1 Enteric Fermentation - Cattle	CH_4	2117.989	2117.989	0.081	30%
3.D.1. Direct N2O emissions from managed soils	N_2O	1962.776	1962.776	0.075	37%
1.A.3.b Road Transportation - Gasoline	CO_2	1723.750	1723.750	0.066	44%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1410.785	1410.785	0.054	49%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1007.294	1007.294	0.038	53%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798.206	798.206	0.030	56%
1.A.2.g Other - Liquid Fuels	CO_2	795.704	795.704	0.030	59%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778.531	778.531	0.030	62%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	695.076	695.076	0.026	65%
1.A.3.b Road Transportation - Diesel Oil	CO_2	616.136	616.136	0.023	67%
1.A.4.b Residential - Solid Fuels	CO_2	605.818	605.818	0.023	69%
1.A.3.c Railways - Liquid Fuels	CO_2	531.380	531.380	0.020	71%
1.A.2.g Other - Gaseous Fuels	CO_2	524.169	524.169	0.020	73%
5.A.2. Unmanaged Waste Disposal Sites	CH_4	392.831	392.831	0.015	75%
3.D.2 Indirect N2O Emissions from managed soils	N_2O	377.223	377.223	0.014	76%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
3.G. Liming	CO_2	371.419	371.419	0.014	78%
2.A.1. Cement Production	CO_2	370.804	370.804	0.014	79%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	334.009	334.009	0.013	80%
1.A.4.b Residential - Liquid Fuels	CO_2	329.911	329.911	0.013	82%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	314.484	314.484	0.012	83%
1.A.2.c Chemicals - Liquid Fuels	CO_2	276.679	276.679	0.011	84%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	273.577	273.577	0.010	85%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234.464	234.464	0.009	86%
1.A.4.b Residential - Gaseous Fuels	CO_2	219.601	219.601	0.008	87%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	218.053	218.053	0.008	88%
5.D.1 Domestic Wastewater	CH_4	207.775	207.775	0.008	88%
1.B.2.b Natural Gas	CH_4	177.238	177.238	0.007	89%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174.222	174.222	0.007	90%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	149.415	149.415	0.006	90%
2.A.2. Lime Production	CO_2	148.857	148.857	0.006	91%
1.A.1.a Public Electricity and Heat Production - Peat	CO_2	142.827	142.827	0.005	91%
3.B.5 Indirect N2O emissions from Manure Management	N_2O	137.520	137.520	0.005	92%
5.D.2 Industrial Wastewater	CH_4	137.025	137.025	0.005	92%
3.B.2.1 Manure Management - Cattle	N_2O	120.666	120.666	0.005	93%
3.B.1.1 Manure Management - Cattle	CH_4	110.967	110.967	0.004	93%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	103.071	103.071	0.004	94%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	102.282	102.282	0.004	94%
1.A.4.b Residential - Biomass Fuels	CH_4	96.425	96.425	0.004	94%
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	93.252	93.252	0.004	95%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CO_2	73.839	73.839	0.003	95%
1.B.2.c Venting and Flaring	CH_4	70.344	70.344	0.003	95%
2.A.4. Other process uses of carbonates	CO_2	69.185	69.185	0.003	96%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.4.a Commercial/Institutional - Peat	CO_2	66.545	66.545	0.003	96%
3.B.1.3 Manure Management - Swaine	CH_4	65.378	65.378	0.002	96%
1.A.2.a Iron and Steel - Other fossil fuels	CO_2	61.352	61.352	0.002	96%
1.A.3.c Railways - Liquid Fuels	N_2O	61.201	61.201	0.002	97%
2.C.1 Iron and Steel Production	CO_2	52.596	52.596	0.002	97%
3.A.3 Enteric Fermentation - Swine	CH_4	52.541	52.541	0.002	97%
1.A.4.b Residential - Solid Fuels	CH_4	48.030	48.030	0.002	97%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	44.699	44.699	0.002	97%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	43.269	43.269	0.002	97%
1.A.4.b Residential - Peat	CO_2	42.272	42.272	0.002	98%
2.D.3. Solvent Use	CO_2	41.064	41.064	0.002	98%
3.B.2.3 Manure Management - Swaine	N_2O	40.753	40.753	0.002	98%
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	39.135	39.135	0.001	98%
1.A.3.b Road Transportation - LPG	CO_2	36.957	36.957	0.001	98%
3.A.2 Enteric Fermentation - Sheep	CH_4	32.920	32.920	0.001	98%
1.A.2.g Other - Solid Fuels	CO_2	27.263	27.263	0.001	98%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	24.779	24.779	0.001	99%
5.D.1 Domestic Wastewater	N_2O	24.687	24.687	0.001	99%
5.B.1. Composting	CH_4	23.909	23.909	0.001	99%
1.A.2.c Chemicals - Gaseous Fuels	CO_2	23.424	23.424	0.001	99%
2.D.1 Lubricant Use	CO_2	23.251	23.251	0.001	99%
3.B.2.4 Manure Management - Other livestock	N_2O	22.986	22.986	0.001	99%
3.A.4 Enteric Fermentation - Other livestock	CH_4	18.091	18.091	0.001	99%
1.A.3.b Road Transportation - Gaseous Fuels	CO_2	17.617	17.617	0.001	99%
1.A.3.b Road Transportation - Gasoline	CH_4	17.155	17.155	0.001	99%
5.B.1. Composting	N_2O	17.100	17.100	0.001	99%
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	16.429	16.429	0.001	99%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	15.547	15.547	0.001	99%
1.A.3.b Road Transportation - Gasoline	N_2O	13.074	13.074	0.000	99%
3.B.1.4 Manure Management - Other livestock	CH_4	12.485	12.485	0.000	99%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	9.150	9.150	0.000	100%
1.A.4.b Residential - Biomass Fuels	N_2O	8.944	8.944	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	8.109	8.109	0.000	100%
3.H. Urea Application	CO_2	7.709	7.709	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	7.163	7.163	0.000	100%
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	6.666	6.666	0.000	100%
1.A.4.a Commercial/Institutional - Biomass Fuels	N_2O	6.220	6.220	0.000	100%
1.A.3.b Road Transportation - Diesel Oil	N_2O	5.594	5.594	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	5.286	5.286	0.000	100%
5.C.1 Waste Incineration	N_2O	4.847	4.847	0.000	100%
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	3.728	3.728	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	3.495	3.495	0.000	100%
1.A.3.b Road Transportation - Lubricants	CO_2	3.463	3.463	0.000	100%
1.A.4.b Residential - Peat	CH_4	3.188	3.188	0.000	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CO_2	3.079	3.079	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CO_2	3.023	3.023	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	3.005	3.005	0.000	100%
1.A.4.b Residential - Solid Fuels	N_2O	2.863	2.863	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO_2	2.692	2.692	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	2.412	2.412	0.000	100%
5.D.2 Industrial Wastewater	N_2O	2.341	2.341	0.000	100%
1.A.2.g Other - Liquid Fuels	CH_4	2.265	2.265	0.000	100%
1.A.2.g Other - Liquid Fuels	N_2O	2.150	2.150	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1.879	1.879	0.000	100%
3.B.2.2 Manure Management - Sheep	N_2O	1.824	1.824	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	1.774	1.774	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	1.454	1.454	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	1.437	1.437	0.000	100%
2.G.3. N2O from product uses	N_2O	1.302	1.302	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	1.205	1.205	0.000	100%
1.A.3.b Road Transportation - Diesel Oil	CH_4	1.108	1.108	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	1.030	1.030	0.000	100%
1.A.2.a Iron and Steel - Other fossil fuels	N_2O	0.998	0.998	0.000	100%
1.A.4.b Residential - Liquid Fuels	CH_4	0.868	0.868	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	0.833	0.833	0.000	100%
5.C.1 Waste Incineration	CO_2	0.811	0.811	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.789	0.789	0.000	100%
3.B.1.2 Manure Management - Sheep	CH_4	0.782	0.782	0.000	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0.761	0.761	0.000	100%
1.A.3.c Railways - Liquid Fuels	CH_4	0.745	0.745	0.000	100%
1.A.3.b Road Transportation - Gaseous Fuels	CH_4	0.702	0.702	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	N_2O	0.651	0.651	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.641	0.641	0.000	100%
1.A.2.a Iron and Steel - Other fossil fuels	CH_4	0.628	0.628	0.000	100%
1.A.1.a Public Electricity and Heat Production - Peat	N_2O	0.616	0.616	0.000	100%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	0.520	0.520	0.000	100%
1.A.4.b Residential - Gaseous Fuels	CH_4	0.501	0.501	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.483	0.483	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0.478	0.478	0.000	100%
1.A.2.g Other - Biomass Fuels	N_2O	0.455	0.455	0.000	100%
1.A.4.b Residential - Liquid Fuels	N_2O	0.450	0.450	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.423	0.423	0.000	100%
2.A.3. Glass production	CO_2	0.356	0.356	0.000	100%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	0.327	0.327	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	N_2O	0.318	0.318	0.000	100%
1.A.4.a Commercial/Institutional - Peat	N_2O	0.296	0.296	0.000	100%
1.A.2.g Other - Biomass Fuels	CH_4	0.287	0.287	0.000	100%
1.A.2.g Other - Gaseous Fuels	N_2O	0.285	0.285	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.273	0.273	0.000	100%
1.A.3.b Road Transportation - Gaseous Fuels	N_2O	0.273	0.273	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.272	0.272	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.269	0.269	0.000	100%
1.A.2.g Other - Gaseous Fuels	CH_4	0.239	0.239	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CH_4	0.233	0.233	0.000	100%
1.A.2.a Iron and Steel - Liquid Fuels	N_2O	0.218	0.218	0.000	100%
1.A.4.b Residential - Peat	N_2O	0.186	0.186	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.181	0.181	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.173	0.173	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.171	0.171	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.171	0.171	0.000	100%
1.A.4.a Commercial/Institutional - Peat	CH_4	0.168	0.168	0.000	100%
1.A.3.b Road Transportation - LPG	N_2O	0.164	0.164	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.143	0.143	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.127	0.127	0.000	100%
1.A.3.b Road Transportation - LPG	CH_4	0.125	0.125	0.000	100%
1.A.2.g Other - Solid Fuels	N_2O	0.124	0.124	0.000	100%
1.A.4.b Residential - Gaseous Fuels	N_2O	0.119	0.119	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.107	0.107	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	0.101	0.101	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.095	0.095	0.000	100%
1.A.2.a Iron and Steel - Liquid Fuels	CH_4	0.091	0.091	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.081	0.081	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.079	0.079	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	N_2O	0.076	0.076	0.000	100%
2.C.1 Iron and Steel Production	CH_4	0.069	0.069	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0.068	0.068	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.058	0.058	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CO_2	0.055	0.055	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0.054	0.054	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	N_2O	0.050	0.050	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.036	0.036	0.000	100%
1.A.1.a Public Electricity and Heat Production - Peat	CH_4	0.034	0.034	0.000	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CH_4	0.032	0.032	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.027	0.027	0.000	100%
1.A.3.b Road Transportation - Lubricants	CH_4	0.025	0.025	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0.024	0.024	0.000	100%
1.A.3.b Road Transportation - Lubricants	N_2O	0.024	0.024	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CH_4	0.023	0.023	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.020	0.020	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CH_4	0.018	0.018	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.015	0.015	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	N_2O	0.014	0.014	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.013	0.013	0.000	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N_2O	0.013	0.013	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.011	0.011	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0.011	0.011	0.000	100%
1.B.2.b Natural Gas	CO_2	0.009	0.009	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	0.008	0.008	0.000	100%
1.A.2.g Other - Solid Fuels	CH_4	0.007	0.007	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.005	0.005	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.004	0.004	0.000	100%
2.D.3.c Asphalt roofing	CO_2	0.003	0.003	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.003	0.003	0.000	100%
1.B.2.c Venting and Flaring	CO_2	0.003	0.003	0.000	100%
2.D.3.b Road paving with asphalt	CO_2	0.001	0.001	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.001	0.001	0.000	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH_4	0.001	0.001	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CH_4	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CH_4	0.000	0.000	0.000	100%
TOTAL		26256.43	26256.43	1.000	

A.1.3. Spreadsheet for the Approach 2 analysis for 1990 – level assessment with LULUCF

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
4.A.1 Forest Land remaining Forest Land – Drained organic soil	CO_2	4125.549	4125.549	5%	25%	0.256	0.073	0.019	0.097	10%
3.D.1. Direct N2O emissions from managed soils	N_2O	1962.776	1962.776	2%	50%	0.500	0.035	0.017	0.091	19%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	N_2O	567.422	567.422	6%	119%	1.193	0.010	0.012	0.063	25%
4.B.2 Land converted to Cropland – Carbon stock change, forest land converted to cropland	CO_2	373.356	373.356	53%	161%	1.693	0.007	0.011	0.058	31%
4.B.1 Cropland remaining Cropland – Drained organic soil	CO_2	2761.365	2761.365	13%	18%	0.227	0.049	0.011	0.058	37%
4.A.1 Forest Land remaining Forest Land – Carbon stock change, living biomass	CO_2	-19117.243	19117.243	2%	3%	0.032	0.337	0.011	0.057	42%
3.A.1 Enteric Fermentation - Cattle	CH_4	2117.989	2117.989	2%	20%	0.201	0.037	0.008	0.039	46%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778.531	778.531	2%	50%	0.500	0.014	0.007	0.036	50%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
4.E.2 Land converted to Settlements – Carbon stock change – living biomass	CO_2	115.903	115.903	20%	295%	2.953	0.002	0.006	0.032	53%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3049.621	3049.621	2%	10%	0.102	0.054	0.005	0.029	56%
4.C.1 Grassland remaining Grassland – Drained organic soil	CO_2	924.833	924.833	26%	19%	0.319	0.016	0.005	0.027	59%
4.D.1 Wetlands remaining Wetlands – Carbon stock change – living biomass	CO_2	-65.311	65.311	6%	435%	4.352	0.001	0.005	0.026	61%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1410.785	1410.785	2%	20%	0.201	0.025	0.005	0.026	64%
4.D.1. Wetlands, Peat extraction from lands, organic soils	CO_2	1016.928	1016.928	24%		0.242	0.018	0.004	0.023	66%
4.A.1 Forest land remaining forest land - Controlled burning	CO_2	256.178	256.178	92%	6%	0.922	0.005	0.004	0.022	68%
5.A.2. Unmanaged Waste Disposal Sites	CH_4	392.831	392.831	7%	52%	0.525	0.007	0.004	0.019	70%
3.D.2 Indirect N2O Emissions from managed soils	N_2O	377.223	377.223	2%	50%	0.500	0.007	0.003	0.017	72%
4.E.1 Settlements remaining Settlements – Carbon stock change – living biomass	CO_2	-48.284	48.284	9%	389%	3.896	0.001	0.003	0.017	74%
3.G. Liming	CO_2	371.419	371.419	2%	50%	0.500	0.007	0.003	0.017	76%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
4.D.1 Wetlands remaining Wetlands – Carbon stock change –organic soils	CO_2	277.200	277.200	24%	55%	0.604	0.005	0.003	0.015	77%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2644.319	2644.319	2%	5%	0.054	0.047	0.003	0.013	78%
1.A.4.b Residential - Solid Fuels	CO_2	605.818	605.818	2%	20%	0.201	0.011	0.002	0.011	80%
5.D.1 Domestic Wastewater	CH_4	207.775	207.775	45%	30%	0.541	0.004	0.002	0.010	81%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1007.294	1007.294	2%	10%	0.102	0.018	0.002	0.009	82%
5.D.2 Industrial Wastewater	CH_4	137.025	137.025	64%	30%	0.707	0.002	0.002	0.009	82%
4.B. Cropland remaining cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	125.098	125.098	13%	71%	0.722	0.002	0.002	0.008	83%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798.206	798.206	2%	11%	0.111	0.014	0.002	0.008	84%
1.A.2.g Other - Liquid Fuels	CO_2	795.704	795.704	2%	10%	0.102	0.014	0.001	0.008	85%
4.B.1 Land converted to Cropland – Carbon stock change – dead organic matter	CO_2	147.054	147.054	53%		0.534	0.003	0.001	0.007	86%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	695.076	695.076	2%	11%	0.109	0.012	0.001	0.007	86%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
2.A.2. Lime Production	CO_2	148.857	148.857	2%	50%	0.500	0.003	0.001	0.007	87%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	56.126	56.126	5%	119%	1.186	0.001	0.001	0.006	88%
1.B.2.b Natural Gas	CH_4	177.238	177.238	32%	0%	0.322	0.003	0.001	0.005	88%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	102.282	102.282	2%	50%	0.500	0.002	0.001	0.005	89%
1.A.3.b Road Transportation - Gasoline	CO_2	1723.750	1723.750	2%	2%	0.028	0.030	0.001	0.005	89%
4.C. Grassland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	69.988	69.988	24%	58%	0.629	0.001	0.001	0.004	89%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	218.053	218.053	2%	20%	0.201	0.004	0.001	0.004	90%
4.B.1 Cropland remaining Cropland – Carbon stock change – living biomass	CO_2	-6.124	6.124	3%	701%	7.007	0.000	0.001	0.004	90%
2.A.1. Cement Production	CO_2	370.804	370.804	10%	5%	0.112	0.007	0.001	0.004	91%
3.B.5 Indirect N2O emissions from Manure Management	N_2O	137.520	137.520	2%	30%	0.301	0.002	0.001	0.004	91%
3.B.2.1 Manure Management -	N_2O	120.666	120.666	25%	20%	0.320	0.002	0.001	0.004	91%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
Cattle										
3.B.1.1 Manure Management - Cattle	CH_4	110.967	110.967	25%	20%	0.320	0.002	0.001	0.003	92%
5.D.1 Domestic Wastewater	N_2O	24.687	24.687	140%	30%	1.432	0.000	0.001	0.003	92%
2.A.4. Other process uses of carbonates	CO_2	69.185	69.185	2%	50%	0.500	0.001	0.001	0.003	92%
1.A.4.b Residential - Liquid Fuels	CO_2	329.911	329.911	2%	10%	0.102	0.006	0.001	0.003	93%
1.A.3.c Railways - Liquid Fuels	N_2O	61.201	61.201	2%	50%	0.500	0.001	0.001	0.003	93%
1.A.3.c Railways - Liquid Fuels	CO_2	531.380	531.380	2%	5%	0.054	0.009	0.001	0.003	93%
1.A.2.g Other - Gaseous Fuels	CO_2	524.169	524.169	2%	5%	0.054	0.009	0.000	0.003	93%
1.A.2.c Chemicals - Liquid Fuels	CO_2	276.679	276.679	2%	10%	0.102	0.005	0.000	0.003	94%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	273.577	273.577	2%	10%	0.102	0.005	0.000	0.003	94%
4. G. Harvested wood products	CO_2	-166.356	166.356	15%	0%	0.150	0.003	0.000	0.002	94%
4.A.1 Forest land remaining forest land - Controlled burning	CH_4	25.205	25.205	92%	36%	0.988	0.000	0.000	0.002	94%
5.B.1. Composting	CH_4	23.909	23.909	29%	100%	1.041	0.000	0.000	0.002	95%
1.A.4.b Residential - Solid Fuels	CH_4	48.030	48.030	2%	50%	0.500	0.001	0.000	0.002	95%
4.C.1 Grassland remaining Grassland – Carbon stock change – living biomass	CO_2	-19.180	19.180	5%	122%	1.222	0.000	0.000	0.002	95%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	43.269	43.269	2%	50%	0.500	0.001	0.000	0.002	95%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
4.D.1. Wetlands, Peat extraction from lands, organic soils	CH_4	28.534	28.534	24%	71%	0.751	0.001	0.000	0.002	95%
3.B.1.3 Manure Management - Swaine	CH_4	65.378	65.378	25%	20%	0.320	0.001	0.000	0.002	96%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	103.071	103.071	2%	20%	0.201	0.002	0.000	0.002	96%
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	39.135	39.135	5%	50%	0.502	0.001	0.000	0.002	96%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	334.009	334.009	2%	5%	0.054	0.006	0.000	0.002	96%
1.A.3.b Road Transportation - Diesel Oil	CO_2	616.136	616.136	2%	2%	0.028	0.011	0.000	0.002	96%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	314.484	314.484	2%	5%	0.054	0.006	0.000	0.002	97%
3.A.2 Enteric Fermentation - Sheep	CH_4	32.920	32.920	2%	50%	0.500	0.001	0.000	0.002	97%
5.B.1. Composting	N_2O	17.100	17.100	29%	90%	0.946	0.000	0.000	0.001	97%
1.A.1.a Public Electricity and Heat Production - Peat	CO_2	142.827	142.827	2%	10%	0.102	0.003	0.000	0.001	97%
4.B.2 Land converted to Cropland – Drained organic soil	CO_2	12.456	12.456	114%	18%	1.153	0.000	0.000	0.001	97%
1.A.4.b Residential - Biomass Fuels	CH_4	96.425	96.425	10%	10%	0.141	0.002	0.000	0.001	97%
2.C.1 Iron and Steel Production	CO_2	52.596	52.596	5%	25%	0.255	0.001	0.000	0.001	97%
3.B.2.3 Manure Management -	N_2O	40.753	40.753	25%	20%	0.320	0.001	0.000	0.001	97%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
Swaine										
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234.464	234.464	2%	5%	0.054	0.004	0.000	0.001	98%
1.A.2.a Iron and Steel - Other fossil fuels	CO_2	61.352	61.352	2%	20%	0.201	0.001	0.000	0.001	98%
1.A.4.b Residential - Gaseous Fuels	CO_2	219.601	219.601	2%	5%	0.054	0.004	0.000	0.001	98%
2.D.1 Lubricant Use	CO_2	23.251	23.251	2%	50%	0.500	0.000	0.000	0.001	98%
3.A.3 Enteric Fermentation - Swine	CH_4	52.541	52.541	2%	20%	0.201	0.001	0.000	0.001	98%
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	93.252	93.252	2%	10%	0.102	0.002	0.000	0.001	98%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174.222	174.222	2%	5%	0.054	0.003	0.000	0.001	98%
3.A.4 Enteric Fermentation - Other livestock	CH_4	18.091	18.091	2%	50%	0.500	0.000	0.000	0.001	98%
3.B.2.4 Manure Management - Other livestock	N_2O	22.986	22.986	25%	30%	0.391	0.000	0.000	0.001	98%
4.E.2 Land converted to Settlements – Carbon stock change – dead organic matter	CO_2	45.651	45.651	20%		0.196	0.001	0.000	0.001	98%
2.D.3. Solvent Use	CO_2	41.064	41.064	2%	20%	0.201	0.001	0.000	0.001	99%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	149.415	149.415	2%	5%	0.054	0.003	0.000	0.001	99%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CO_2	73.839	73.839	2%	10%	0.102	0.001	0.000	0.001	99%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.4.a Commercial/Institutional - Peat	CO_2	66.545	66.545	2%	11%	0.111	0.001	0.000	0.001	99%
1.B.2.c Venting and Flaring	CH_4	70.344	70.344	10%	0%	0.100	0.001	0.000	0.001	99%
1.A.3.b Road Transportation - Gasoline	N_2O	13.074	13.074	2%	50%	0.500	0.000	0.000	0.001	99%
4.B.2 Land converted to Cropland – Mineral soil	CO_2	6.935	6.935	64%	61%	0.889	0.000	0.000	0.001	99%
1.A.2.g Other - Solid Fuels	CO_2	27.263	27.263	2%	20%	0.201	0.000	0.000	0.001	99%
5.C.1 Waste Incineration	N_2O	4.847	4.847	43%	100%	1.089	0.000	0.000	0.000	99%
1.A.3.b Road Transportation - Gasoline	CH_4	17.155	17.155	2%	30%	0.301	0.000	0.000	0.000	99%
3.B.1.4 Manure Management - Other livestock	CH_4	12.485	12.485	25%	30%	0.391	0.000	0.000	0.000	99%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	9.150	9.150	5%	50%	0.502	0.000	0.000	0.000	99%
4.D.1. Wetlands, Peat extraction from lands, organic soils	N_2O	3.793	3.793	24%	112%	1.146	0.000	0.000	0.000	99%
1.A.4.b Residential - Peat	CO_2	42.272	42.272	2%	10%	0.102	0.001	0.000	0.000	99%
3.H. Urea Application	CO_2	7.709	7.709	20%	50%	0.539	0.000	0.000	0.000	99%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	8.109	8.109	2%	50%	0.500	0.000	0.000	0.000	99%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
4.A.1 Forest Land remaining Forest Land – Carbon stock change, dead wood	CO_2	77.311	77.311	2%	5%	0.050	0.001	0.000	0.000	99%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	7.163	7.163	2%	50%	0.500	0.000	0.000	0.000	99%
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	6.666	6.666	2%	50%	0.500	0.000	0.000	0.000	99%
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	16.429	16.429	2%	20%	0.201	0.000	0.000	0.000	99%
1.A.4.a Commercial/Institutional - Biomass Fuels	N_2O	6.220	6.220	5%	50%	0.502	0.000	0.000	0.000	99%
1.A.4.b Residential - Biomass Fuels	N_2O	8.944	8.944	10%	30%	0.316	0.000	0.000	0.000	99%
1.A.3.b Road Transportation - Diesel Oil	N_2O	5.594	5.594	2%	50%	0.500	0.000	0.000	0.000	99%
4.A.1 Forest land remaining forest land - Controlled burning	N_2O	2.956	2.956	92%		0.920	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	5.286	5.286	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	24.779	24.779	2%	10%	0.102	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	44.699	44.699	2%	5%	0.054	0.001	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.3.b Road Transportation - LPG	CO_2	36.957	36.957	2%	5%	0.054	0.001	0.000	0.000	100%
4.E.2 Land converted to Settlements – Organic soils	CO_2	3.766	3.766	47%	18%	0.505	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	3.728	3.728	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	3.495	3.495	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.b Residential - Peat	CH_4	3.188	3.188	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	15.547	15.547	2%	10%	0.102	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CO_2	3.023	3.023	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	3.005	3.005	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.b Residential - Solid Fuels	N_2O	2.863	2.863	2%	50%	0.500	0.000	0.000	0.000	100%
4.A.1 Forest land remaining forest land - wildfires	CH_4	2.525	2.525	37%	36%	0.516	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	CO_2	23.424	23.424	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	2.412	2.412	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Liquid Fuels	CH_4	2.265	2.265	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Liquid Fuels	N_2O	2.150	2.150	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
4.B.2 Land converted to cropland, Direct nitrous oxide (N2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	0.590	0.590	64%	151%	1.639	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Gaseous Fuels	CO_2	17.617	17.617	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1.879	1.879	2%	50%	0.500	0.000	0.000	0.000	100%
4.E.2 Land converted to Settlements – Mineral soils	CO_2	1.400	1.400	22%	60%	0.639	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	1.774	1.774	2%	50%	0.500	0.000	0.000	0.000	100%
5.D.2 Industrial Wastewater	N_2O	2.341	2.341	23%	30%	0.378	0.000	0.000	0.000	100%
4.D.1 Wetlands remaining Wetlands – Carbon stock change – dead organic matter	CO_2	-13.810	13.810	6%		0.059	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	1.454	1.454	5%	50%	0.502	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	1.437	1.437	2%	50%	0.500	0.000	0.000	0.000	100%
3.B.2.2 Manure Management - Sheep	N_2O	1.824	1.824	25%	30%	0.391	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CO_2	3.079	3.079	2%	20%	0.201	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	1.205	1.205	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO_2	2.692	2.692	2%	20%	0.201	0.000	0.000	0.000	100%
4.E.1 Settlements remaining Settlements – Carbon stock change – dead organic matter	CO_2	-6.108	6.108	9%		0.087	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	1.030	1.030	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Other fossil fuels	N_2O	0.998	0.998	2%	50%	0.500	0.000	0.000	0.000	100%
5.C.1 Waste Incineration	CO_2	0.811	0.811	43%	40%	0.587	0.000	0.000	0.000	100%
1.A.4.b Residential - Liquid Fuels	CH_4	0.868	0.868	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.789	0.789	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Lubricants	CO_2	3.463	3.463	10%	5%	0.112	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
4.E.2 Lands converted to settlements, Direct nitrous oxide (N2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	0.911	0.911	20%	38%	0.425	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0.761	0.761	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.c Railways - Liquid Fuels	CH_4	0.745	0.745	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Gaseous Fuels	CH_4	0.702	0.702	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Diesel Oil	CH_4	1.108	1.108	2%	30%	0.301	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	N_2O	0.651	0.651	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.641	0.641	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Other fossil fuels	CH_4	0.628	0.628	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Peat	N_2O	0.616	0.616	2%	50%	0.500	0.000	0.000	0.000	100%
2.A.3. Glass production	CO_2	0.356	0.356	2%	86%	0.860	0.000	0.000	0.000	100%
3.B.1.2 Manure Management -	CH_4	0.782	0.782	25%	30%	0.391	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
Sheep										
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	0.520	0.520	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.4.b Residential - Gaseous Fuels	CH_4	0.501	0.501	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.483	0.483	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0.478	0.478	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Biomass Fuels	N_2O	0.455	0.455	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.4.b Residential - Liquid Fuels	N_2O	0.450	0.450	2%	50%	0.500	0.000	0.000	0.000	100%
4.C.1 Grassland remaining Grassland – Carbon stock change – dead organic matter	CO_2	-4.284	4.284	5%		0.050	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.423	0.423	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	0.327	0.327	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	N_2O	0.318	0.318	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Peat	N_2O	0.296	0.296	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Biomass Fuels	CH_4	0.287	0.287	5%	50%	0.502	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.2.g Other - Gaseous Fuels	N_2O	0.285	0.285	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.273	0.273	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.272	0.272	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Gaseous Fuels	N_2O	0.273	0.273	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.269	0.269	2%	50%	0.500	0.000	0.000	0.000	100%
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, dead wood	CO_2	-1.612	1.612	8%		0.080	0.000	0.000	0.000	100%
1.A.2.g Other - Gaseous Fuels	CH_4	0.239	0.239	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CH_4	0.233	0.233	2%	50%	0.500	0.000	0.000	0.000	100%
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, litter	CO_2	-1.382	1.382	8%		0.080	0.000	0.000	0.000	100%
4.A.1 Forest land remaining forest land - wildfires	N_2O	0.296	0.296	37%		0.370	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Liquid Fuels	N_2O	0.218	0.218	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.b Residential - Peat	N_2O	0.186	0.186	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.181	0.181	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.171	0.171	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.171	0.171	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Peat	CH_4	0.168	0.168	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - LPG	N_2O	0.164	0.164	2%	50%	0.500	0.000	0.000	0.000	100%
4.A.2 Land converted to Forest Land – Carbon stock change, grassland converted to forest land	CO_2	-0.158	0.158	8%	50%	0.504	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.143	0.143	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.127	0.127	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - LPG	CH_4	0.125	0.125	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Solid Fuels	N_2O	0.124	0.124	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.b Residential - Gaseous Fuels	N_2O	0.119	0.119	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.107	0.107	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	0.101	0.101	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.095	0.095	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Liquid Fuels	CH_4	0.091	0.091	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	0.833	0.833	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.081	0.081	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.079	0.079	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	N_2O	0.076	0.076	2%	50%	0.500	0.000	0.000	0.000	100%
2.G.3. N2O from product uses	N_2O	1.302	1.302	2%	2%	0.028	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.173	0.173	20%	5%	0.206	0.000	0.000	0.000	100%
4.B.1 Cropland remaining Cropland – Carbon stock change – dead organic matter	CO_2	-1.368	1.368	3%		0.026	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0.068	0.068	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.058	0.058	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0.054	0.054	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
4.C.1 Grassland remaining Grassland, wildfires	N_2O	0.054	0.054	10%	48%	0.490	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	N_2O	0.050	0.050	2%	50%	0.500	0.000	0.000	0.000	100%
4.C.1 Grassland remaining Grassland, wildfires	CH_4	0.050	0.050	10%	39%	0.403	0.000	0.000	0.000	100%
2.C.1 Iron and Steel Production	CH_4	0.069	0.069	10%	25%	0.269	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.036	0.036	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Peat	CH_4	0.034	0.034	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CH_4	0.032	0.032	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.027	0.027	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Lubricants	CH_4	0.025	0.025	10%	50%	0.510	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Lubricants	N_2O	0.024	0.024	10%	50%	0.510	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0.024	0.024	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid	CH_4	0.023	0.023	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
Fuels										
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.020	0.020	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CH_4	0.018	0.018	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.015	0.015	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	N_2O	0.014	0.014	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.013	0.013	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N_2O	0.013	0.013	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0.011	0.011	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	0.008	0.008	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.g Other - Solid Fuels	CH_4	0.007	0.007	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CO_2	0.055	0.055	2%	5%	0.054	0.000	0.000	0.000	100%
1.B.2.b Natural Gas	CO_2	0.009	0.009	32%	0%	0.322	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.005	0.005	5%	50%	0.502	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.004	0.004	2%	50%	0.500	0.000	0.000	0.000	100%
4.C.2 Land converted to Grassland – Mineral soil	CO_2	-0.003	0.003	10%	61%	0.620	0.000	0.000	0.000	100%
2.D.3.c Asphalt roofing	CO_2	0.003	0.003	20%	60%	0.632	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.003	0.003	20%	50%	0.539	0.000	0.000	0.000	100%
2.D.3.b Road paving with asphalt	CO_2	0.001	0.001	20%	60%	0.632	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.011	0.011	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.001	0.001	2%	50%	0.500	0.000	0.000	0.000	100%
4.C.2 Land converted to Grassland – Drained organic soil	CO_2	0.001	0.001	55%	19%	0.583	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH_4	0.001	0.001	2%	50%	0.500	0.000	0.000	0.000	100%
1.B.2.c Venting and Flaring	CO_2	0.003	0.003	10%	0%	0.100	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.000	0.000	20%	50%	0.539	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet	CH_4	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
kerosene										
1.A.3.a Domestic Aviation - Aviation Gasoline	CH_4	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
TOTAL		17834.80	56737.089			162.446	1.000	0.191	1.000	

A.1.4. Spreadsheet for the Approach 2 analysis for 1990 – level assessment without LULUCF

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
3.D.1. Direct N_2O emissions from managed soils	N_2O	1962.776	1962.776	2%	50%	0.500	0.075	0.037	0.201	20%
3.A.1 Enteric Fermentation - Cattle	CH_4	2117.989	2117.989	2%	20%	0.201	0.081	0.016	0.087	29%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778.531	778.531	2%	50%	0.500	0.030	0.015	0.080	37%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3049.621	3049.621	2%	10%	0.102	0.116	0.012	0.064	43%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1410.785	1410.785	2%	20%	0.201	0.054	0.011	0.058	49%
5.A.2. Unmanaged Waste Disposal Sites	CH_4	392.831	392.831	7%	52%	0.525	0.015	0.008	0.042	53%
3.D.2 Indirect N_2O Emissions from managed soils	N_2O	377.223	377.223	2%	50%	0.500	0.014	0.007	0.039	57%
3.G. Liming	CO_2	371.419	371.419	2%	50%	0.500	0.014	0.007	0.038	61%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2644.319	2644.319	2%	5%	0.054	0.101	0.005	0.029	64%
1.A.4.b Residential - Solid Fuels	CO_2	605.818	605.818	2%	20%	0.201	0.023	0.005	0.025	66%
5.D.1 Domestic Wastewater	CH_4	207.775	207.775	45%	30%	0.541	0.008	0.004	0.023	68%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1007.294	1007.294	2%	10%	0.102	0.038	0.004	0.021	71%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798.206	798.206	2%	11%	0.111	0.030	0.003	0.018	72%
1.A.2.g Other - Liquid Fuels	CO_2	795.704	795.704	2%	10%	0.102	0.030	0.003	0.017	74%

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1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	695.076	695.076	2%	11%	0.109	0.026	0.003	0.015	76%
2.A.2. Lime Production	CO_2	148.857	148.857	2%	50%	0.500	0.006	0.003	0.015	77%
1.B.2.b Natural Gas	CH_4	177.238	177.238	32%	0%	0.322	0.007	0.002	0.012	78%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	102.282	102.282	2%	50%	0.500	0.004	0.002	0.010	79%
1.A.3.b Road Transportation - Gasoline	CO_2	1723.750	1723.750	2%	2%	0.028	0.066	0.002	0.010	80%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	218.053	218.053	2%	20%	0.201	0.008	0.002	0.009	81%
2.A.1. Cement Production	CO_2	370.804	370.804	10%	5%	0.112	0.014	0.002	0.008	82%
3.B.5 Indirect N_2O emissions from Manure Management	N_2O	137.520	137.520	2%	30%	0.301	0.005	0.002	0.008	83%
3.B.2.1 Manure Management - Cattle	N_2O	120.666	120.666	25%	20%	0.320	0.005	0.001	0.008	84%
3.B.1.1 Manure Management - Cattle	CH_4	110.967	110.967	25%	20%	0.320	0.004	0.001	0.007	84%
5.D.1 Domestic Wastewater	N_2O	24.687	24.687	140%	30%	1.432	0.001	0.001	0.007	85%
2.A.4. Other process uses of carbonates	CO_2	69.185	69.185	2%	50%	0.500	0.003	0.001	0.007	86%
1.A.4.b Residential - Liquid Fuels	CO_2	329.911	329.911	2%	10%	0.102	0.013	0.001	0.007	87%
1.A.3.c Railways - Liquid Fuels	N_2O	61.201	61.201	2%	50%	0.500	0.002	0.001	0.006	87%
1.A.3.c Railways - Liquid Fuels	CO_2	531.380	531.380	2%	5%	0.054	0.020	0.001	0.006	88%
1.A.2.g Other - Gaseous Fuels	CO_2	524.169	524.169	2%	5%	0.054	0.020	0.001	0.006	88%
1.A.2.c Chemicals - Liquid Fuels	CO_2	276.679	276.679	2%	10%	0.102	0.011	0.001	0.006	89%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	273.577	273.577	2%	10%	0.102	0.010	0.001	0.006	90%
5.B.1. Composting	CH_4	23.909	23.909	29%	100%	1.041	0.001	0.001	0.005	90%

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1.A.4.b Residential - Solid Fuels	CH_4	48.030	48.030	2%	50%	0.500	0.002	0.001	0.005	91%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	43.269	43.269	2%	50%	0.500	0.002	0.001	0.004	91%
3.B.1.3 Manure Management - Swaine	CH_4	65.378	65.378	25%	20%	0.320	0.002	0.001	0.004	91%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	103.071	103.071	2%	20%	0.201	0.004	0.001	0.004	92%
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	39.135	39.135	5%	50%	0.502	0.001	0.001	0.004	92%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	334.009	334.009	2%	5%	0.054	0.013	0.001	0.004	93%
1.A.3.b Road Transportation - Diesel Oil	CO_2	616.136	616.136	2%	2%	0.028	0.023	0.001	0.004	93%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	314.484	314.484	2%	5%	0.054	0.012	0.001	0.003	93%
3.A.2 Enteric Fermentation - Sheep	CH_4	32.920	32.920	2%	50%	0.500	0.001	0.001	0.003	94%
5.B.1. Composting	N_2O	17.100	17.100	29%	90%	0.946	0.001	0.001	0.003	94%
1.A.1.a Public Electricity and Heat Production - Peat	CO_2	142.827	142.827	2%	10%	0.102	0.005	0.001	0.003	94%
1.A.4.b Residential - Biomass Fuels	CH_4	96.425	96.425	10%	10%	0.141	0.004	0.001	0.003	95%
2.C.1 Iron and Steel Production	CO_2	52.596	52.596	5%	25%	0.255	0.002	0.001	0.003	95%
3.B.2.3 Manure Management - Swaine	N_2O	40.753	40.753	25%	20%	0.320	0.002	0.000	0.003	95%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234.464	234.464	2%	5%	0.054	0.009	0.000	0.003	95%
1.A.2.a Iron and Steel - Other fossil fuels	CO_2	61.352	61.352	2%	20%	0.201	0.002	0.000	0.003	96%
1.A.4.b Residential - Gaseous Fuels	CO_2	219.601	219.601	2%	5%	0.054	0.008	0.000	0.002	96%
2.D.1 Lubricant Use	CO_2	23.251	23.251	2%	50%	0.500	0.001	0.000	0.002	96%

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3.A.3 Enteric Fermentation - Swine	CH_4	52.541	52.541	2%	20%	0.201	0.002	0.000	0.002	96%
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	93.252	93.252	2%	10%	0.102	0.004	0.000	0.002	96%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174.222	174.222	2%	5%	0.054	0.007	0.000	0.002	97%
3.A.4 Enteric Fermentation - Other livestock	CH_4	18.091	18.091	2%	50%	0.500	0.001	0.000	0.002	97%
3.B.2.4 Manure Management - Other livestock	N_2O	22.986	22.986	25%	30%	0.391	0.001	0.000	0.002	97%
2.D.3. Solvent Use	CO_2	41.064	41.064	2%	20%	0.201	0.002	0.000	0.002	97%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	149.415	149.415	2%	5%	0.054	0.006	0.000	0.002	97%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CO_2	73.839	73.839	2%	10%	0.102	0.003	0.000	0.002	98%
1.A.4.a Commercial/Institutional - Peat	CO_2	66.545	66.545	2%	11%	0.111	0.003	0.000	0.002	98%
1.B.2.c Venting and Flaring	CH_4	70.344	70.344	10%	0%	0.100	0.003	0.000	0.001	98%
1.A.3.b Road Transportation - Gasoline	N_2O	13.074	13.074	2%	50%	0.500	0.000	0.000	0.001	98%
1.A.2.g Other - Solid Fuels	CO_2	27.263	27.263	2%	20%	0.201	0.001	0.000	0.001	98%
5.C.1 Waste Incineration	N_2O	4.847	4.847	43%	100%	1.089	0.000	0.000	0.001	98%
1.A.3.b Road Transportation - Gasoline	CH_4	17.155	17.155	2%	30%	0.301	0.001	0.000	0.001	98%
3.B.1.4 Manure Management - Other livestock	CH_4	12.485	12.485	25%	30%	0.391	0.000	0.000	0.001	98%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	9.150	9.150	5%	50%	0.502	0.000	0.000	0.001	98%
1.A.4.b Residential - Peat	CO_2	42.272	42.272	2%	10%	0.102	0.002	0.000	0.001	99%

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3.H. Urea Application	CO_2	7.709	7.709	20%	50%	0.539	0.000	0.000	0.001	99%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	8.109	8.109	2%	50%	0.500	0.000	0.000	0.001	99%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	7.163	7.163	2%	50%	0.500	0.000	0.000	0.001	99%
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	6.666	6.666	2%	50%	0.500	0.000	0.000	0.001	99%
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	16.429	16.429	2%	20%	0.201	0.001	0.000	0.001	99%
1.A.4.a Commercial/Institutional - Biomass Fuels	N_2O	6.220	6.220	5%	50%	0.502	0.000	0.000	0.001	99%
1.A.4.b Residential - Biomass Fuels	N_2O	8.944	8.944	10%	30%	0.316	0.000	0.000	0.001	99%
1.A.3.b Road Transportation - Diesel Oil	N_2O	5.594	5.594	2%	50%	0.500	0.000	0.000	0.001	99%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	5.286	5.286	2%	50%	0.500	0.000	0.000	0.001	99%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	24.779	24.779	2%	10%	0.102	0.001	0.000	0.001	99%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	44.699	44.699	2%	5%	0.054	0.002	0.000	0.000	99%
1.A.3.b Road Transportation - LPG	CO_2	36.957	36.957	2%	5%	0.054	0.001	0.000	0.000	99%
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	3.728	3.728	2%	50%	0.500	0.000	0.000	0.000	99%
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	3.495	3.495	2%	50%	0.500	0.000	0.000	0.000	99%

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1.A.4.b Residential - Peat	CH_4	3.188	3.188	2%	50%	0.500	0.000	0.000	0.000	99%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	15.547	15.547	2%	10%	0.102	0.001	0.000	0.000	99%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CO_2	3.023	3.023	2%	50%	0.500	0.000	0.000	0.000	99%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	3.005	3.005	2%	50%	0.500	0.000	0.000	0.000	99%
1.A.4.b Residential - Solid Fuels	N_2O	2.863	2.863	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	CO_2	23.424	23.424	2%	5%	0.054	0.001	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	2.412	2.412	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Liquid Fuels	CH_4	2.265	2.265	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Liquid Fuels	N_2O	2.150	2.150	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Gaseous Fuels	CO_2	17.617	17.617	2%	5%	0.054	0.001	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1.879	1.879	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	1.774	1.774	2%	50%	0.500	0.000	0.000	0.000	100%
5.D.2 Industrial Wastewater	N_2O	2.341	2.341	23%	30%	0.378	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	1.454	1.454	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	1.437	1.437	2%	50%	0.500	0.000	0.000	0.000	100%

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3.B.2.2 Manure Management - Sheep	N_2O	1.824	1.824	25%	30%	0.391	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CO_2	3.079	3.079	2%	20%	0.201	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	1.205	1.205	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO_2	2.692	2.692	2%	20%	0.201	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	1.030	1.030	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Other fossil fuels	N_2O	0.998	0.998	2%	50%	0.500	0.000	0.000	0.000	100%
5.C.1 Waste Incineration	CO_2	0.811	0.811	43%	40%	0.587	0.000	0.000	0.000	100%
1.A.4.b Residential - Liquid Fuels	CH_4	0.868	0.868	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.789	0.789	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Lubricants	CO_2	3.463	3.463	10%	5%	0.112	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0.761	0.761	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.c Railways - Liquid Fuels	CH_4	0.745	0.745	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Gaseous Fuels	CH_4	0.702	0.702	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Diesel Oil	CH_4	1.108	1.108	2%	30%	0.301	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	N_2O	0.651	0.651	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.641	0.641	2%	50%	0.500	0.000	0.000	0.000	100%

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1.A.2.a Iron and Steel - Other fossil fuels	CH_4	0.628	0.628	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Peat	N_2O	0.616	0.616	2%	50%	0.500	0.000	0.000	0.000	100%
2.A.3. Glass production	CO_2	0.356	0.356	2%	86%	0.860	0.000	0.000	0.000	100%
3.B.1.2 Manure Management - Sheep	CH_4	0.782	0.782	25%	30%	0.391	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	0.520	0.520	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.4.b Residential - Gaseous Fuels	CH_4	0.501	0.501	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.483	0.483	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0.478	0.478	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Biomass Fuels	N_2O	0.455	0.455	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.4.b Residential - Liquid Fuels	N_2O	0.450	0.450	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.423	0.423	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	0.327	0.327	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	N_2O	0.318	0.318	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Peat	N_2O	0.296	0.296	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Biomass Fuels	CH_4	0.287	0.287	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.g Other - Gaseous Fuels	N_2O	0.285	0.285	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.273	0.273	2%	50%	0.500	0.000	0.000	0.000	100%

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1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.272	0.272	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Gaseous Fuels	N_2O	0.273	0.273	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.269	0.269	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Gaseous Fuels	CH_4	0.239	0.239	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CH_4	0.233	0.233	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Liquid Fuels	N_2O	0.218	0.218	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.b Residential - Peat	N_2O	0.186	0.186	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.181	0.181	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.171	0.171	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.171	0.171	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Peat	CH_4	0.168	0.168	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - LPG	N_2O	0.164	0.164	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.143	0.143	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.127	0.127	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - LPG	CH_4	0.125	0.125	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Solid Fuels	N_2O	0.124	0.124	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.4.b Residential - Gaseous Fuels	N_2O	0.119	0.119	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.107	0.107	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	0.101	0.101	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.095	0.095	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Liquid Fuels	CH_4	0.091	0.091	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	0.833	0.833	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.081	0.081	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.079	0.079	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	N_2O	0.076	0.076	2%	50%	0.500	0.000	0.000	0.000	100%
2.G.3. N_2O from product uses	N_2O	1.302	1.302	2%	2%	0.028	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.173	0.173	20%	5%	0.206	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0.068	0.068	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.058	0.058	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0.054	0.054	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	N_2O	0.050	0.050	2%	50%	0.500	0.000	0.000	0.000	100%
2.C.1 Iron and Steel Production	CH_4	0.069	0.069	10%	25%	0.269	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.036	0.036	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Peat	CH_4	0.034	0.034	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CH_4	0.032	0.032	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.027	0.027	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Lubricants	CH_4	0.025	0.025	10%	50%	0.510	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Lubricants	N_2O	0.024	0.024	10%	50%	0.510	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0.024	0.024	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CH_4	0.023	0.023	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.020	0.020	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CH_4	0.018	0.018	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.015	0.015	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	N_2O	0.014	0.014	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.013	0.013	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N_2O	0.013	0.013	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0.011	0.011	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	0.008	0.008	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.g Other - Solid Fuels	CH_4	0.007	0.007	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CO_2	0.055	0.055	2%	5%	0.054	0.000	0.000	0.000	100%
1.B.2.b Natural Gas	CO_2	0.009	0.009	32%	0%	0.322	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.005	0.005	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.004	0.004	2%	50%	0.500	0.000	0.000	0.000	100%
2.D.3.c Asphalt roofing	CO_2	0.003	0.003	20%	60%	0.632	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.003	0.003	20%	50%	0.539	0.000	0.000	0.000	100%
2.D.3.b Road paving with asphalt	CO_2	0.001	0.001	20%	60%	0.632	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.011	0.011	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.001	0.001	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH_4	0.001	0.001	2%	50%	0.500	0.000	0.000	0.000	100%
1.B.2.c Venting and Flaring	CO_2	0.003	0.003	10%	0%	0.100	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.000	0.000	20%	50%	0.539	0.000	0.000	0.000	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	Absolute value of 1990 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CH_4	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CH_4	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
TOTAL		26256.43	26256.43			113.077	1.000	0.186	1.000	

A.1.5 Spreadsheet for the Approach 1 analysis for 2014 – level assessment with LULUCF

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
4.A.1 Forest Land remaining Forest Land – Drained organic soil	CO_2	4583.281	4583.281	0.150	15%
4.A.1 Forest Land remaining Forest Land – Carbon stock change, dead wood	CO_2	-3792.439	3792.439	0.124	27%
4.B.1 Cropland remaining Cropland – Drained organic soil	CO_2	2598.777	2598.777	0.085	36%
1.A.3.b Road Transportation - Diesel Oil	CO_2	1880.266	1880.266	0.061	42%
4. G. Harvested wood products	CO_2	-1817.580	1817.580	0.059	48%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	1575.699	1575.699	0.052	53%
3.D.1. Direct N_2O emissions from managed soils	N_2O	1429.498	1429.498	0.047	58%
4.D.1. Wetlands, Peat extraction from lands, organic soils	CO_2	899.741	899.741	0.029	61%
3.A.1 Enteric Fermentation - Cattle	CH_4	828.043	828.043	0.027	63%
4.C.1 Grassland remaining Grassland – Drained organic soil	CO_2	684.007	684.007	0.022	66%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	N_2O	638.801	638.801	0.021	68%
1.A.3.b Road Transportation - Gasoline	CO_2	613.358	613.358	0.020	70%
2.A.1. Cement Production	CO_2	555.776	555.776	0.018	72%
4.A.1 Forest Land remaining Forest Land – Carbon stock change, living biomass	CO_2	-529.092	529.092	0.017	73%
4.C.2 Land converted to Grassland – Mineral soil	CO_2	-495.257	495.257	0.016	75%
4.E.2 Land converted to Settlements – Carbon stock change – living biomass	CO_2	480.918	480.918	0.016	77%
4.A.2 Land converted to Forest Land – Carbon stock change, grassland converted to forest land	CO_2	-341.174	341.174	0.011	78%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	320.575	320.575	0.010	79%
5.A.1. Managed Waste Disposal on Land	CH_4	301.024	301.024	0.010	80%
4.D.1 Wetlands remaining Wetlands – Carbon stock change –organic soils	CO_2	277.200	277.200	0.009	81%
4.C.2 Land converted to Grassland – Drained organic soil	CO_2	275.392	275.392	0.009	81%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	238.797	238.797	0.008	82%
1.A.4.b Residential - Gaseous Fuels	CO_2	230.712	230.712	0.008	83%
5.A.2. Unmanaged Waste Disposal Sites	CH_4	227.802	227.802	0.007	84%
1.A.3.c Railways - Liquid Fuels	CO_2	213.786	213.786	0.007	84%
2.F.1. Refrigeration and air conditioning	HFCs	206.377	206.377	0.007	85%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
4.E.2 Land converted to Settlements – Carbon stock change – dead organic matter	CO_2	197.497	197.497	0.006	86%
3.D.2 Indirect N_2O Emissions from managed soils	N_2O	196.044	196.044	0.006	86%
4.E.2 Land converted to Settlements – Organic soils	CO_2	166.176	166.176	0.005	87%
1.A.3.b Road Transportation - LPG	CO_2	165.243	165.243	0.005	88%
4.D.1 Wetlands remaining Wetlands – Carbon stock change – living biomass	CO_2	-165.232	165.232	0.005	88%
1.A.4.b Residential - Liquid Fuels	CO_2	157.132	157.132	0.005	89%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	155.562	155.562	0.005	89%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	149.853	149.853	0.005	90%
5.D.2 Industrial Wastewater	CH_4	138.525	138.525	0.005	90%
4.B. Cropland remaining cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	119.045	119.045	0.004	90%
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	118.628	118.628	0.004	91%
5.D.1 Domestic Wastewater	CH_4	109.507	109.507	0.004	91%
1.B.2.b Natural Gas	CH_4	109.190	109.190	0.004	92%
4.E.1 Settlements remaining Settlements – Carbon stock change – living biomass	CO_2	-108.186	108.186	0.004	92%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CO_2	107.569	107.569	0.004	92%
4.E.2 Land converted to Settlements – Mineral soils	CO_2	107.292	107.292	0.004	93%
1.A.2.g Other - Liquid Fuels	CO_2	104.814	104.814	0.003	93%
1.A.4.b Residential - Biomass Fuels	CH_4	101.654	101.654	0.003	93%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	93.815	93.815	0.003	94%
1.A.2.g Other - Gaseous Fuels	CO_2	91.048	91.048	0.003	94%
4.B.2 Land converted to Cropland – Drained organic soil	CO_2	89.507	89.507	0.003	94%
4.A.1 Forest land remaining forest land - Controlled burning	CO_2	88.884	88.884	0.003	94%
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, dead wood	CO_2	-83.797	83.797	0.003	95%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	73.413	73.413	0.002	95%
4.C. Grassland, Emissions and removals from drainage and rewetting and other	CH_4	72.895	72.895	0.002	95%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
management of organic and mineral soils					
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, litter	CO_2	-71.844	71.844	0.002	95%
3.B.1.1 Manure Management - Cattle	CH_4	70.595	70.595	0.002	96%
4.A.2 Land converted to Forest Land – grassland converted to forest land, Drained organic soil	CO_2	61.248	61.248	0.002	96%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	55.182	55.182	0.002	96%
1.A.4.b Residential - Solid Fuels	CO_2	50.233	50.233	0.002	96%
4.B.2 Land converted to Cropland – Mineral soil	CO_2	48.750	48.750	0.002	96%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	45.035	45.035	0.001	96%
3.B.2.1 Manure Management - Cattle	N_2O	42.947	42.947	0.001	97%
4.C.1 Grassland remaining Grassland – Carbon stock change – living biomass	CO_2	-42.877	42.877	0.001	97%
3.B.5 Indirect N_2O emissions from Manure Management	N_2O	41.938	41.938	0.001	97%
4.E.2 Lands converted to settlements, Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	40.479	40.479	0.001	97%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	38.502	38.502	0.001	97%
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	34.973	34.973	0.001	97%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	33.544	33.544	0.001	97%
2.D.3. Solvent Use	CO_2	32.197	32.197	0.001	97%
4.D.1 Wetlands remaining Wetlands – Carbon stock change – dead organic matter	CO_2	-29.466	29.466	0.001	98%
4.D.1. Wetlands, Peat extraction from lands, organic soils	CH_4	28.534	28.534	0.001	98%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	26.178	26.178	0.001	98%
1.B.2.c Venting and Flaring	CH_4	26.126	26.126	0.001	98%
1.A.3.c Railways - Liquid Fuels	N_2O	24.624	24.624	0.001	98%
5.B.1. Composting	CH_4	22.465	22.465	0.001	98%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	22.068	22.068	0.001	98%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
4.B.2 Land converted to Cropland – Carbon stock change, forest land converted to cropland	CO_2	21.176	21.176	0.001	98%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	21.164	21.164	0.001	98%
3.B.1.3 Manure Management - Swaine	CH_4	20.646	20.646	0.001	98%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	20.350	20.350	0.001	98%
3.G. Liming	CO_2	19.686	19.686	0.001	98%
1.A.3.b Road Transportation - Diesel Oil	N_2O	19.447	19.447	0.001	98%
4.E.1 Settlements remaining Settlements – Drained organic soils	CO_2	19.430	19.430	0.001	99%
3.A.2 Enteric Fermentation - Sheep	CH_4	18.500	18.500	0.001	99%
1.A.2.g Other - Biomass Fuels	N_2O	17.427	17.427	0.001	99%
1.A.2.c Chemicals - Gaseous Fuels	CO_2	17.146	17.146	0.001	99%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	16.555	16.555	0.001	99%
5.D.1 Domestic Wastewater	N_2O	16.537	16.537	0.001	99%
5.B.1. Composting	N_2O	16.067	16.067	0.001	99%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	13.386	13.386	0.000	99%
3.A.3 Enteric Fermentation - Swine	CH_4	13.103	13.103	0.000	99%
3.A.4 Enteric Fermentation - Other livestock	CH_4	13.022	13.022	0.000	99%
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	12.580	12.580	0.000	99%
3.B.2.4 Manure Management - Other livestock	N_2O	11.522	11.522	0.000	99%
1.A.2.g Other - Biomass Fuels	CH_4	10.965	10.965	0.000	99%
2.A.4. Other process uses of carbonates	CO_2	10.833	10.833	0.000	99%
4.E.1 Settlements remaining Settlements – Carbon stock change – dead organic matter	CO_2	-10.612	10.612	0.000	99%
1.A.4.b Residential - Biomass Fuels	N_2O	10.597	10.597	0.000	99%
1.A.2.c Chemicals - Liquid Fuels	CO_2	10.101	10.101	0.000	99%
1.A.5.b Mobile - Liquid Fuels	CO_2	9.442	9.442	0.000	99%
4.A.1 Forest land remaining forest land - wildfires	CH_4	9.198	9.198	0.000	99%
4.A.1 Forest land remaining forest land - Controlled burning	CH_4	8.745	8.745	0.000	99%
4.B.1 Land converted to Cropland – Carbon stock change – dead organic matter	CO_2	8.696	8.696	0.000	99%
2.G.1. Electrical equipment	SF6	8.578	8.578	0.000	99%
4.C.1 Grassland remaining Grassland – Carbon stock change – dead organic	CO_2	-8.557	8.557	0.000	99%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
matter					
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	8.434	8.434	0.000	99%
2.D.1 Lubricant Use	CO_2	8.298	8.298	0.000	99%
4.B.1 Cropland remaining Cropland – Carbon stock change – living biomass	CO_2	-8.288	8.288	0.000	100%
3.B.1.4 Manure Management - Other livestock	CH_4	7.840	7.840	0.000	100%
3.B.2.3 Manure Management - Swaine	N_2O	5.647	5.647	0.000	100%
1.A.4.a Commercial/Institutional - Biomass Fuels	N_2O	5.564	5.564	0.000	100%
1.A.2.g Other - Solid Fuels	CO_2	5.487	5.487	0.000	100%
4.B.2 Settlements converted to cropland, mineral soils	CO_2	5.310	5.310	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	5.263	5.263	0.000	100%
2.D.2 Paraffin wax use	CO_2	4.912	4.912	0.000	100%
4.B.2 Land converted to cropland, Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	4.883	4.883	0.000	100%
3.H. Urea Application	CO_2	4.726	4.726	0.000	100%
2.F.4. Aerosols	HFCs	4.698	4.698	0.000	100%
1.A.3.b Road Transportation - Gasoline	N_2O	4.607	4.607	0.000	100%
1.A.3.b Road Transportation - Lubricants	CO_2	4.555	4.555	0.000	100%
5.C.1 Waste Incineration	N_2O	4.381	4.381	0.000	100%
4.E.2 Settlements remaining Settlements, Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	4.083	4.083	0.000	100%
1.A.4.b Residential - Solid Fuels	CH_4	3.983	3.983	0.000	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CO_2	3.907	3.907	0.000	100%
4.B.2 Wetlands converted to cropland, organic soil	CO_2	3.824	3.824	0.000	100%
4.D.1. Wetlands, Peat extraction from lands, organic soils	N_2O	3.793	3.793	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CO_2	3.134	3.134	0.000	100%
1.A.3.b Road Transportation - LPG	N_2O	2.934	2.934	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	2.625	2.625	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	2.456	2.456	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	2.270	2.270	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	2.270	2.270	0.000	100%
3.B.2.2 Manure Management - Sheep	N_2O	2.221	2.221	0.000	100%
1.A.3.b Road Transportation - Gasoline	CH_4	2.207	2.207	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CO_2	2.126	2.126	0.000	100%
2.G.3. N_2O from product uses	N_2O	2.014	2.014	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	1.520	1.520	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	1.509	1.509	0.000	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	N_2O	1.490	1.490	0.000	100%
1.A.3.b Road Transportation - Diesel Oil	CH_4	1.357	1.357	0.000	100%
1.A.2.g Other - Peat	CO_2	1.331	1.331	0.000	100%
4.B.1 Cropland remaining Cropland – Carbon stock change – dead organic matter	CO_2	-1.291	1.291	0.000	100%
1.A.4.b Residential - Liquid Fuels	CH_4	1.276	1.276	0.000	100%
1.A.4.a Commercial/Institutional - Peat	CO_2	1.136	1.136	0.000	100%
1.A.2.c Chemicals - Peat	CO_2	1.122	1.122	0.000	100%
4.A.1 Forest land remaining forest land - wildfires	N_2O	1.078	1.078	0.000	100%
4.A.1 Forest land remaining forest land - Controlled burning	N_2O	1.025	1.025	0.000	100%
2.F.2 Foam blowing agents	HFCs	0.961	0.961	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.949	0.949	0.000	100%
2.A.3. Glass production	CO_2	0.943	0.943	0.000	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CH_4	0.937	0.937	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	0.865	0.865	0.000	100%
1.A.3.b Road Transportation - LPG	CH_4	0.864	0.864	0.000	100%
2.D.3.d Urea Use	CO_2	0.817	0.817	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	0.726	0.726	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	0.705	0.705	0.000	100%
4.C.1 Grassland remaining Grassland, wildfires	N_2O	0.663	0.663	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	0.650	0.650	0.000	100%
4.C.1 Grassland remaining Grassland, wildfires	CH_4	0.609	0.609	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	0.591	0.591	0.000	100%
5.C.1 Waste Incineration	CO_2	0.563	0.563	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	N_2O	0.561	0.561	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.557	0.557	0.000	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0.550	0.550	0.000	100%
1.A.4.b Residential - Gaseous Fuels	CH_4	0.532	0.532	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	N_2O	0.470	0.470	0.000	100%
2.A.2. Lime Production	CO_2	0.460	0.460	0.000	100%
3.B.1.2 Manure Management - Sheep	CH_4	0.439	0.439	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	0.431	0.431	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	0.398	0.398	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	0.370	0.370	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.351	0.351	0.000	100%
1.A.3.b Road Transportation - Biomass	N_2O	0.349	0.349	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.347	0.347	0.000	100%
1.A.4.b Residential - Liquid Fuels	N_2O	0.345	0.345	0.000	100%
1.A.2.c Chemicals - Biomass Fuels	N_2O	0.335	0.335	0.000	100%
1.A.3.c Railways - Liquid Fuels	CH_4	0.300	0.300	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	CH_4	0.296	0.296	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.280	0.280	0.000	100%
1.A.2.g Other - Liquid Fuels	N_2O	0.252	0.252	0.000	100%
1.A.4.b Residential - Solid Fuels	N_2O	0.237	0.237	0.000	100%
1.A.2.c Chemicals - Biomass Fuels	CH_4	0.211	0.211	0.000	100%
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	0.182	0.182	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	0.180	0.180	0.000	100%
1.A.2.g Other - Liquid Fuels	CH_4	0.174	0.174	0.000	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.131	0.131	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	0.127	0.127	0.000	100%
1.A.4.b Residential - Gaseous Fuels	N_2O	0.127	0.127	0.000	100%
5.D.2 Industrial Wastewater	N_2O	0.116	0.116	0.000	100%
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	0.102	0.102	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	0.078	0.078	0.000	100%
1.A.5.b Mobile - Liquid Fuels	N_2O	0.076	0.076	0.000	100%
2.D.3.b Road paving with asphalt	CO_2	0.054	0.054	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.052	0.052	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0.051	0.051	0.000	100%
1.A.2.g Other - Gaseous Fuels	N_2O	0.050	0.050	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.049	0.049	0.000	100%
2.D.3.c Asphalt roofing	CO_2	0.049	0.049	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	0.044	0.044	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.043	0.043	0.000	100%
1.A.2.g Other - Gaseous Fuels	CH_4	0.042	0.042	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.040	0.040	0.000	100%
1.A.3.c. Railway Biomass Fuels	N_2O	0.035	0.035	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	N_2O	0.035	0.035	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.034	0.034	0.000	100%
1.A.3.b Road Transportation - Lubricants	N_2O	0.033	0.033	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.031	0.031	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.030	0.030	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.029	0.029	0.000	100%
2.F.3. Fire Protection	HFCs	0.028	0.028	0.000	100%
1.A.2.g Other - Solid Fuels	N_2O	0.026	0.026	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0.025	0.025	0.000	100%
1.A.3.b Road Transportation - Biomass	CH_4	0.023	0.023	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CH_4	0.022	0.022	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CH_4	0.021	0.021	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.021	0.021	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.021	0.021	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.020	0.020	0.000	100%
1.A.5.b Mobile - Liquid Fuels	CH_4	0.019	0.019	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.017	0.017	0.000	100%
1.A.3.b Road Transportation - Lubricants	CH_4	0.015	0.015	0.000	100%
1.B.2.b Natural Gas	CO_2	0.011	0.011	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0.011	0.011	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.011	0.011	0.000	100%
2.C.1 Iron and Steel Production	CO_2	0.010	0.010	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.009	0.009	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0.008	0.008	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	N_2O	0.007	0.007	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.006	0.006	0.000	100%
1.A.2.g Other - Peat	N_2O	0.006	0.006	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	0.006	0.006	0.000	100%
1.A.2.c Chemicals - Peat	N_2O	0.005	0.005	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.005	0.005	0.000	100%
1.A.4.a Commercial/Institutional - Peat	N_2O	0.005	0.005	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.004	0.004	0.000	100%
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	N_2O	0.004	0.004	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.003	0.003	0.000	100%
1.A.4.a Commercial/Institutional - Peat	CH_4	0.003	0.003	0.000	100%
1.B.2.c Venting and Flaring	CO_2	0.003	0.003	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	0.002	0.002	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0.002	0.002	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	0.002	0.002	0.000	100%
1.A.3.c. Railway Biomass Fuels	CH_4	0.002	0.002	0.000	100%
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	CH_4	0.002	0.002	0.000	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	N_2O	0.002	0.002	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.3.a Domestic Aviation - Jet kerosene	CH_4	0.002	0.002	0.000	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CH_4	0.002	0.002	0.000	100%
1.A.2.g Other - Solid Fuels	CH_4	0.001	0.001	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.001	0.001	0.000	100%
1.A.2.g Other - Peat	CH_4	0.001	0.001	0.000	100%
1.A.2.c Chemicals - Peat	CH_4	0.001	0.001	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CH_4	0.000	0.000	0.000	100%
2.C.1 Iron and Steel Production	CH_4	0.000	0.000	0.000	100%
TOTAL		15573.52	30581.938		

A.1.6 Spreadsheet for the Approach 1 analysis for 2014 – level assessment without LULUCF

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.3.b Road Transportation - Diesel Oil	CO_2	1880.266	1880.266	0.166	17%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	1575.699	1575.699	0.139	30%
3.D.1. Direct N_2O emissions from managed soils	N_2O	1429.498	1429.498	0.126	43%
3.A.1 Enteric Fermentation - Cattle	CH_4	828.043	828.043	0.073	50%
1.A.3.b Road Transportation - Gasoline	CO_2	613.358	613.358	0.054	56%
2.A.1. Cement Production	CO_2	555.776	555.776	0.049	61%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	320.575	320.575	0.028	63%
5.A.1. Managed Waste Disposal on Land	CH_4	301.024	301.024	0.027	66%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	238.797	238.797	0.021	68%
1.A.4.b Residential - Gaseous Fuels	CO_2	230.712	230.712	0.020	70%
5.A.2. Unmanaged Waste Disposal Sites	CH_4	227.802	227.802	0.020	72%
1.A.3.c Railways - Liquid Fuels	CO_2	213.786	213.786	0.019	74%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
2.F.1. Refrigeration and air conditioning	HFCs	206.377	206.377	0.018	76%
3.D.2 Indirect N_2O Emissions from managed soils	N_2O	196.044	196.044	0.017	78%
1.A.3.b Road Transportation - LPG	CO_2	165.243	165.243	0.015	79%
1.A.4.b Residential - Liquid Fuels	CO_2	157.132	157.132	0.014	81%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	155.562	155.562	0.014	82%
5.D.2 Industrial Wastewater	CH_4	138.525	138.525	0.012	83%
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	118.628	118.628	0.010	84%
5.D.1 Domestic Wastewater	CH_4	109.507	109.507	0.010	85%
1.B.2.b Natural Gas	CH_4	109.190	109.190	0.010	86%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CO_2	107.569	107.569	0.009	87%
1.A.2.g Other - Liquid Fuels	CO_2	104.814	104.814	0.009	88%
1.A.4.b Residential - Biomass Fuels	CH_4	101.654	101.654	0.009	89%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	93.815	93.815	0.008	90%
1.A.2.g Other - Gaseous Fuels	CO_2	91.048	91.048	0.008	90%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	73.413	73.413	0.006	91%
3.B.1.1 Manure Management - Cattle	CH_4	70.595	70.595	0.006	92%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	55.182	55.182	0.005	92%
1.A.4.b Residential - Solid Fuels	CO_2	50.233	50.233	0.004	93%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	45.035	45.035	0.004	93%
3.B.2.1 Manure Management - Cattle	N_2O	42.947	42.947	0.004	93%
3.B.5 Indirect N_2O emissions from Manure Management	N_2O	41.938	41.938	0.004	94%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	38.502	38.502	0.003	94%
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	34.973	34.973	0.003	94%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	33.544	33.544	0.003	95%
2.D.3. Solvent Use	CO_2	32.197	32.197	0.003	95%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	26.178	26.178	0.002	95%
1.B.2.c Venting and Flaring	CH_4	26.126	26.126	0.002	95%
1.A.3.c Railways - Liquid Fuels	N_2O	24.624	24.624	0.002	96%
5.B.1. Composting	CH_4	22.465	22.465	0.002	96%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	21.164	21.164	0.002	96%
3.B.1.3 Manure Management - Swaine	CH_4	20.646	20.646	0.002	96%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	20.350	20.350	0.002	96%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
3.G. Liming	CO_2	19.686	19.686	0.002	97%
1.A.3.b Road Transportation - Diesel Oil	N_2O	19.447	19.447	0.002	97%
3.A.2 Enteric Fermentation - Sheep	CH_4	18.500	18.500	0.002	97%
1.A.2.g Other - Biomass Fuels	N_2O	17.427	17.427	0.002	97%
1.A.2.c Chemicals - Gaseous Fuels	CO_2	17.146	17.146	0.002	97%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	16.555	16.555	0.001	97%
5.D.1 Domestic Wastewater	N_2O	16.537	16.537	0.001	98%
5.B.1. Composting	N_2O	16.067	16.067	0.001	98%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	13.386	13.386	0.001	98%
3.A.3 Enteric Fermentation - Swine	CH_4	13.103	13.103	0.001	98%
3.A.4 Enteric Fermentation - Other livestock	CH_4	13.022	13.022	0.001	98%
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	12.580	12.580	0.001	98%
3.B.2.4 Manure Management - Other livestock	N_2O	11.522	11.522	0.001	98%
1.A.2.g Other - Biomass Fuels	CH_4	10.965	10.965	0.001	98%
2.A.4. Other process uses of carbonates	CO_2	10.833	10.833	0.001	98%
1.A.4.b Residential - Biomass Fuels	N_2O	10.597	10.597	0.001	99%
1.A.2.c Chemicals - Liquid Fuels	CO_2	10.101	10.101	0.001	99%
1.A.5.b Mobile - Liquid Fuels	CO_2	9.442	9.442	0.001	99%
2.G.1. Electrical equipment	SF6	8.578	8.578	0.001	99%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	8.434	8.434	0.001	99%
2.D.1 Lubricant Use	CO_2	8.298	8.298	0.001	99%
3.B.1.4 Manure Management - Other livestock	CH_4	7.840	7.840	0.001	99%
3.B.2.3 Manure Management - Swaine	N_2O	5.647	5.647	0.000	99%
1.A.4.a Commercial/Institutional - Biomass Fuels	N_2O	5.564	5.564	0.000	99%
1.A.2.g Other - Solid Fuels	CO_2	5.487	5.487	0.000	99%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	5.263	5.263	0.000	99%
2.D.2 Paraffin wax use	CO_2	4.912	4.912	0.000	99%
3.H. Urea Application	CO_2	4.726	4.726	0.000	99%
2.F.4. Aerosols	HFCs	4.698	4.698	0.000	99%
1.A.3.b Road Transportation - Gasoline	N_2O	4.607	4.607	0.000	99%
1.A.3.b Road Transportation - Lubricants	CO_2	4.555	4.555	0.000	99%
5.C.1 Waste Incineration	N_2O	4.381	4.381	0.000	99%
1.A.4.b Residential - Solid Fuels	CH_4	3.983	3.983	0.000	99%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CO_2	3.907	3.907	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CO_2	3.134	3.134	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.3.b Road Transportation - LPG	N_2O	2.934	2.934	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	2.625	2.625	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	2.456	2.456	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	2.270	2.270	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	2.270	2.270	0.000	100%
3.B.2.2 Manure Management - Sheep	N_2O	2.221	2.221	0.000	100%
1.A.3.b Road Transportation - Gasoline	CH_4	2.207	2.207	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CO_2	2.126	2.126	0.000	100%
2.G.3. N_2O from product uses	N_2O	2.014	2.014	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	1.520	1.520	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	1.509	1.509	0.000	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	N_2O	1.490	1.490	0.000	100%
1.A.3.b Road Transportation - Diesel Oil	CH_4	1.357	1.357	0.000	100%
1.A.2.g Other - Peat	CO_2	1.331	1.331	0.000	100%
1.A.4.b Residential - Liquid Fuels	CH_4	1.276	1.276	0.000	100%
1.A.4.a Commercial/Institutional - Peat	CO_2	1.136	1.136	0.000	100%
1.A.2.c Chemicals - Peat	CO_2	1.122	1.122	0.000	100%
2.F.2 Foam blowing agents	HFCs	0.961	0.961	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.949	0.949	0.000	100%
2.A.3. Glass production	CO_2	0.943	0.943	0.000	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CH_4	0.937	0.937	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	0.865	0.865	0.000	100%
1.A.3.b Road Transportation - LPG	CH_4	0.864	0.864	0.000	100%
2.D.3.d Urea Use	CO_2	0.817	0.817	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	0.726	0.726	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	0.705	0.705	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	0.650	0.650	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	0.591	0.591	0.000	100%
5.C.1 Waste Incineration	CO_2	0.563	0.563	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	N_2O	0.561	0.561	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.557	0.557	0.000	100%
1.A.4.a Commercial/Institutional - Gaseous	CH_4	0.550	0.550	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
Fuels					
1.A.4.b Residential - Gaseous Fuels	CH_4	0.532	0.532	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	N_2O	0.470	0.470	0.000	100%
2.A.2. Lime Production	CO_2	0.460	0.460	0.000	100%
3.B.1.2 Manure Management - Sheep	CH_4	0.439	0.439	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	0.431	0.431	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	0.398	0.398	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	0.370	0.370	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.351	0.351	0.000	100%
1.A.3.b Road Transportation - Biomass	N_2O	0.349	0.349	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.347	0.347	0.000	100%
1.A.4.b Residential - Liquid Fuels	N_2O	0.345	0.345	0.000	100%
1.A.2.c Chemicals - Biomass Fuels	N_2O	0.335	0.335	0.000	100%
1.A.3.c Railways - Liquid Fuels	CH_4	0.300	0.300	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	CH_4	0.296	0.296	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.280	0.280	0.000	100%
1.A.2.g Other - Liquid Fuels	N_2O	0.252	0.252	0.000	100%
1.A.4.b Residential - Solid Fuels	N_2O	0.237	0.237	0.000	100%
1.A.2.c Chemicals - Biomass Fuels	CH_4	0.211	0.211	0.000	100%
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	0.182	0.182	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	0.180	0.180	0.000	100%
1.A.2.g Other - Liquid Fuels	CH_4	0.174	0.174	0.000	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.131	0.131	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	0.127	0.127	0.000	100%
1.A.4.b Residential - Gaseous Fuels	N_2O	0.127	0.127	0.000	100%
5.D.2 Industrial Wastewater	N_2O	0.116	0.116	0.000	100%
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	0.102	0.102	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	0.078	0.078	0.000	100%
1.A.5.b Mobile - Liquid Fuels	N_2O	0.076	0.076	0.000	100%
2.D.3.b Road paving with asphalt	CO_2	0.054	0.054	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.052	0.052	0.000	100%
1.A.1.c Manufacture of Solid Fuels and	N_2O	0.051	0.051	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
Other Energy Industries - Liquid Fuels					
1.A.2.g Other - Gaseous Fuels	N_2O	0.050	0.050	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.049	0.049	0.000	100%
2.D.3.c Asphalt roofing	CO_2	0.049	0.049	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	0.044	0.044	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.043	0.043	0.000	100%
1.A.2.g Other - Gaseous Fuels	CH_4	0.042	0.042	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.040	0.040	0.000	100%
1.A.3.c. Railway Biomass Fuels	N_2O	0.035	0.035	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	N_2O	0.035	0.035	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.034	0.034	0.000	100%
1.A.3.b Road Transportation - Lubricants	N_2O	0.033	0.033	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.031	0.031	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.030	0.030	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.029	0.029	0.000	100%
2.F.3. Fire Protection	HFCs	0.028	0.028	0.000	100%
1.A.2.g Other - Solid Fuels	N_2O	0.026	0.026	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0.025	0.025	0.000	100%
1.A.3.b Road Transportation - Biomass	CH_4	0.023	0.023	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CH_4	0.022	0.022	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CH_4	0.021	0.021	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.021	0.021	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.021	0.021	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.020	0.020	0.000	100%
1.A.5.b Mobile - Liquid Fuels	CH_4	0.019	0.019	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.017	0.017	0.000	100%
1.A.3.b Road Transportation - Lubricants	CH_4	0.015	0.015	0.000	100%
1.B.2.b Natural Gas	CO_2	0.011	0.011	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0.011	0.011	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.011	0.011	0.000	100%
2.C.1 Iron and Steel Production	CO_2	0.010	0.010	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.009	0.009	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0.008	0.008	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	N_2O	0.007	0.007	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.006	0.006	0.000	100%
1.A.2.g Other - Peat	N_2O	0.006	0.006	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	0.006	0.006	0.000	100%
1.A.2.c Chemicals - Peat	N_2O	0.005	0.005	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.005	0.005	0.000	100%
1.A.4.a Commercial/Institutional - Peat	N_2O	0.005	0.005	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.004	0.004	0.000	100%
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	N_2O	0.004	0.004	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.003	0.003	0.000	100%
1.A.4.a Commercial/Institutional - Peat	CH_4	0.003	0.003	0.000	100%
1.B.2.c Venting and Flaring	CO_2	0.003	0.003	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	0.002	0.002	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0.002	0.002	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	0.002	0.002	0.000	100%
1.A.3.c. Railway Biomass Fuels	CH_4	0.002	0.002	0.000	100%
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	CH_4	0.002	0.002	0.000	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	N_2O	0.002	0.002	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CH_4	0.002	0.002	0.000	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CH_4	0.002	0.002	0.000	100%
1.A.2.g Other - Solid Fuels	CH_4	0.001	0.001	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.001	0.001	0.000	100%
1.A.2.g Other - Peat	CH_4	0.001	0.001	0.000	100%
1.A.2.c Chemicals - Peat	CH_4	0.001	0.001	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CH_4	0.000	0.000	0.000	100%
2.C.1 Iron and Steel Production	CH_4	0.000	0.000	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Level assessment	Cumulative total of Level assessment
TOTAL		11353.38	11353.38	1.000	

A.1.7 Spreadsheet for the Approach 2 analysis for 2014 – level assessment with LULUCF

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative total
4.E.2 Land converted to Settlements – Carbon stock change – living biomass	CO_2	480.918	480.918	20%	295%	2.953	0.016	0.046	0.139	14%
4.A.1 Forest Land remaining Forest Land – Drained organic soil	CO_2	4583.281	4583.281	5%	25%	0.256	0.150	0.038	0.114	25%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	N_2O	638.801	638.801	6%	119%	1.193	0.021	0.025	0.074	33%
4.D.1 Wetlands remaining Wetlands – Carbon stock change – living biomass	CO_2	-165.232	165.232	6%	435%	4.352	0.005	0.024	0.070	40%
3.D.1. Direct N_2O emissions from managed soils	N_2O	1429.498	1429.498	2%	50%	0.500	0.047	0.023	0.070	47%
4.B.1 Cropland remaining Cropland – Drained organic soil	CO_2	2598.777	2598.777	13%	18%	0.227	0.085	0.019	0.058	53%
4.E.1 Settlements remaining Settlements – Carbon stock change – living biomass	CO_2	-108.186	108.186	9%	389%	3.896	0.004	0.014	0.041	57%
4.C.2 Land converted to Grassland –Mineral soil	CO_2	-495.257	495.257	10%	61%	0.620	0.016	0.010	0.030	60%
4. G. Harvested wood products	CO_2	-1817.580	1817.580	15%	0%	0.150	0.059	0.009	0.027	62%
4.C.1 Grassland remaining Grassland – Drained organic soil	CO_2	684.007	684.007	26%	19%	0.319	0.022	0.007	0.021	64%
4.D.1. Wetlands, Peat extraction from lands, organic soils	CO_2	899.741	899.741	24%		0.242	0.029	0.007	0.021	67%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative total
4.A.1 Forest Land remaining Forest Land – Carbon stock change, dead wood	CO_2	-3792.439	3792.439	2%	5%	0.050	0.124	0.006	0.018	68%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	149.853	149.853	5%	119%	1.186	0.005	0.006	0.017	70%
4.A.2 Land converted to Forest Land – Carbon stock change, grassland converted to forest land	CO_2	-341.174	341.174	8%	50%	0.504	0.011	0.006	0.017	72%
4.D.1 Wetlands remaining Wetlands – Carbon stock change –organic soils	CO_2	277.200	277.200	24%	55%	0.604	0.009	0.005	0.016	74%
3.A.1 Enteric Fermentation - Cattle	CH_4	828.043	828.043	2%	20%	0.201	0.027	0.005	0.016	75%
4.C.2 Land converted to Grassland – Drained organic soil	CO_2	275.392	275.392	55%	19%	0.583	0.009	0.005	0.016	77%
5.A.1. Managed Waste Disposal on Land	CH_4	301.024	301.024	7%	52%	0.525	0.010	0.005	0.015	78%
2.F.1. Refrigeration and air conditioning	HFCs	206.377	206.377	50%	50%	0.707	0.007	0.005	0.014	80%
5.A.2. Unmanaged Waste Disposal Sites	CH_4	227.802	227.802	7%	52%	0.525	0.007	0.004	0.012	81%
4.B.2 Land converted to Cropland – Drained organic soil	CO_2	89.507	89.507	114%	18%	1.153	0.003	0.003	0.010	82%
3.D.2 Indirect N_2O Emissions from managed soils	N_2O	196.044	196.044	2%	50%	0.500	0.006	0.003	0.010	83%
5.D.2 Industrial Wastewater	CH_4	138.525	138.525	64%	30%	0.707	0.005	0.003	0.010	84%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative total
4.B. Cropland remaining cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	119.045	119.045	13%	71%	0.722	0.004	0.003	0.008	85%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	1575.699	1575.699	2%	5%	0.054	0.052	0.003	0.008	85%
4.E.2 Land converted to Settlements – Organic soils	CO_2	166.176	166.176	47%	18%	0.505	0.005	0.003	0.008	86%
4.A.1 Forest land remaining forest land - Controlled burning	CO_2	88.884	88.884	92%	6%	0.922	0.003	0.003	0.008	87%
4.E.2 Land converted to Settlements – Mineral soils	CO_2	107.292	107.292	22%	60%	0.639	0.004	0.002	0.007	88%
2.A.1. Cement Production	CO_2	555.776	555.776	10%	5%	0.112	0.018	0.002	0.006	88%
5.D.1 Domestic Wastewater	CH_4	109.507	109.507	45%	30%	0.541	0.004	0.002	0.006	89%
4.B.1 Cropland remaining Cropland – Carbon stock change – living biomass	CO_2	-8.288	8.288	3%	701%	7.007	0.000	0.002	0.006	89%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	22.068	22.068	5%	242%	2.421	0.001	0.002	0.005	90%
1.A.3.b Road Transportation - Diesel Oil	CO_2	1880.266	1880.266	2%	2%	0.028	0.061	0.002	0.005	91%
4.C.1 Grassland remaining Grassland – Carbon stock change – living biomass	CO_2	-42.877	42.877	5%	122%	1.222	0.001	0.002	0.005	91%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative total
4.C. Grassland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	72.895	72.895	24%	58%	0.629	0.002	0.002	0.004	91%
4.B.2 Land converted to Cropland –Mineral soil	CO_2	48.750	48.750	64%	61%	0.889	0.002	0.001	0.004	92%
4.E.2 Land converted to Settlements – Carbon stock change – dead organic matter	CO_2	197.497	197.497	20%		0.196	0.006	0.001	0.004	92%
4.B.2 Land converted to Cropland – Carbon stock change, forest land converted to cropland	CO_2	21.176	21.176	53%	161%	1.693	0.001	0.001	0.004	93%
1.B.2.b Natural Gas	CH_4	109.190	109.190	32%	0%	0.322	0.004	0.001	0.003	93%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	320.575	320.575	2%	11%	0.109	0.010	0.001	0.003	93%
4.A.2 Land converted to Forest Land – grassland converted to forest land, Drained organic soil	CO_2	61.248	61.248	44%	25%	0.502	0.002	0.001	0.003	94%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	55.182	55.182	2%	50%	0.500	0.002	0.001	0.003	94%
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	118.628	118.628	2%	20%	0.201	0.004	0.001	0.002	94%
5.D.1 Domestic Wastewater	N_2O	16.537	16.537	140%	30%	1.432	0.001	0.001	0.002	94%
5.B.1. Composting	CH_4	22.465	22.465	29%	100%	1.041	0.001	0.001	0.002	95%
3.B.1.1 Manure Management - Cattle	CH_4	70.595	70.595	25%	20%	0.320	0.002	0.001	0.002	95%
4.D.1. Wetlands, Peat extraction from lands, organic soils	CH_4	28.534	28.534	24%	71%	0.751	0.001	0.001	0.002	95%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative total
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	34.973	34.973	5%	50%	0.502	0.001	0.001	0.002	95%
1.A.3.b Road Transportation - Gasoline	CO_2	613.358	613.358	2%	2%	0.028	0.020	0.001	0.002	95%
4.E.2 Lands converted to settlements, Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	40.479	40.479	20%	38%	0.425	0.001	0.001	0.002	96%
4.A.1 Forest Land remaining Forest Land – Carbon stock change, living biomass	CO_2	-529.092	529.092	2%	3%	0.032	0.017	0.001	0.002	96%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	33.544	33.544	2%	50%	0.500	0.001	0.001	0.002	96%
1.A.4.b Residential - Liquid Fuels	CO_2	157.132	157.132	2%	10%	0.102	0.005	0.001	0.002	96%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	155.562	155.562	2%	10%	0.102	0.005	0.001	0.002	96%
5.B.1. Composting	N_2O	16.067	16.067	29%	90%	0.946	0.001	0.000	0.001	96%
1.A.4.b Residential - Biomass Fuels	CH_4	101.654	101.654	10%	10%	0.141	0.003	0.000	0.001	96%
3.B.2.1 Manure Management - Cattle	N_2O	42.947	42.947	25%	20%	0.320	0.001	0.000	0.001	97%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	238.797	238.797	2%	5%	0.054	0.008	0.000	0.001	97%
3.B.5 Indirect N_2O emissions from Manure Management	N_2O	41.938	41.938	2%	30%	0.301	0.001	0.000	0.001	97%
1.A.4.b Residential - Gaseous Fuels	CO_2	230.712	230.712	2%	5%	0.054	0.008	0.000	0.001	97%
1.A.3.c Railways - Liquid Fuels	N_2O	24.624	24.624	2%	50%	0.500	0.001	0.000	0.001	97%
1.A.3.c Railways - Liquid Fuels	CO_2	213.786	213.786	2%	5%	0.054	0.007	0.000	0.001	97%

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1.A.2.g Other - Liquid Fuels	CO_2	104.814	104.814	2%	10%	0.102	0.003	0.000	0.001	97%
1.A.4.b Residential - Solid Fuels	CO_2	50.233	50.233	2%	20%	0.201	0.002	0.000	0.001	97%
3.G. Liming	CO_2	19.686	19.686	2%	50%	0.500	0.001	0.000	0.001	98%
1.A.3.b Road Transportation - Diesel Oil	N_2O	19.447	19.447	2%	50%	0.500	0.001	0.000	0.001	98%
3.A.2 Enteric Fermentation - Sheep	CH_4	18.500	18.500	2%	50%	0.500	0.001	0.000	0.001	98%
1.A.3.b Road Transportation - LPG	CO_2	165.243	165.243	2%	5%	0.054	0.005	0.000	0.001	98%
1.A.2.g Other - Biomass Fuels	N_2O	17.427	17.427	5%	50%	0.502	0.001	0.000	0.001	98%
4.A.1 Forest land remaining forest land - Controlled burning	CH_4	8.745	8.745	92%	36%	0.988	0.000	0.000	0.001	98%
4.B.2 Land converted to cropland, Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	4.883	4.883	64%	151%	1.639	0.000	0.000	0.001	98%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	38.502	38.502	2%	20%	0.201	0.001	0.000	0.001	98%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	13.386	13.386	5%	50%	0.502	0.000	0.000	0.001	98%
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, dead wood	CO_2	-83.797	83.797	8%		0.080	0.003	0.000	0.001	98%
3.B.1.3 Manure Management - Swaine	CH_4	20.646	20.646	25%	20%	0.320	0.001	0.000	0.001	98%
3.A.4 Enteric Fermentation - Other livestock	CH_4	13.022	13.022	2%	50%	0.500	0.000	0.000	0.001	98%

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2.D.3. Solvent Use	CO_2	32.197	32.197	2%	20%	0.201	0.001	0.000	0.001	98%
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, litter	CO_2	-71.844	71.844	8%		0.080	0.002	0.000	0.001	98%
1.A.2.g Other - Biomass Fuels	CH_4	10.965	10.965	5%	50%	0.502	0.000	0.000	0.001	99%
2.A.4. Other process uses of carbonates	CO_2	10.833	10.833	2%	50%	0.500	0.000	0.000	0.001	99%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	93.815	93.815	2%	5%	0.054	0.003	0.000	0.000	99%
2.D.2 Paraffin wax use	CO_2	4.912	4.912	2%	100%	1.000	0.000	0.000	0.000	99%
1.A.2.g Other - Gaseous Fuels	CO_2	91.048	91.048	2%	5%	0.054	0.003	0.000	0.000	99%
5.C.1 Waste Incineration	N_2O	4.381	4.381	43%	100%	1.089	0.000	0.000	0.000	99%
4.A.1 Forest land remaining forest land - wildfires	CH_4	9.198	9.198	37%	36%	0.516	0.000	0.000	0.000	99%
1.A.5.b Mobile - Liquid Fuels	CO_2	9.442	9.442	2%	50%	0.500	0.000	0.000	0.000	99%
4.B.2 Settlements converted to cropland, mineral soils	CO_2	5.310	5.310	64%	60%	0.881	0.000	0.000	0.000	99%
4.B.1 Land converted to Cropland – Carbon stock change – dead organic matter	CO_2	8.696	8.696	53%		0.534	0.000	0.000	0.000	99%
3.B.2.4 Manure Management - Other livestock	N_2O	11.522	11.522	25%	30%	0.391	0.000	0.000	0.000	99%
4.B.2 Wetlands converted to cropland, organic soil	CO_2	3.824	3.824	114%	18%	1.153	0.000	0.000	0.000	99%
4.D.1. Wetlands, Peat extraction from lands, organic soils	N_2O	3.793	3.793	24%	112%	1.146	0.000	0.000	0.000	99%

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1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	8.434	8.434	5%	50%	0.502	0.000	0.000	0.000	99%
2.D.1 Lubricant Use	CO_2	8.298	8.298	2%	50%	0.500	0.000	0.000	0.000	99%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	73.413	73.413	2%	5%	0.054	0.002	0.000	0.000	99%
4.E.1 Settlements remaining Settlements – Drained organic soils	CO_2	19.430	19.430	9%	18%	0.203	0.001	0.000	0.000	99%
1.A.4.b Residential - Biomass Fuels	N_2O	10.597	10.597	10%	30%	0.316	0.000	0.000	0.000	99%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	16.555	16.555	2%	20%	0.201	0.001	0.000	0.000	99%
2.F.4. Aerosols	HFCs	4.698	4.698	50%	50%	0.707	0.000	0.000	0.000	99%
3.B.1.4 Manure Management - Other livestock	CH_4	7.840	7.840	25%	30%	0.391	0.000	0.000	0.000	99%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CO_2	107.569	107.569	2%	2%	0.028	0.004	0.000	0.000	99%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	26.178	26.178	2%	11%	0.111	0.001	0.000	0.000	99%
1.A.4.a Commercial/Institutional - Biomass Fuels	N_2O	5.564	5.564	5%	50%	0.502	0.000	0.000	0.000	99%
3.A.3 Enteric Fermentation - Swine	CH_4	13.103	13.103	2%	20%	0.201	0.000	0.000	0.000	99%
1.B.2.c Venting and Flaring	CH_4	26.126	26.126	10%	0%	0.100	0.001	0.000	0.000	100%
2.G.1. Electrical equipment	SF6	8.578	8.578	2%	30%	0.301	0.000	0.000	0.000	100%
3.H. Urea Application	CO_2	4.726	4.726	20%	50%	0.539	0.000	0.000	0.000	100%

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1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	45.035	45.035	2%	5%	0.054	0.001	0.000	0.000	100%
1.A.3.b Road Transportation - Gasoline	N_2O	4.607	4.607	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	21.164	21.164	2%	10%	0.102	0.001	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	20.350	20.350	2%	10%	0.102	0.001	0.000	0.000	100%
1.A.4.b Residential - Solid Fuels	CH_4	3.983	3.983	2%	50%	0.500	0.000	0.000	0.000	100%
3.B.2.3 Manure Management - Swaine	N_2O	5.647	5.647	25%	20%	0.320	0.000	0.000	0.000	100%
4.D.1 Wetlands remaining Wetlands – Carbon stock change – dead organic matter	CO_2	-29.466	29.466	6%		0.059	0.001	0.000	0.000	100%
4.E.2 Settlements remaining Settlements, Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	4.083	4.083	9%	38%	0.387	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - LPG	N_2O	2.934	2.934	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	2.625	2.625	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	2.270	2.270	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Solid Fuels	CO_2	5.487	5.487	2%	20%	0.201	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	CO_2	10.101	10.101	2%	10%	0.102	0.000	0.000	0.000	100%

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4.A.1 Forest land remaining forest land - Controlled burning	N_2O	1.025	1.025	92%		0.920	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	CO_2	17.146	17.146	2%	5%	0.054	0.001	0.000	0.000	100%
4.E.1 Settlements remaining Settlements – Carbon stock change – dead organic matter	CO_2	-10.612	10.612	9%		0.087	0.000	0.000	0.000	100%
3.B.2.2 Manure Management - Sheep	N_2O	2.221	2.221	25%	30%	0.391	0.000	0.000	0.000	100%
2.A.3. Glass production	CO_2	0.943	0.943	2%	86%	0.860	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	1.520	1.520	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	1.509	1.509	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	N_2O	1.490	1.490	2%	50%	0.500	0.000	0.000	0.000	100%
2.F.2 Foam blowing agents	HFCs	0.961	0.961	50%	50%	0.707	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	12.580	12.580	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Gasoline	CH_4	2.207	2.207	2%	30%	0.301	0.000	0.000	0.000	100%
1.A.4.b Residential - Liquid Fuels	CH_4	1.276	1.276	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Lubricants	CO_2	4.555	4.555	10%	5%	0.112	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.949	0.949	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CH_4	0.937	0.937	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	2.270	2.270	2%	20%	0.201	0.000	0.000	0.000	100%

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1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	0.865	0.865	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - LPG	CH_4	0.864	0.864	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CO_2	2.126	2.126	2%	20%	0.201	0.000	0.000	0.000	100%
4.C.1 Grassland remaining Grassland – Carbon stock change – dead organic matter	CO_2	-8.557	8.557	5%		0.050	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Diesel Oil	CH_4	1.357	1.357	2%	30%	0.301	0.000	0.000	0.000	100%
4.A.1 Forest land remaining forest land - wildfires	N_2O	1.078	1.078	37%		0.370	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	0.726	0.726	2%	50%	0.500	0.000	0.000	0.000	100%
5.C.1 Waste Incineration	CO_2	0.563	0.563	43%	40%	0.587	0.000	0.000	0.000	100%
4.C.1 Grassland remaining Grassland, wildfires	N_2O	0.663	0.663	10%	48%	0.490	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	0.650	0.650	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	0.591	0.591	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	5.263	5.263	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	N_2O	0.561	0.561	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.557	0.557	5%	50%	0.502	0.000	0.000	0.000	100%

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1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0.550	0.550	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.b Residential - Gaseous Fuels	CH_4	0.532	0.532	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	2.456	2.456	2%	10%	0.102	0.000	0.000	0.000	100%
4.C.1 Grassland remaining Grassland, wildfires	CH_4	0.609	0.609	10%	39%	0.403	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	N_2O	0.470	0.470	5%	50%	0.502	0.000	0.000	0.000	100%
2.A.2. Lime Production	CO_2	0.460	0.460	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	0.431	0.431	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CO_2	3.907	3.907	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	0.370	0.370	2%	50%	0.500	0.000	0.000	0.000	100%
2.D.3.d Urea Use	CO_2	0.817	0.817	20%	10%	0.224	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.351	0.351	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Biomass	N_2O	0.349	0.349	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.b Residential - Liquid Fuels	N_2O	0.345	0.345	2%	50%	0.500	0.000	0.000	0.000	100%
3.B.1.2 Manure Management - Sheep	CH_4	0.439	0.439	25%	30%	0.391	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CO_2	3.134	3.134	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Biomass Fuels	N_2O	0.335	0.335	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.3.c Railways - Liquid Fuels	CH_4	0.300	0.300	2%	50%	0.500	0.000	0.000	0.000	100%

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1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	CH_4	0.296	0.296	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.g Other - Peat	CO_2	1.331	1.331	2%	10%	0.102	0.000	0.000	0.000	100%
1.A.2.g Other - Liquid Fuels	N_2O	0.252	0.252	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Peat	CO_2	1.136	1.136	2%	11%	0.111	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Peat	CO_2	1.122	1.122	2%	11%	0.111	0.000	0.000	0.000	100%
1.A.4.b Residential - Solid Fuels	N_2O	0.237	0.237	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Biomass Fuels	CH_4	0.211	0.211	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	0.182	0.182	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	0.180	0.180	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Liquid Fuels	CH_4	0.174	0.174	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.347	0.347	20%	5%	0.206	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.131	0.131	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	0.127	0.127	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.b Residential - Gaseous Fuels	N_2O	0.127	0.127	2%	50%	0.500	0.000	0.000	0.000	100%
2.G.3. N_2O from product uses	N_2O	2.014	2.014	2%	2%	0.028	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	0.102	0.102	2%	50%	0.500	0.000	0.000	0.000	100%
5.D.2 Industrial Wastewater	N_2O	0.116	0.116	23%	30%	0.378	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	0.398	0.398	2%	10%	0.102	0.000	0.000	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative total
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	0.078	0.078	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.5.b Mobile - Liquid Fuels	N_2O	0.076	0.076	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	0.705	0.705	2%	5%	0.054	0.000	0.000	0.000	100%
2.D.3.b Road paving with asphalt	CO_2	0.054	0.054	20%	60%	0.632	0.000	0.000	0.000	100%
4.B.1 Cropland remaining Cropland – Carbon stock change – dead organic matter	CO_2	-1.291	1.291	3%		0.026	0.000	0.000	0.000	100%
2.D.3.c Asphalt roofing	CO_2	0.049	0.049	20%	60%	0.632	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.052	0.052	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0.051	0.051	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Gaseous Fuels	N_2O	0.050	0.050	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.049	0.049	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	0.044	0.044	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.043	0.043	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Gaseous Fuels	CH_4	0.042	0.042	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.040	0.040	2%	50%	0.500	0.000	0.000	0.000	100%
2.F.3. Fire Protection	HFCs	0.028	0.028	50%	50%	0.707	0.000	0.000	0.000	100%
1.A.3.c. Railway Biomass Fuels	N_2O	0.035	0.035	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative total
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	N_2O	0.035	0.035	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.034	0.034	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Lubricants	N_2O	0.033	0.033	10%	50%	0.510	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.031	0.031	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.030	0.030	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.280	0.280	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.029	0.029	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Solid Fuels	N_2O	0.026	0.026	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0.025	0.025	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Biomass	CH_4	0.023	0.023	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CH_4	0.022	0.022	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CH_4	0.021	0.021	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.021	0.021	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.021	0.021	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.020	0.020	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative total
1.A.5.b Mobile - Liquid Fuels	CH_4	0.019	0.019	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.017	0.017	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Lubricants	CH_4	0.015	0.015	10%	50%	0.510	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0.011	0.011	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.011	0.011	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.009	0.009	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0.008	0.008	2%	50%	0.500	0.000	0.000	0.000	100%
1.B.2.b Natural Gas	CO_2	0.011	0.011	32%	0%	0.322	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	N_2O	0.007	0.007	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.006	0.006	20%	50%	0.539	0.000	0.000	0.000	100%
1.A.2.g Other - Peat	N_2O	0.006	0.006	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	0.006	0.006	2%	50%	0.500	0.000	0.000	0.000	100%
2.C.1 Iron and Steel Production	CO_2	0.010	0.010	5%	25%	0.255	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Peat	N_2O	0.005	0.005	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.005	0.005	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Peat	N_2O	0.005	0.005	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.004	0.004	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	N_2O	0.004	0.004	5%	50%	0.502	0.000	0.000	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative total
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.003	0.003	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Peat	CH_4	0.003	0.003	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.c. Railway Biomass Fuels	CH_4	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	CH_4	0.002	0.002	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	N_2O	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CH_4	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CH_4	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Solid Fuels	CH_4	0.001	0.001	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.001	0.001	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Peat	CH_4	0.001	0.001	2%	50%	0.500	0.000	0.000	0.000	100%
1.B.2.c Venting and Flaring	CO_2	0.003	0.003	10%	0%	0.100	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Peat	CH_4	0.001	0.001	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.000	0.000	20%	50%	0.539	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative total
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CH_4	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
2.C.1 Iron and Steel Production	CH_4	0.000	0.000	10%	25%	0.269	0.000	0.000	0.000	100%
TOTAL		15573.52	30581.938			162.446	1.000	0.335	1.000	

A.1.8 Spreadsheet for the Approach 2 analysis for 2014 – level assessment without LULUCF

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
3.D.1. Direct N_2O emissions from managed soils	N_2O	1429.498	1429.498	2%	50%	0.500	0.126	0.063	0.303	30%
3.A.1 Enteric Fermentation - Cattle	CH_4	828.043	828.043	2%	20%	0.201	0.073	0.015	0.070	37%
5.A.1. Managed Waste Disposal on Land	CH_4	301.024	301.024	7%	52%	0.525	0.027	0.014	0.067	44%
2.F.1. Refrigeration and air conditioning	HFCs	206.377	206.377	50%	50%	0.707	0.018	0.013	0.062	50%
5.A.2. Unmanaged Waste Disposal Sites	CH_4	227.802	227.802	7%	52%	0.525	0.020	0.011	0.051	55%
3.D.2 Indirect N_2O Emissions from managed soils	N_2O	196.044	196.044	2%	50%	0.500	0.017	0.009	0.042	59%
5.D.2 Industrial Wastewater	CH_4	138.525	138.525	64%	30%	0.707	0.012	0.009	0.041	64%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	1575.699	1575.699	2%	5%	0.054	0.139	0.007	0.036	67%
2.A.1. Cement Production	CO_2	555.776	555.776	10%	5%	0.112	0.049	0.005	0.026	70%
5.D.1 Domestic Wastewater	CH_4	109.507	109.507	45%	30%	0.541	0.010	0.005	0.025	72%
1.A.3.b Road Transportation - Diesel Oil	CO_2	1880.266	1880.266	2%	2%	0.028	0.166	0.005	0.022	74%
1.B.2.b Natural Gas	CH_4	109.190	109.190	32%	0%	0.322	0.010	0.003	0.015	76%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	320.575	320.575	2%	11%	0.109	0.028	0.003	0.015	77%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	55.182	55.182	2%	50%	0.500	0.005	0.002	0.012	79%
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	118.628	118.628	2%	20%	0.201	0.010	0.002	0.010	80%
5.D.1 Domestic Wastewater	N_2O	16.537	16.537	140%	30%	1.432	0.001	0.002	0.010	81%
5.B.1. Composting	CH_4	22.465	22.465	29%	100%	1.041	0.002	0.002	0.010	82%
3.B.1.1 Manure Management - Cattle	CH_4	70.595	70.595	25%	20%	0.320	0.006	0.002	0.010	83%
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	34.973	34.973	5%	50%	0.502	0.003	0.002	0.007	83%
1.A.3.b Road Transportation - Gasoline	CO_2	613.358	613.358	2%	2%	0.028	0.054	0.002	0.007	84%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	33.544	33.544	2%	50%	0.500	0.003	0.001	0.007	85%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.4.b Residential - Liquid Fuels	CO_2	157.132	157.132	2%	10%	0.102	0.014	0.001	0.007	85%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	155.562	155.562	2%	10%	0.102	0.014	0.001	0.007	86%
5.B.1. Composting	N_2O	16.067	16.067	29%	90%	0.946	0.001	0.001	0.006	87%
1.A.4.b Residential - Biomass Fuels	CH_4	101.654	101.654	10%	10%	0.141	0.009	0.001	0.006	87%
3.B.2.1 Manure Management - Cattle	N_2O	42.947	42.947	25%	20%	0.320	0.004	0.001	0.006	88%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	238.797	238.797	2%	5%	0.054	0.021	0.001	0.005	88%
3.B.5 Indirect N_2O emissions from Manure Management	N_2O	41.938	41.938	2%	30%	0.301	0.004	0.001	0.005	89%
1.A.4.b Residential - Gaseous Fuels	CO_2	230.712	230.712	2%	5%	0.054	0.020	0.001	0.005	90%
1.A.3.c Railways - Liquid Fuels	N_2O	24.624	24.624	2%	50%	0.500	0.002	0.001	0.005	90%
1.A.3.c Railways - Liquid Fuels	CO_2	213.786	213.786	2%	5%	0.054	0.019	0.001	0.005	91%
1.A.2.g Other - Liquid Fuels	CO_2	104.814	104.814	2%	10%	0.102	0.009	0.001	0.005	91%
1.A.4.b Residential - Solid Fuels	CO_2	50.233	50.233	2%	20%	0.201	0.004	0.001	0.004	91%
3.G. Liming	CO_2	19.686	19.686	2%	50%	0.500	0.002	0.001	0.004	92%
1.A.3.b Road Transportation - Diesel Oil	N_2O	19.447	19.447	2%	50%	0.500	0.002	0.001	0.004	92%
3.A.2 Enteric Fermentation - Sheep	CH_4	18.500	18.500	2%	50%	0.500	0.002	0.001	0.004	93%
1.A.3.b Road Transportation - LPG	CO_2	165.243	165.243	2%	5%	0.054	0.015	0.001	0.004	93%
1.A.2.g Other - Biomass Fuels	N_2O	17.427	17.427	5%	50%	0.502	0.002	0.001	0.004	93%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	38.502	38.502	2%	20%	0.201	0.003	0.001	0.003	94%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	13.386	13.386	5%	50%	0.502	0.001	0.001	0.003	94%
3.B.1.3 Manure Management - Swaine	CH_4	20.646	20.646	25%	20%	0.320	0.002	0.001	0.003	94%
3.A.4 Enteric Fermentation - Other livestock	CH_4	13.022	13.022	2%	50%	0.500	0.001	0.001	0.003	95%
2.D.3. Solvent Use	CO_2	32.197	32.197	2%	20%	0.201	0.003	0.001	0.003	95%
1.A.2.g Other - Biomass Fuels	CH_4	10.965	10.965	5%	50%	0.502	0.001	0.000	0.002	95%
2.A.4. Other process uses of carbonates	CO_2	10.833	10.833	2%	50%	0.500	0.001	0.000	0.002	95%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	93.815	93.815	2%	5%	0.054	0.008	0.000	0.002	96%
2.D.2 Paraffin wax use	CO_2	4.912	4.912	2%	100%	1.000	0.000	0.000	0.002	96%
1.A.2.g Other - Gaseous Fuels	CO_2	91.048	91.048	2%	5%	0.054	0.008	0.000	0.002	96%
5.C.1 Waste Incineration	N_2O	4.381	4.381	43%	100%	1.089	0.000	0.000	0.002	96%
1.A.5.b Mobile - Liquid Fuels	CO_2	9.442	9.442	2%	50%	0.500	0.001	0.000	0.002	96%
3.B.2.4 Manure Management - Other livestock	N_2O	11.522	11.522	25%	30%	0.391	0.001	0.000	0.002	97%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	8.434	8.434	5%	50%	0.502	0.001	0.000	0.002	97%
2.D.1 Lubricant Use	CO_2	8.298	8.298	2%	50%	0.500	0.001	0.000	0.002	97%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	73.413	73.413	2%	5%	0.054	0.006	0.000	0.002	97%
1.A.4.b Residential - Biomass Fuels	N_2O	10.597	10.597	10%	30%	0.316	0.001	0.000	0.001	97%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	16.555	16.555	2%	20%	0.201	0.001	0.000	0.001	97%
2.F.4. Aerosols	HFCs	4.698	4.698	50%	50%	0.707	0.000	0.000	0.001	97%
3.B.1.4 Manure Management - Other livestock	CH_4	7.840	7.840	25%	30%	0.391	0.001	0.000	0.001	98%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CO_2	107.569	107.569	2%	2%	0.028	0.009	0.000	0.001	98%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	26.178	26.178	2%	11%	0.111	0.002	0.000	0.001	98%
1.A.4.a Commercial/Institutional - Biomass Fuels	N_2O	5.564	5.564	5%	50%	0.502	0.000	0.000	0.001	98%
3.A.3 Enteric Fermentation - Swine	CH_4	13.103	13.103	2%	20%	0.201	0.001	0.000	0.001	98%
1.B.2.c Venting and Flaring	CH_4	26.126	26.126	10%	0%	0.100	0.002	0.000	0.001	98%
2.G.1. Electrical equipment	SF6	8.578	8.578	2%	30%	0.301	0.001	0.000	0.001	98%
3.H. Urea Application	CO_2	4.726	4.726	20%	50%	0.539	0.000	0.000	0.001	98%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	45.035	45.035	2%	5%	0.054	0.004	0.000	0.001	99%
1.A.3.b Road Transportation - Gasoline	N_2O	4.607	4.607	2%	50%	0.500	0.000	0.000	0.001	99%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	21.164	21.164	2%	10%	0.102	0.002	0.000	0.001	99%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	20.350	20.350	2%	10%	0.102	0.002	0.000	0.001	99%
1.A.4.b Residential - Solid Fuels	CH_4	3.983	3.983	2%	50%	0.500	0.000	0.000	0.001	99%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
3.B.2.3 Manure Management - Swaine	N_2O	5.647	5.647	25%	20%	0.320	0.000	0.000	0.001	99%
1.A.3.b Road Transportation - LPG	N_2O	2.934	2.934	2%	50%	0.500	0.000	0.000	0.001	99%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	2.625	2.625	5%	50%	0.502	0.000	0.000	0.001	99%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	2.270	2.270	2%	50%	0.500	0.000	0.000	0.000	99%
1.A.2.g Other - Solid Fuels	CO_2	5.487	5.487	2%	20%	0.201	0.000	0.000	0.000	99%
1.A.2.c Chemicals - Liquid Fuels	CO_2	10.101	10.101	2%	10%	0.102	0.001	0.000	0.000	99%
1.A.2.c Chemicals - Gaseous Fuels	CO_2	17.146	17.146	2%	5%	0.054	0.002	0.000	0.000	99%
3.B.2.2 Manure Management - Sheep	N_2O	2.221	2.221	25%	30%	0.391	0.000	0.000	0.000	99%
2.A.3. Glass production	CO_2	0.943	0.943	2%	86%	0.860	0.000	0.000	0.000	99%
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	1.520	1.520	2%	50%	0.500	0.000	0.000	0.000	99%
1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	1.509	1.509	5%	50%	0.502	0.000	0.000	0.000	99%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	N_2O	1.490	1.490	2%	50%	0.500	0.000	0.000	0.000	99%
2.F.2 Foam blowing agents	HFCs	0.961	0.961	50%	50%	0.707	0.000	0.000	0.000	99%
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	12.580	12.580	2%	5%	0.054	0.001	0.000	0.000	99%
1.A.3.b Road Transportation - Gasoline	CH_4	2.207	2.207	2%	30%	0.301	0.000	0.000	0.000	99%
1.A.4.b Residential - Liquid Fuels	CH_4	1.276	1.276	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.3.b Road Transportation - Lubricants	CO_2	4.555	4.555	10%	5%	0.112	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.949	0.949	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CH_4	0.937	0.937	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	2.270	2.270	2%	20%	0.201	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	0.865	0.865	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - LPG	CH_4	0.864	0.864	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CO_2	2.126	2.126	2%	20%	0.201	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Diesel Oil	CH_4	1.357	1.357	2%	30%	0.301	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	0.726	0.726	2%	50%	0.500	0.000	0.000	0.000	100%
5.C.1 Waste Incineration	CO_2	0.563	0.563	43%	40%	0.587	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	0.650	0.650	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	0.591	0.591	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	5.263	5.263	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals -	N_2O	0.561	0.561	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
Solid Fuels										
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.557	0.557	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0.550	0.550	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.b Residential - Gaseous Fuels	CH_4	0.532	0.532	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	2.456	2.456	2%	10%	0.102	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	N_2O	0.470	0.470	5%	50%	0.502	0.000	0.000	0.000	100%
2.A.2. Lime Production	CO_2	0.460	0.460	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	0.431	0.431	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CO_2	3.907	3.907	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	0.370	0.370	2%	50%	0.500	0.000	0.000	0.000	100%
2.D.3.d Urea Use	CO_2	0.817	0.817	20%	10%	0.224	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.351	0.351	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Biomass	N_2O	0.349	0.349	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.b Residential - Liquid Fuels	N_2O	0.345	0.345	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
3.B.1.2 Manure Management - Sheep	CH_4	0.439	0.439	25%	30%	0.391	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CO_2	3.134	3.134	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Biomass Fuels	N_2O	0.335	0.335	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.3.c Railways - Liquid Fuels	CH_4	0.300	0.300	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	CH_4	0.296	0.296	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.g Other - Peat	CO_2	1.331	1.331	2%	10%	0.102	0.000	0.000	0.000	100%
1.A.2.g Other - Liquid Fuels	N_2O	0.252	0.252	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Peat	CO_2	1.136	1.136	2%	11%	0.111	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Peat	CO_2	1.122	1.122	2%	11%	0.111	0.000	0.000	0.000	100%
1.A.4.b Residential - Solid Fuels	N_2O	0.237	0.237	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Biomass Fuels	CH_4	0.211	0.211	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	0.182	0.182	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	0.180	0.180	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Liquid Fuels	CH_4	0.174	0.174	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.347	0.347	20%	5%	0.206	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.131	0.131	2%	50%	0.500	0.000	0.000	0.000	100%

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1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	0.127	0.127	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.b Residential - Gaseous Fuels	N_2O	0.127	0.127	2%	50%	0.500	0.000	0.000	0.000	100%
2.G.3. N_2O from product uses	N_2O	2.014	2.014	2%	2%	0.028	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	0.102	0.102	2%	50%	0.500	0.000	0.000	0.000	100%
5.D.2 Industrial Wastewater	N_2O	0.116	0.116	23%	30%	0.378	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	0.398	0.398	2%	10%	0.102	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	0.078	0.078	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.5.b Mobile - Liquid Fuels	N_2O	0.076	0.076	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	0.705	0.705	2%	5%	0.054	0.000	0.000	0.000	100%
2.D.3.b Road paving with asphalt	CO_2	0.054	0.054	20%	60%	0.632	0.000	0.000	0.000	100%
2.D.3.c Asphalt roofing	CO_2	0.049	0.049	20%	60%	0.632	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.052	0.052	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0.051	0.051	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Gaseous Fuels	N_2O	0.050	0.050	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.049	0.049	2%	50%	0.500	0.000	0.000	0.000	100%

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1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	0.044	0.044	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.043	0.043	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Gaseous Fuels	CH_4	0.042	0.042	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.040	0.040	2%	50%	0.500	0.000	0.000	0.000	100%
2.F.3. Fire Protection	HFCs	0.028	0.028	50%	50%	0.707	0.000	0.000	0.000	100%
1.A.3.c. Railway Biomass Fuels	N_2O	0.035	0.035	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	N_2O	0.035	0.035	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.034	0.034	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Lubricants	N_2O	0.033	0.033	10%	50%	0.510	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.031	0.031	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.030	0.030	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.280	0.280	2%	5%	0.054	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.029	0.029	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Solid Fuels	N_2O	0.026	0.026	2%	50%	0.500	0.000	0.000	0.000	100%

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1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0.025	0.025	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Biomass	CH_4	0.023	0.023	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CH_4	0.022	0.022	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CH_4	0.021	0.021	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.021	0.021	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.021	0.021	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.020	0.020	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.5.b Mobile - Liquid Fuels	CH_4	0.019	0.019	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.017	0.017	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.b Road Transportation - Lubricants	CH_4	0.015	0.015	10%	50%	0.510	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0.011	0.011	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.011	0.011	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.009	0.009	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0.008	0.008	2%	50%	0.500	0.000	0.000	0.000	100%
1.B.2.b Natural Gas	CO_2	0.011	0.011	32%	0%	0.322	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	N_2O	0.007	0.007	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.006	0.006	20%	50%	0.539	0.000	0.000	0.000	100%
1.A.2.g Other - Peat	N_2O	0.006	0.006	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	0.006	0.006	2%	50%	0.500	0.000	0.000	0.000	100%
2.C.1 Iron and Steel Production	CO_2	0.010	0.010	5%	25%	0.255	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Peat	N_2O	0.005	0.005	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.005	0.005	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Peat	N_2O	0.005	0.005	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.004	0.004	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	N_2O	0.004	0.004	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.003	0.003	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.4.a Commercial/Institutional - Peat	CH_4	0.003	0.003	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print -	CH_4	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
Gaseous Fuels										
1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.c. Railway Biomass Fuels	CH_4	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	CH_4	0.002	0.002	5%	50%	0.502	0.000	0.000	0.000	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	N_2O	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Jet kerosene	CH_4	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CH_4	0.002	0.002	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Solid Fuels	CH_4	0.001	0.001	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.001	0.001	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.g Other - Peat	CH_4	0.001	0.001	2%	50%	0.500	0.000	0.000	0.000	100%
1.B.2.c Venting and Flaring	CO_2	0.003	0.003	10%	0%	0.100	0.000	0.000	0.000	100%
1.A.2.c Chemicals - Peat	CH_4	0.001	0.001	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.000	0.000	20%	50%	0.539	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%

IPCC category/Group	Gas	2014 emissions or removals (kt CO_2 eq)	Absolute value of 2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Level Assessment	Level Assessment with Uncertainty	Contribution to Level Assessment	Cumulative Total
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CH_4	0.000	0.000	2%	50%	0.500	0.000	0.000	0.000	100%
2.C.1 Iron and Steel Production	CH_4	0.000	0.000	10%	25%	0.269	0.000	0.000	0.000	100%
TOTAL		11353.38	11353.38			113.783	1.000	0.208	1.000	

A 1.9 Spreadsheet for the Approach 1 analysis for 2014 – trend assessment with LULUCF

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
4.A.1 Forest Land remaining Forest Land – Carbon stock change, living biomass	CO_2	-19117.24262	-529.091989	0.906170707	0.379688889	38%
4.A.1 Forest Land remaining Forest Land – Carbon stock change, dead wood	CO_2	77.31120783	-3792.439229	0.216429105	0.090684598	47%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3049.621305	2.456340066	0.149148925	0.062493953	53%
4. G. Harvested wood products	CO_2	-166.3561979	-1817.58	0.093769333	0.039289699	57%
1.A.3.b Road Transportation - Diesel Oil	CO_2	616.1359677	1880.266	0.075266324	0.031536869	60%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1410.784936	38.5022	0.066902637	0.028032453	63%
3.A.1 Enteric Fermentation - Cattle	CH_4	2117.989353	828.0431219	0.057252005	0.023988803	66%
4.A.1 Forest Land remaining Forest Land – Drained organic soil	CO_2	4125.54896	4583.280676	0.055031493	0.0230584	68%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.3.b Road Transportation - Gasoline	CO_2	1723.750448	613.35806	0.049990547	0.020946225	70%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2644.318679	1575.698976	0.041095605	0.017219211	72%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1007.294341	155.5621374	0.040587128	0.017006157	73%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798.2058686	26.17773966	0.037606387	0.015757216	75%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778.5312078	55.18201994	0.035016974	0.014672242	76%
1.A.2.g Other - Liquid Fuels	CO_2	795.7039841	104.8142275	0.033074715	0.013858428	78%
4.C.2 Land converted to Grassland –Mineral soil	CO_2	-0.0030613	-495.2573527	0.027769251	0.011635419	79%
1.A.4.b Residential - Solid Fuels	CO_2	605.8184	50.2326	0.026839764	0.011245961	80%
4.E.2 Land converted to Settlements – Carbon stock change – living biomass	CO_2	115.9029234	480.9177105	0.021291627	0.008921271	81%
1.A.2.g Other - Gaseous Fuels	CO_2	524.168965	91.04761992	0.020554294	0.008612325	82%
4.A.2 Land converted to Forest Land – Carbon stock change, grassland converted to forest land	CO_2	-0.15774	-341.1744233	0.019122149	0.008012252	83%
4.B.2 Land converted to Cropland – Carbon stock change, forest land converted to cropland	CO_2	373.3561333	21.17573333	0.017089387	0.007160517	83%
3.G. Liming	CO_2	371.4186667	19.68633333	0.017078055	0.007155768	84%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	695.0757089	320.5751539	0.016050852	0.006725367	85%
3.D.1. Direct N_2O emissions from managed soils	N_2O	1962.775641	1429.497775	0.015929951	0.006674708	85%
4.C.2 Land converted to Grassland – Drained organic soil	CO_2	0.0008613	275.3924023	0.015441388	0.006469999	86%
1.A.3.c Railways - Liquid Fuels	CO_2	531.37994	213.786	0.014025269	0.00587664	87%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
2.A.1. Cement Production	CO_2	370.8039966	555.775815	0.013010919	0.005451624	87%
1.A.2.c Chemicals - Liquid Fuels	CO_2	276.6786727	10.10088453	0.012977756	0.005437728	88%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	273.5769252	20.35027526	0.012251227	0.00513331	88%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234.4643123	0.705374886	0.011438069	0.004792593	89%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	314.4838285	73.41324777	0.011278448	0.004725712	89%
4.B.1 Cropland remaining Cropland – Drained organic soil	CO_2	2761.364974	2598.776785	0.01053932	0.004416014	90%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	218.053	16.555	0.009745995	0.004083608	90%
4.E.2 Land converted to Settlements – Organic soils	CO_2	3.765666667	166.1761669	0.009133267	0.003826873	90%
4.E.2 Land converted to Settlements – Carbon stock change – dead organic matter	CO_2	45.65085251	197.4969716	0.008839059	0.003703598	91%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	N_2O	567.421657	638.8013455	0.008041284	0.003369328	91%
4.A.1 Forest land remaining forest land - Controlled burning	CO_2	256.17754	88.88382	0.007556763	0.003166312	91%
3.D.2 Indirect N_2O Emissions from managed soils	N_2O	377.2229002	196.0440499	0.007473695	0.003131506	92%
1.A.3.b Road Transportation - LPG	CO_2	36.95737306	165.2425801	0.007456102	0.003124134	92%
1.A.4.b Residential - Liquid Fuels	CO_2	329.9110639	157.1324033	0.007339463	0.003075262	92%
2.A.2. Lime Production	CO_2	148.8573814	0.459881348	0.007261158	0.003042452	93%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	149.4154681	5.263181843	0.007019154	0.002941052	93%
1.A.1.a Public Electricity and Heat Production - Peat	CO_2	142.826737	0	0.006991729	0.00292956	93%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
4.C.1 Grassland remaining Grassland – Drained organic soil	CO_2	924.832656	684.0066031	0.006920197	0.002899588	94%
4.B.1 Land converted to Cropland – Carbon stock change – dead organic matter	CO_2	147.0542333	8.696233333	0.006711072	0.002811964	94%
5.A.2. Unmanaged Waste Disposal Sites	CH_4	392.8311633	227.8019525	0.006457073	0.002705538	94%
4.D.1 Wetlands remaining Wetlands – Carbon stock change – living biomass	CO_2	-65.31052768	-165.2320183	0.006067551	0.002542327	94%
4.E.2 Land converted to Settlements – Mineral soils	CO_2	1.399566667	107.2922807	0.005947435	0.002491998	95%
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	16.4292	118.6284	0.005847321	0.002450049	95%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	56.12604453	149.8529208	0.005654839	0.002369399	95%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	103.071464	2.2704	0.004918305	0.002060788	95%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	102.28152	2.2704	0.004879636	0.002044585	96%
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, dead wood	CO_2	-1.612112333	-83.797142	0.004619643	0.001935648	96%
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	93.25228881	0	0.004564935	0.001912725	96%
4.B.2 Land converted to Cropland – Drained organic soil	CO_2	12.45566667	89.507	0.004408979	0.001847379	96%
3.B.5 Indirect N_2O emissions from Manure Management	N_2O	137.5202478	41.93797066	0.004380474	0.001835435	96%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
5.D.1 Domestic Wastewater	CH_4	207.775	109.5074001	0.004030959	0.001688987	96%
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, litter	CO_2	-1.3821621	-71.8444518	0.003960705	0.00165955	97%
4.E.1 Settlements remaining Settlements – Carbon stock change – living biomass	CO_2	-48.28378427	-108.185671	0.003702428	0.001551331	97%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CO_2	73.83865681	0	0.003614588	0.001514526	97%
3.B.2.1 Manure Management - Cattle	N_2O	120.6657672	42.94734024	0.003498808	0.001466014	97%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174.2220665	93.81485986	0.00326835	0.001369451	97%
1.A.4.a Commercial/Institutional - Peat	CO_2	66.54499789	1.136164465	0.00319384	0.001338231	97%
1.A.2.a Iron and Steel - Other fossil fuels	CO_2	61.3521	0	0.00300334	0.001258411	97%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	334.0088098	238.7965288	0.002961097	0.001240711	98%
2.A.4. Other process uses of carbonates	CO_2	69.184752	10.8326905	0.002779372	0.001164567	98%
2.C.1 Iron and Steel Production	CO_2	52.59606386	0.01036233	0.002574129	0.00107857	98%
1.B.2.b Natural Gas	CH_4	177.238	109.190125	0.002553886	0.001070088	98%
4.B.2 Land converted to Cropland –Mineral soil	CO_2	6.935133333	48.7498	0.002393941	0.00100307	98%
4.E.2 Lands converted to settlements, Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	0.910565999	40.47931849	0.002225127	0.000932337	98%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.4.b Residential - Gaseous Fuels	CO_2	219.6011945	230.7118474	0.002186131	0.000915997	98%
1.A.4.b Residential - Solid Fuels	CH_4	48.03	3.9825	0.002127888	0.000891593	98%
1.A.4.b Residential - Peat	CO_2	42.27150449	0	0.002069297	0.000867043	98%
3.B.1.3 Manure Management - Swaine	CH_4	65.37841625	20.64571937	0.002042819	0.000855949	98%
1.B.2.c Venting and Flaring	CH_4	70.344325	26.126175	0.001978621	0.000829049	99%
4.D.1 Wetlands remaining Wetlands – Carbon stock change –organic soils	CO_2	277.2	277.2	0.001973145	0.000826755	99%
3.A.3 Enteric Fermentation - Swine	CH_4	52.54125	13.1025	0.001837361	0.000769861	99%
3.B.2.3 Manure Management - Swaine	N_2O	40.75322335	5.647103039	0.001678336	0.000703229	99%
1.A.3.c Railways - Liquid Fuels	N_2O	61.20060747	24.62371876	0.001615256	0.000676798	99%
3.B.1.1 Manure Management - Cattle	CH_4	110.9670107	70.59473241	0.001473823	0.000617537	99%
4.C.1 Grassland remaining Grassland – Carbon stock change – living biomass	CO_2	-19.17968712	-42.87716154	0.001465256	0.000613948	99%
5.D.2 Industrial Wastewater	CH_4	137.025	138.525	0.001059467	0.000443921	99%
1.A.2.g Other - Solid Fuels	CO_2	27.263264	5.4868	0.001026957	0.000430299	99%
1.A.4.b Residential - Biomass Fuels	CH_4	96.42474185	101.6540154	0.000979572	0.000410444	99%
4.D.1 Wetlands remaining Wetlands – Carbon stock change – dead organic matter	CO_2	-13.80988549	-29.46614791	0.000976157	0.000409014	99%
1.A.2.g Other - Biomass Fuels	N_2O	0.455344	17.42704	0.000954855	0.000400088	99%
1.A.3.b Road Transportation - Gaseous Fuels	CO_2	17.6165255	0	0.000862373	0.000361338	99%
1.A.3.b Road Transportation - Diesel Oil	N_2O	5.593827044	19.44722022	0.000816586	0.000342153	99%
4.A.1 Forest land remaining forest land - Controlled burning	CH_4	25.2045	8.745	0.000743486	0.000311523	99%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	15.54739345	0.397748377	0.000738782	0.000309552	99%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	0.519712	13.38625669	0.000725135	0.000303834	99%
1.A.3.b Road Transportation - Gasoline	CH_4	17.15516309	2.207274532	0.000716025	0.000300017	99%
2.D.1 Lubricant Use	CO_2	23.25102433	8.297813333	0.000672933	0.000281961	99%
4.D.1. Wetlands, Peat extraction from lands, organic soils	CO_2	1016.928	899.740705	0.000667854	0.000279833	99%
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	0.8332289	12.58	0.00066458	0.000278462	99%
4.C. Grassland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	69.98791354	72.89522859	0.000661198	0.000277044	100%
1.A.2.g Other - Biomass Fuels	CH_4	0.2865	10.965	0.00060079	0.000251733	100%
3.A.2 Enteric Fermentation - Sheep	CH_4	32.92	18.5	0.00057421	0.000240596	100%
4.B. Cropland remaining cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	125.0975756	119.0448062	0.000551078	0.000230904	100%
3.B.2.4 Manure Management - Other livestock	N_2O	22.98598703	11.52240459	0.000479153	0.000200767	100%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	0.327	8.434081116	0.000456897	0.000191442	100%
4.A.1 Forest land remaining forest land - wildfires	CH_4	2.525	9.198	0.000392133	0.000164305	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	8.109	0.18	0.000386863	0.000162097	100%
1.A.3.b Road Transportation - Gasoline	N_2O	13.07410741	4.606850327	0.000381701	0.000159934	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	7.1626684	0.0057514	0.000350308	0.00014678	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	44.69904433	45.0354735	0.000337037	0.00014122	100%
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	6.66618252	0.181929	0.000316126	0.000132458	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	9.15	2.625286653	0.000300714	0.000126	100%
4.E.1 Settlements remaining Settlements – Carbon stock change – dead organic matter	CO_2	-6.10842148	-10.61212032	0.000296006	0.000124028	100%
5.D.1 Domestic Wastewater	N_2O	24.687214	16.53660558	0.000281283	0.000117859	100%
4.C.1 Grassland remaining Grassland – Carbon stock change – dead organic matter	CO_2	-4.284491677	-8.55723594	0.000270073	0.000113162	100%
4.B.2 Land converted to cropland, Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	0.590489444	4.882747284	0.000244873	0.000102603	100%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	43.26924002	33.54418198	0.000237294	9.94272E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	5.286318275	0.590724755	0.000225656	9.45508E-05	100%
2.D.3. Solvent Use	CO_2	41.0641984	32.19721064	0.000204878	8.58445E-05	100%
4.D.1. Wetlands, Peat extraction from lands, organic soils	CH_4	28.53444375	28.53444375	0.000203112	8.51046E-05	100%
1.A.2.c Chemicals - Gaseous Fuels	CO_2	23.42449305	17.14603569	0.000185299	7.76408E-05	100%
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	3.72829	0.10175	0.000176804	7.40815E-05	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.3.a Domestic Aviation - Jet kerosene	CO_2	0.054819072	3.13427	0.000173057	7.25115E-05	100%
3.B.1.4 Manure Management - Other livestock	CH_4	12.4845375	7.840283798	0.00017154	7.18758E-05	100%
4.B.1 Cropland remaining Cropland – Carbon stock change – living biomass	CO_2	-6.124066667	-8.288426667	0.000164949	6.91142E-05	100%
1.A.3.b Road Transportation - LPG	N_2O	0.163685304	2.934347457	0.000156518	6.55816E-05	100%
1.A.4.b Residential - Biomass Fuels	N_2O	8.94447	10.597476	0.000156353	6.55125E-05	100%
1.A.4.b Residential - Peat	CH_4	3.1875	0	0.000156036	6.53797E-05	100%
3.A.4 Enteric Fermentation - Other livestock	CH_4	18.090525	13.021775	0.000155437	6.51289E-05	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CO_2	3.0786	0	0.000150705	6.31461E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CO_2	3.0225	0	0.000147959	6.19954E-05	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	3.00505	0.002425	0.000146969	6.15805E-05	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	3.495	0.649625	0.000134664	5.64248E-05	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO_2	2.692316	0	0.000131796	5.52229E-05	100%
1.A.4.b Residential - Solid Fuels	N_2O	2.862588	0.237357	0.000126822	5.31389E-05	100%
3.H. Urea Application	CO_2	7.7088	4.726333333	0.000112357	4.70778E-05	100%
5.D.2 Industrial Wastewater	N_2O	2.341428614	0.115643072	0.000108135	4.53088E-05	100%
1.A.2.g Other - Liquid Fuels	CH_4	2.26531	0.173975	0.000101138	4.23771E-05	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	2.411706848	0.369840648	9.73219E-05	4.07782E-05	100%
1.A.2.g Other - Liquid Fuels	N_2O	2.149772	0.252487056	9.10796E-05	3.81627E-05	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1.87891384	0.0437464	8.95247E-05	3.75112E-05	100%
5.B.1. Composting	CH_4	23.90918253	22.4652	8.92235E-05	3.7385E-05	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
4.A.1 Forest land remaining forest land - Controlled burning	N_2O	2.95616	1.02512	8.72323E-05	3.65507E-05	100%
1.A.3.b Road Transportation - Lubricants	CO_2	3.4629	4.554798669	8.58728E-05	3.5981E-05	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	0.008344	1.509107769	8.42082E-05	3.52835E-05	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	0.1006644	1.5198	8.02884E-05	3.36411E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	1.774375	0.127125	7.97321E-05	3.34081E-05	100%
5.B.1. Composting	N_2O	17.09984734	16.06711104	6.38127E-05	2.67378E-05	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.00525	0.949410006	5.2977E-05	2.21976E-05	100%
2.G.3. N_2O from product uses	N_2O	1.30226	2.01448	4.92043E-05	2.06168E-05	100%
1.A.2.a Iron and Steel - Other fossil fuels	N_2O	0.997704	0	4.88401E-05	2.04642E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	1.45424	0.431444174	4.69974E-05	1.96921E-05	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	1.030335	0.078225	4.60514E-05	1.92957E-05	100%
4.A.1 Forest land remaining forest land - wildfires	N_2O	0.295616	1.078462	4.59989E-05	1.92737E-05	100%
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	39.135	34.97326278	4.52166E-05	1.89459E-05	100%
1.A.3.b Road Transportation - LPG	CH_4	0.124565463	0.863788568	4.23354E-05	1.77387E-05	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.78871	0.02035	3.74683E-05	1.56994E-05	100%
2.A.3. Glass production	CO_2	0.355752064	0.942744575	3.54453E-05	1.48517E-05	100%
3.B.2.2 Manure Management - Sheep	N_2O	1.824479542	2.221483039	3.52471E-05	1.47687E-05	100%
4.C.1 Grassland remaining Grassland, wildfires	N_2O	0.053992802	0.663123844	3.45387E-05	1.44718E-05	100%
1.A.3.b Road Transportation - Gaseous Fuels	CH_4	0.7015	0	3.43402E-05	1.43887E-05	100%
4.C.1 Grassland remaining Grassland, wildfires	CH_4	0.049609865	0.609294045	3.1735E-05	1.32971E-05	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.2.c Chemicals - Liquid Fuels	N_2O	0.65129688	0.0069732	3.14916E-05	1.31951E-05	100%
1.A.2.a Iron and Steel - Other fossil fuels	CH_4	0.62775	0	3.07299E-05	1.2876E-05	100%
1.A.1.a Public Electricity and Heat Production - Peat	N_2O	0.615519	0	3.01312E-05	1.26251E-05	100%
1.A.4.b Residential - Liquid Fuels	CH_4	0.868375	1.276125	2.9044E-05	1.21695E-05	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.64092648	0.04917	2.8618E-05	1.1991E-05	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	N_2O	0.07599	0.560538	2.77098E-05	1.16105E-05	100%
4.D.1. Wetlands, Peat extraction from lands, organic soils	N_2O	3.793114158	3.793114158	2.69999E-05	1.1313E-05	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	24.7792529	21.16428627	2.63117E-05	1.10247E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.4832964	0.010728	2.30571E-05	9.66099E-06	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0.47777148	0.010728	2.27866E-05	9.54767E-06	100%
1.A.3.b Road Transportation - Diesel Oil	CH_4	1.108041461	1.356526416	2.18199E-05	9.14262E-06	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	1.4367772	0.865392	2.18108E-05	9.1388E-06	100%
1.A.3.c Railways - Liquid Fuels	CH_4	0.745009038	0.299750179	1.96629E-05	8.23882E-06	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.423011	0.0303066	1.90081E-05	7.96448E-06	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	1.20535	0.726	1.82976E-05	7.66678E-06	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.271776	0.556962	1.79251E-05	7.51068E-06	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	N_2O	0.3177723	0	1.55558E-05	6.51792E-06	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.011005031	0.28	1.51611E-05	6.35254E-06	100%
1.A.4.a Commercial/Institutional - Peat	N_2O	0.2955862	0.004619	1.42107E-05	5.95434E-06	100%
3.B.1.2 Manure Management - Sheep	CH_4	0.78185	0.439375	1.36375E-05	5.71416E-06	100%
1.A.3.b Road Transportation - Gaseous Fuels	N_2O	0.27267	0	1.33479E-05	5.59281E-06	100%
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.273195	0.004725	1.31087E-05	5.49257E-06	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.268845	0.020625	1.20042E-05	5.0298E-06	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CH_4	0.2325	0	1.13815E-05	4.76887E-06	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.171	0.3505	1.12819E-05	4.72715E-06	100%
1.A.2.g Other - Gaseous Fuels	N_2O	0.28480456	0.0500044	1.11381E-05	4.66691E-06	100%
1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.172771761	0.3465	1.09709E-05	4.59683E-06	100%
1.A.2.a Iron and Steel - Liquid Fuels	N_2O	0.2179572	0	1.06696E-05	4.47058E-06	100%
1.A.2.g Other - Gaseous Fuels	CH_4	0.23893	0.04195	9.34406E-06	3.9152E-06	100%
1.A.4.b Residential - Peat	N_2O	0.1860712	0	9.10865E-06	3.81656E-06	100%
5.C.1 Waste Incineration	N_2O	4.847024532	4.3807102	8.35519E-06	3.50085E-06	100%
5.C.1 Waste Incineration	CO_2	0.810707594	0.56263867	8.13867E-06	3.41013E-06	100%
1.A.4.a Commercial/Institutional - Peat	CH_4	0.168	0.00275	8.06983E-06	3.38129E-06	100%
1.A.4.a Commercial/Institutional - Biomass Fuels	N_2O	6.219856	5.564080248	7.50395E-06	3.14418E-06	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0.76125	0.550125	6.41924E-06	2.68969E-06	100%
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.127395	0.0003874	6.21458E-06	2.60393E-06	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.1708732	0.0403194	6.10394E-06	2.55757E-06	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
4.B.1 Cropland remaining Cropland – Carbon stock change – dead organic matter	CO_2	-1.368033333	-1.2914	5.44095E-06	2.27978E-06	100%
1.A.4.b Residential - Gaseous Fuels	CH_4	0.5005	0.5315	5.30081E-06	2.22106E-06	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.106875	0.000325	5.21358E-06	2.18451E-06	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.14335	0.033825	5.12075E-06	2.14562E-06	100%
1.A.2.g Other - Solid Fuels	N_2O	0.12419448	0.025926	4.62595E-06	1.93829E-06	100%
1.A.2.a Iron and Steel - Liquid Fuels	CH_4	0.091425	0	4.47548E-06	1.87524E-06	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.08118414	0.0028906	3.81209E-06	1.59728E-06	100%
2.C.1 Iron and Steel Production	CH_4	0.06875	1.15638E-05	3.36484E-06	1.40988E-06	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0.0681075	0.002425	3.19806E-06	1.34E-06	100%
2.D.3.b Road paving with asphalt	CO_2	0.001463305	0.054450618	2.98145E-06	1.24924E-06	100%
1.A.4.b Residential - Liquid Fuels	N_2O	0.4500694	0.344594088	2.71042E-06	1.13568E-06	100%
2.D.3.c Asphalt roofing	CO_2	0.002972338	0.049156808	2.61075E-06	1.09391E-06	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.057625	0.004375	2.57558E-06	1.07918E-06	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	N_2O	0.050064	0	2.45076E-06	1.02688E-06	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.0362964	0.0004768	1.75007E-06	7.33284E-07	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.09466268	0.0515242	1.74498E-06	7.31154E-07	100%
1.A.1.a Public Electricity and Heat Production - Peat	CH_4	0.034425	0	1.68519E-06	7.06101E-07	100%
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.000453151	0.029353	1.62366E-06	6.80319E-07	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.00425	0.03135	1.54977E-06	6.49358E-07	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CH_4	0.0315	0	1.542E-06	6.46106E-07	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.181482	0.1311498	1.53035E-06	6.41221E-07	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.079415	0.043225	1.46391E-06	6.13384E-07	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.026721	0.0006	1.27442E-06	5.33986E-07	100%
1.A.4.b Residential - Gaseous Fuels	N_2O	0.1193192	0.1267096	1.26371E-06	5.29501E-07	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.001126	0.017	8.9808E-07	3.76299E-07	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CH_4	0.0177725	0	8.70009E-07	3.64537E-07	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.015225	0.00025	7.31284E-07	3.06411E-07	100%
1.A.3.b Road Transportation - Lubricants	N_2O	0.02384	0.032918912	6.78757E-07	2.84402E-07	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	N_2O	0.013857	0	6.78335E-07	2.84225E-07	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N_2O	0.01272162	0	6.22755E-07	2.60937E-07	100%
1.A.3.b Road Transportation - Lubricants	CH_4	0.02475	0.014988474	3.71161E-07	1.55518E-07	100%
1.A.2.g Other - Solid Fuels	CH_4	0.006946	0.00145	2.58722E-07	1.08405E-07	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0.05379496	0.0511368	2.33875E-07	9.79943E-08	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0.024287	0.024734	1.97942E-07	8.29382E-08	100%
1.B.2.b Natural Gas	CO_2	0.008686	0.011105	1.97463E-07	8.27377E-08	100%
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.00295205	0.005924494	1.8768E-07	7.86386E-08	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.020375	0.02075	1.66058E-07	6.95791E-08	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	9.36998E-05	0.002384	1.29086E-07	5.40873E-08	100%
1.A.3.a Domestic Aviation - Jet kerosene	CH_4	0.000009504	0.0021375	1.19386E-07	5.00231E-08	100%
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.01272758	0.0094168	9.50411E-08	3.98226E-08	100%
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0.0106775	0.0079	7.97324E-08	3.34082E-08	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CH_4	0.02314	0.02145	6.9954E-08	2.9311E-08	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH_4	0.0007115	0	3.48297E-08	1.45938E-08	100%
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.000219506	0.000440227	1.39385E-08	5.84027E-09	100%
1.B.2.c Venting and Flaring	CO_2	0.002806	0.002657	1.16189E-08	4.86838E-09	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CH_4	1.96519E-06	0.00005	2.70733E-09	1.13438E-09	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	CH_4	0	0.2955		0	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	N_2O	0	0.469648		0	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CO_2	0	3.906691677		0	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CH_4	0	0.0018		0	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	N_2O	0	0.0021456		0	100%
1.A.2.c Chemicals - Peat	CO_2	0	1.12172959		0	100%
1.A.2.c Chemicals - Biomass Fuels	CH_4	0	0.211451058		0	100%
1.A.2.c Chemicals - Peat	CH_4	0	0.000521299		0	100%
1.A.2.c Chemicals - Biomass Fuels	N_2O	0	0.334983061		0	100%
1.A.2.c Chemicals - Peat	N_2O	0	0.004850822		0	100%
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	CH_4	0	0.00225		0	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	N_2O	0	0.003576		0	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CO_2	0	2.1257		0	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CH_4	0	0.02175		0	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	N_2O	0	0.034568		0	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CO_2	0	107.5693		0	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CH_4	0	0.937280723		0	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	N_2O	0	1.489651495		0	100%
1.A.2.g Other - Peat	CO_2	0	1.331164465		0	100%
1.A.2.g Other - Peat	CH_4	0	0.000575		0	100%
1.A.2.g Other - Peat	N_2O	0	0.005811		0	100%
1.A.3.b Road Transportation - Biomass	CH_4	0	0.023009615		0	100%
1.A.3.b Road Transportation - Biomass	N_2O	0	0.349076786		0	100%
1.A.3.c. Railway Biomass Fuels	CH_4	0	0.0022825		0	100%
1.A.3.c. Railway Biomass Fuels	N_2O	0	0.0346276		0	100%
1.A.5.b Mobile - Liquid Fuels	CO_2	0	9.442494289		0	100%
1.A.5.b Mobile - Liquid Fuels	CH_4	0	0.018743571		0	100%
1.A.5.b Mobile - Liquid Fuels	N_2O	0	0.076423393		0	100%
2.D.2 Paraffin wax use	CO_2	0	4.911573333		0	100%
2.D.3.d Urea Use	CO_2	0	0.817		0	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
2.F.1. Refrigeration and air conditioning	HFCs	0	206.3769351		0	100%
2.F.2 Foam blowing agents	HFCs	0	0.961490119		0	100%
2.F.3. Fire Protection	HFCs	0	0.02767976		0	100%
2.F.4. Aerosols	HFCs	0	4.697766137		0	100%
2.G.1. Electrical equipment	SF6	0	8.577903643		0	100%
4.A.2 Land converted to Forest Land – grassland converted to forest land, Drained organic soil	CO_2	0	61.24812203		0	100%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	0	22.06783674		0	100%
4.B.2 Wetlands converted to cropland, organic soil	CO_2	0	3.8236		0	100%
4.B.2 Settlements converted to cropland, mineral soils	CO_2	0	5.310433333		0	100%
4.E.1 Settlements remaining Settlements – Drained organic soils	CO_2	0	19.43012935		0	100%
4.E.2 Settlements remaining Settlements, Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	0	4.083489381		0	100%
5.A.1. Managed Waste Disposal on Land	CH_4	0	301.0244136		0	100%
TOTAL		17834.80	15573.52	2.386613709	1	

A 1.10 Spreadsheet for the Approach 1 analysis for 2014 – trend assessment without LULUCF

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.3.b Road Transportation - Diesel Oil	CO_2	616.1359677	1880.266	0.061464797	0.181518726	18%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3049.621305	2.456340066	0.05012911	0.148042013	33%
3.D.1. Direct N_2O emissions from managed soils	N_2O	1962.775641	1429.497775	0.022119758	0.065324391	39%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1410.784936	38.5022	0.021767108	0.064282939	46%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2644.318679	1575.698976	0.016463977	0.048621656	51%
2.A.1. Cement Production	CO_2	370.8039966	555.775815	0.015060641	0.044477302	55%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798.2058686	26.17773966	0.012148244	0.035876369	59%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778.5312078	55.18201994	0.010719577	0.031657211	62%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1007.294341	155.5621374	0.010663894	0.031492765	65%
1.A.2.g Other - Liquid Fuels	CO_2	795.7039841	104.8142275	0.0091121	0.026909985	68%
1.A.4.b Residential - Solid Fuels	CO_2	605.8184	50.2326	0.008063761	0.023814016	70%
1.A.3.b Road Transportation - LPG	CO_2	36.95737306	165.2425801	0.005684781	0.016788376	72%
3.G. Liming	CO_2	371.4186667	19.68633333	0.005366933	0.015849705	73%
1.A.4.b Residential - Gaseous Fuels	CO_2	219.6011945	230.7118474	0.005170368	0.015269207	75%
1.A.2.g Other - Gaseous Fuels	CO_2	524.168965	91.04761992	0.005164641	0.015252293	77%
1.A.3.b Road Transportation - Gasoline	CO_2	1723.750448	613.35806	0.005027274	0.014846619	78%
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	16.4292	118.6284	0.004247505	0.012543795	79%
1.A.2.c Chemicals - Liquid Fuels	CO_2	276.6786727	10.10088453	0.004171779	0.012320158	80%

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234.4643123	0.705374886	0.003834409	0.011323831	82%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	273.5769252	20.35027526	0.003730341	0.011016496	83%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	334.0088098	238.7965288	0.00359416	0.010614325	84%
3.A.1 Enteric Fermentation - Cattle	CH_4	2117.989353	828.0431219	0.00334332	0.009873541	85%
5.D.2 Industrial Wastewater	CH_4	137.025	138.525	0.003019255	0.008916506	86%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	218.053	16.555	0.002960492	0.008742967	87%
2.A.2. Lime Production	CO_2	148.8573814	0.459881348	0.002433941	0.007187951	87%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	314.4838285	73.41324777	0.002383064	0.0070377	88%
1.A.1.a Public Electricity and Heat Production - Peat	CO_2	142.826737	0	0.002352141	0.006946376	89%
1.A.4.b Residential - Biomass Fuels	CH_4	96.42474185	101.6540154	0.002283615	0.006744004	89%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	149.4154681	5.263181843	0.002260194	0.006674839	90%
5.A.2. Unmanaged Waste Disposal Sites	CH_4	392.8311633	227.8019525	0.002206706	0.006516877	91%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	103.071464	2.2704	0.001610961	0.004757514	91%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	102.28152	2.2704	0.001597952	0.004719095	92%
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	93.25228881	0	0.001535725	0.004535324	92%
3.D.2 Indirect N_2O Emissions from managed soils	N_2O	377.2229002	196.0440499	0.001254222	0.003703988	92%
1.B.2.b Natural Gas	CH_4	177.238	109.190125	0.001239762	0.003661283	93%

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CO_2	73.83865681	0	0.001216011	0.003591142	93%
1.A.4.a Commercial/Institutional - Peat	CO_2	66.54499789	1.136164465	0.001052624	0.003108624	93%
1.A.2.a Iron and Steel - Other fossil fuels	CO_2	61.3521	0	0.001010377	0.002983859	94%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	44.69904433	45.0354735	0.000979091	0.002891465	94%
2.C.1 Iron and Steel Production	CO_2	52.59606386	0.01036233	0.000865783	0.002556843	94%
3.B.1.1 Manure Management - Cattle	CH_4	110.9670107	70.59473241	0.000861205	0.002543322	95%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	695.0757089	320.5751539	0.000762546	0.002251961	95%
5.D.1 Domestic Wastewater	CH_4	207.775	109.5074001	0.000748947	0.002211802	95%
2.A.4. Other process uses of carbonates	CO_2	69.184752	10.8326905	0.000726796	0.002146384	95%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174.2220665	93.81485986	0.000703849	0.002078617	95%
1.A.4.b Residential - Peat	CO_2	42.27150449	0	0.000696148	0.002055874	96%
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	39.135	34.97326278	0.000687494	0.002030317	96%
3.B.5 Indirect N_2O emissions from Manure Management	N_2O	137.5202478	41.93797066	0.000667506	0.001971287	96%
1.A.2.g Other - Biomass Fuels	N_2O	0.455344	17.42704	0.000656226	0.001937975	96%
1.A.3.b Road Transportation - Diesel Oil	N_2O	5.593827044	19.44722022	0.000648543	0.001915287	96%
1.A.4.b Residential - Solid Fuels	CH_4	48.03	3.9825	0.000639305	0.001888003	97%
1.A.3.c Railways - Liquid Fuels	CO_2	531.37994	213.786	0.000608793	0.001797897	97%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	43.26924002	33.54418198	0.000564981	0.001668511	97%

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1.A.4.b Residential - Liquid Fuels	CO_2	329.9110639	157.1324033	0.000551392	0.001628378	97%
2.D.3. Solvent Use	CO_2	41.0641984	32.19721064	0.000549994	0.001624251	97%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	0.519712	13.38625669	0.000501269	0.001480354	97%
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	0.8332289	12.58	0.000465399	0.001374422	98%
5.B.1. Composting	CH_4	23.90918253	22.4652	0.000461859	0.001363969	98%
3.B.2.3 Manure Management - Swaine	N_2O	40.75322335	5.647103039	0.000456069	0.00134687	98%
1.A.2.g Other - Biomass Fuels	CH_4	0.2865	10.965	0.000412894	0.001219364	98%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	24.7792529	21.16428627	0.000397984	0.001175332	98%
3.A.3 Enteric Fermentation - Swine	CH_4	52.54125	13.1025	0.000366255	0.001081628	98%
3.B.2.1 Manure Management - Cattle	N_2O	120.6657672	42.94734024	0.000351495	0.00103804	98%
5.B.1. Composting	N_2O	17.09984734	16.06711104	0.000330322	0.000975511	98%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	0.327	8.434081116	0.000315834	0.000932727	98%
3.B.1.3 Manure Management - Swaine	CH_4	65.37841625	20.64571937	0.000290373	0.000857534	99%
1.A.3.b Road Transportation - Gaseous Fuels	CO_2	17.6165255	0	0.000290118	0.000856779	99%
1.A.2.c Chemicals - Gaseous Fuels	CO_2	23.42449305	17.14603569	0.000267256	0.000789265	99%
1.A.4.b Residential - Biomass Fuels	N_2O	8.94447	10.597476	0.000256313	0.000756946	99%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	15.54739345	0.397748377	0.000240894	0.00071141	99%
1.A.2.g Other - Solid Fuels	CO_2	27.263264	5.4868	0.000240015	0.000708816	99%
5.D.1 Domestic Wastewater	N_2O	24.687214	16.53660558	0.00022325	0.000659306	99%
1.A.3.b Road Transportation - Gasoline	CH_4	17.15516309	2.207274532	0.000198454	0.000586076	99%
3.A.4 Enteric Fermentation - Other livestock	CH_4	18.090525	13.021775	0.000198022	0.000584803	99%
1.B.2.c Venting and Flaring	CH_4	70.344325	26.126175	0.000163426	0.000482632	99%

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3.A.2 Enteric Fermentation - Sheep	CH_4	32.92	18.5	0.000162446	0.000479739	99%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	8.109	0.18	0.000126688	0.000374135	99%
1.A.3.a Domestic Aviation - Jet kerosene	CO_2	0.054819072	3.13427	0.000118469	0.000349864	99%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	7.1626684	0.0057514	0.000117739	0.000347709	99%
1.A.3.b Road Transportation - Lubricants	CO_2	3.4629	4.554798669	0.000116445	0.000343887	99%
1.A.4.a Commercial/Institutional - Biomass Fuels	N_2O	6.219856	5.564080248	0.000109481	0.000323322	99%
1.A.3.b Road Transportation - LPG	N_2O	0.163685304	2.934347457	0.000109062	0.000322082	99%
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	6.66618252	0.181929	0.000102853	0.000303747	99%
3.B.1.4 Manure Management - Other livestock	CH_4	12.4845375	7.840283798	9.30028E-05	0.000274657	99%
5.C.1 Waste Incineration	N_2O	4.847024532	4.3807102	8.70201E-05	0.000256989	100%
1.A.3.c Railways - Liquid Fuels	N_2O	61.20060747	24.62371876	7.00651E-05	0.000206917	100%
2.D.1 Lubricant Use	CO_2	23.25102433	8.297813333	6.68796E-05	0.00019751	100%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	5.286318275	0.590724755	6.45594E-05	0.000190658	100%
3.B.2.4 Manure Management - Other livestock	N_2O	22.98598703	11.52240459	6.02966E-05	0.000178069	100%
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	3.72829	0.10175	5.75241E-05	0.000169881	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	0.008344	1.509107769	5.73383E-05	0.000169332	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	0.1006644	1.5198	5.62252E-05	0.000166045	100%
2.G.3. N_2O from product uses	N_2O	1.30226	2.01448	5.5277E-05	0.000163245	100%
3.B.2.2 Manure Management - Sheep	N_2O	1.824479542	2.221483039	5.45608E-05	0.00016113	100%
3.H. Urea Application	CO_2	7.7088	4.726333333	5.30544E-05	0.000156681	100%
1.A.4.b Residential - Peat	CH_4	3.1875	0	5.24933E-05	0.000155024	100%

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1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	9.15	2.625286653	5.07003E-05	0.000149729	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CO_2	3.0786	0	5.06999E-05	0.000149728	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CO_2	3.0225	0	4.9776E-05	0.000146999	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	3.00505	0.002425	4.93963E-05	0.000145878	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO_2	2.692316	0	4.43384E-05	0.000130941	100%
1.A.3.b Road Transportation - Gasoline	N_2O	13.07410741	4.606850327	3.98548E-05	0.0001177	100%
1.A.4.b Residential - Solid Fuels	N_2O	2.862588	0.237357	3.81026E-05	0.000112525	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.00525	0.949410006	3.60727E-05	0.00010653	100%
1.A.4.b Residential - Liquid Fuels	CH_4	0.868375	1.276125	3.43015E-05	0.0001013	100%
5.D.2 Industrial Wastewater	N_2O	2.341428614	0.115643072	3.41554E-05	0.000100868	100%
1.A.3.b Road Transportation - Diesel Oil	CH_4	1.108041461	1.356526416	3.34168E-05	9.86869E-05	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	3.495	0.649625	3.28158E-05	9.69122E-05	100%
1.A.3.b Road Transportation - LPG	CH_4	0.124565463	0.863788568	3.08468E-05	9.10971E-05	100%
1.A.2.g Other - Liquid Fuels	CH_4	2.26531	0.173975	3.06802E-05	9.06053E-05	100%
2.A.3. Glass production	CO_2	0.355752064	0.942744575	3.00466E-05	8.8734E-05	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1.87891384	0.0437464	2.92768E-05	8.64605E-05	100%
1.A.2.g Other - Liquid Fuels	N_2O	2.149772	0.252487056	2.57873E-05	7.61554E-05	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	2.411706848	0.369840648	2.56315E-05	7.56952E-05	100%

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1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	1.774375	0.127125	2.43796E-05	7.19982E-05	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	N_2O	0.07599	0.560538	2.00972E-05	5.93512E-05	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.271776	0.556962	1.67367E-05	4.94269E-05	100%
1.A.2.a Iron and Steel - Other fossil fuels	N_2O	0.997704	0	1.64307E-05	4.85233E-05	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	1.030335	0.078225	1.39888E-05	4.13119E-05	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.78871	0.02035	1.22138E-05	3.607E-05	100%
1.A.4.b Residential - Gaseous Fuels	CH_4	0.5005	0.5315	1.20002E-05	3.54391E-05	100%
1.A.3.b Road Transportation - Gaseous Fuels	CH_4	0.7015	0	1.15526E-05	3.41174E-05	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.171	0.3505	1.0533E-05	3.11062E-05	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.011005031	0.28	1.04828E-05	3.0958E-05	100%
1.A.2.c Chemicals - Liquid Fuels	N_2O	0.65129688	0.0069732	1.04603E-05	3.08915E-05	100%
1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.172771761	0.3465	1.03515E-05	3.05701E-05	100%
1.A.2.a Iron and Steel - Other fossil fuels	CH_4	0.62775	0	1.03381E-05	3.05306E-05	100%
1.A.1.a Public Electricity and Heat Production - Peat	N_2O	0.615519	0	1.01367E-05	2.99358E-05	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	1.4367772	0.865392	9.29768E-06	2.7458E-05	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.64092648	0.04917	8.68241E-06	2.5641E-05	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0.76125	0.550125	8.41537E-06	2.48524E-05	100%

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5.C.1 Waste Incineration	CO_2	0.810707594	0.56263867	8.07747E-06	2.38545E-05	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	1.20535	0.726	7.80007E-06	2.30353E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.4832964	0.010728	7.55058E-06	2.22985E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	1.45424	0.431444174	7.5172E-06	2.21999E-05	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0.47777148	0.010728	7.45959E-06	2.20298E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.423011	0.0303066	5.8121E-06	1.71644E-05	100%
1.A.4.b Residential - Liquid Fuels	N_2O	0.4500694	0.344594088	5.71221E-06	1.68694E-05	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	N_2O	0.3177723	0	5.23323E-06	1.54549E-05	100%
1.A.4.a Commercial/Institutional - Peat	N_2O	0.2955862	0.004619	4.69194E-06	1.38563E-05	100%
1.A.3.b Road Transportation - Gaseous Fuels	N_2O	0.27267	0	4.49046E-06	1.32613E-05	100%
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.273195	0.004725	4.31915E-06	1.27554E-05	100%
3.B.1.2 Manure Management - Sheep	CH_4	0.78185	0.439375	3.8581E-06	1.13938E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CH_4	0.2325	0	3.82892E-06	1.13076E-05	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.268845	0.020625	3.64195E-06	1.07555E-05	100%
1.A.2.a Iron and Steel - Liquid Fuels	N_2O	0.2179572	0	3.58943E-06	1.06003E-05	100%
1.A.4.b Residential - Peat	N_2O	0.1860712	0	3.06431E-06	9.04957E-06	100%
1.A.4.b Residential - Gaseous Fuels	N_2O	0.1193192	0.1267096	2.86084E-06	8.44868E-06	100%
1.A.2.g Other - Gaseous Fuels	N_2O	0.28480456	0.0500044	2.78584E-06	8.22718E-06	100%
1.A.4.a Commercial/Institutional - Peat	CH_4	0.168	0.00275	2.66197E-06	7.86137E-06	100%

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1.A.2.g Other - Gaseous Fuels	CH_4	0.23893	0.04195	2.33711E-06	6.902E-06	100%
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.127395	0.0003874	2.08325E-06	6.15228E-06	100%
2.D.3.b Road paving with asphalt	CO_2	0.001463305	0.054450618	2.0497E-06	6.05321E-06	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.181482	0.1311498	2.00622E-06	5.92481E-06	100%
2.D.3.c Asphalt roofing	CO_2	0.002972338	0.049156808	1.82323E-06	5.38439E-06	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.106875	0.000325	1.74769E-06	5.16131E-06	100%
1.A.2.a Iron and Steel - Liquid Fuels	CH_4	0.091425	0	1.50563E-06	4.44645E-06	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.1708732	0.0403194	1.27842E-06	3.77546E-06	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.08118414	0.0028906	1.22689E-06	3.62327E-06	100%
2.C.1 Iron and Steel Production	CH_4	0.06875	1.15638E-05	1.13177E-06	3.34235E-06	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.00425	0.03135	1.124E-06	3.31942E-06	100%
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.000453151	0.029353	1.11047E-06	3.27946E-06	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.14335	0.033825	1.0725E-06	3.16733E-06	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0.05379496	0.0511368	1.06167E-06	3.13534E-06	100%
1.A.2.g Other - Solid Fuels	N_2O	0.12419448	0.025926	1.05788E-06	3.12415E-06	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0.0681075	0.002425	1.02927E-06	3.03965E-06	100%
1.A.3.b Road Transportation - Lubricants	N_2O	0.02384	0.032918912	8.61138E-07	2.54312E-06	100%
1.A.3.c Railways - Liquid Fuels	CH_4	0.745009038	0.299750179	8.52919E-07	2.51885E-06	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	N_2O	0.050064	0	8.24479E-07	2.43486E-06	100%

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1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.057625	0.004375	7.82371E-07	2.31051E-06	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.001126	0.017	6.28917E-07	1.85733E-06	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.0362964	0.0004768	5.79588E-07	1.71165E-06	100%
1.A.1.a Public Electricity and Heat Production - Peat	CH_4	0.034425	0	5.66928E-07	1.67426E-06	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0.024287	0.024734	5.42046E-07	1.60078E-06	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CH_4	0.0315	0	5.18757E-07	1.532E-06	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.020375	0.02075	4.54737E-07	1.34294E-06	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CH_4	0.02314	0.02145	4.35862E-07	1.28719E-06	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.026721	0.0006	4.17203E-07	1.23209E-06	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.09466268	0.0515242	4.03394E-07	1.19131E-06	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.079415	0.043225	3.38418E-07	9.99421E-07	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CH_4	0.0177725	0	2.92686E-07	8.64365E-07	100%
1.B.2.b Natural Gas	CO_2	0.008686	0.011105	2.79899E-07	8.26601E-07	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.015225	0.00025	2.41211E-07	7.12349E-07	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	N_2O	0.013857	0	2.28204E-07	6.73935E-07	100%

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N_2O	0.01272162	0	2.09506E-07	6.18716E-07	100%
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.00295205	0.005924494	1.77024E-07	5.2279E-07	100%
1.A.3.b Road Transportation - Lubricants	CH_4	0.02475	0.014988474	1.63254E-07	4.82125E-07	100%
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.01272758	0.0094168	1.49043E-07	4.40157E-07	100%
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0.0106775	0.0079	1.25036E-07	3.69259E-07	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	9.36998E-05	0.002384	8.92537E-08	2.63585E-07	100%
1.A.3.a Domestic Aviation - Jet kerosene	CH_4	0.000009504	0.0021375	8.12521E-08	2.39955E-07	100%
1.A.2.g Other - Solid Fuels	CH_4	0.006946	0.00145	5.91656E-08	1.74729E-07	100%
1.B.2.c Venting and Flaring	CO_2	0.002806	0.002657	5.49837E-08	1.62379E-07	100%
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.000219506	0.000440227	1.31515E-08	3.88393E-08	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH_4	0.0007115	0	1.17173E-08	3.46038E-08	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CH_4	1.96519E-06	0.00005	1.87193E-09	5.52822E-09	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	CH_4	0	0.2955		0	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	N_2O	0	0.469648		0	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CO_2	0	3.906691677		0	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CH_4	0	0.0018		0	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	N_2O	0	0.0021456		0	100%
1.A.2.c Chemicals - Peat	CO_2	0	1.12172959		0	100%
1.A.2.c Chemicals - Biomass Fuels	CH_4	0	0.211451058		0	100%
1.A.2.c Chemicals - Peat	CH_4	0	0.000521299		0	100%
1.A.2.c Chemicals - Biomass Fuels	N_2O	0	0.334983061		0	100%
1.A.2.c Chemicals - Peat	N_2O	0	0.004850822		0	100%
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	CH_4	0	0.00225		0	100%

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	N_2O	0	0.003576		0	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CO_2	0	2.1257		0	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CH_4	0	0.02175		0	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	N_2O	0	0.034568		0	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CO_2	0	107.5693		0	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CH_4	0	0.937280723		0	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	N_2O	0	1.489651495		0	100%
1.A.2.g Other - Peat	CO_2	0	1.331164465		0	100%
1.A.2.g Other - Peat	CH_4	0	0.000575		0	100%
1.A.2.g Other - Peat	N_2O	0	0.005811		0	100%
1.A.3.b Road Transportation - Biomass	CH_4	0	0.023009615		0	100%
1.A.3.b Road Transportation - Biomass	N_2O	0	0.349076786		0	100%
1.A.3.c. Railway Biomass Fuels	CH_4	0	0.0022825		0	100%
1.A.3.c. Railway Biomass Fuels	N_2O	0	0.0346276		0	100%
1.A.5.b Mobile - Liquid Fuels	CO_2	0	9.442494289		0	100%
1.A.5.b Mobile - Liquid Fuels	CH_4	0	0.018743571		0	100%
1.A.5.b Mobile - Liquid Fuels	N_2O	0	0.076423393		0	100%
2.D.2 Paraffin wax use	CO_2	0	4.911573333		0	100%
2.D.3.d Urea Use	CO_2	0	0.817		0	100%

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Trend assessment	Contribution to trend	Cumulative total of contribution to trend
2.F.1. Refrigeration and air conditioning	HFCs	0	206.3769351		0	100%
2.F.2 Foam blowing agents	HFCs	0	0.961490119		0	100%
2.F.3. Fire Protection	HFCs	0	0.02767976		0	100%
2.F.4. Aerosols	HFCs	0	4.697766137		0	100%
2.G.1. Electrical equipment	SF6	0	8.577903643		0	100%
5.A.1. Managed Waste Disposal on Land	CH_4	0	301.0244136		0	100%
TOTAL		26256.43	11353.38	0.33861408	1	

A.1.11 Spreadsheet for the Approach 2 analysis for 2014 – trend assessment with LULUCF

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
4.E.2 Land converted to Settlements – Carbon stock change – living biomass	CO_2	115.9029234	480.9177105	20%	295%	2.952512828	0.021291627	0.062863803	0.142540428	14%
4.A.1 Forest Land remaining Forest Land – Carbon stock change, living biomass	CO_2	-19117.24262	-529.091989	2%	3%	0.032298762	0.906170707	0.029268192	0.066364114	21%
4.B.2 Land converted to Cropland – Carbon stock change, forest land converted to cropland	CO_2	373.3561333	21.17573333	53%	161%	1.693305847	0.017089387	0.028937559	0.065614422	27%
4.D.1 Wetlands remaining Wetlands – Carbon stock change – living biomass	CO_2	-65.31052768	-165.2320183	6%	435%	4.35209994	0.006067551	0.02640659	0.059875579	33%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778.5312078	55.18201994	2%	50%	0.50039984	0.035016974	0.017522488	0.039731338	37%
4.C.2 Land converted to Grassland –	CO_2	-0.0030613	-495.2573527	10%	61%	0.62005174	0.027769251	0.017218372	0.039041771	41%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
Mineral soil										
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3049.621305	2.456340066	2%	10%	0.10198039	0.149148925	0.015210266	0.034488492	45%
4.E.1 Settlements remaining Settlements – Carbon stock change – living biomass	CO_2	-48.28378427	-108.185671	9%	389%	3.895664896	0.003702428	0.014423418	0.032704355	48%
4. G. Harvested wood products	CO_2	-166.3561979	-1817.58	15%	0%	0.15	0.093769333	0.0140654	0.031892568	51%
4.A.1 Forest Land remaining Forest Land – Drained organic soil	CO_2	4125.54896	4583.280676	5%	25%	0.255514853	0.055031493	0.014061364	0.031883417	54%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1410.784936	38.5022	2%	20%	0.200997512	0.066902637	0.013447264	0.030490976	57%
3.A.1 Enteric Fermentation - Cattle	CH_4	2117.989353	828.0431219	2%	20%	0.200997512	0.057252005	0.011507511	0.026092686	60%
4.A.1 Forest Land remaining Forest Land – Carbon stock change, dead wood	CO_2	77.31120783	-3792.439229	2%	5%	0.049870332	0.216429105	0.010793391	0.024473458	63%
4.A.2 Land converted to Forest Land – Carbon stock change, grassland converted to forest land	CO_2	-0.15774	-341.1744233	8%	50%	0.504416534	0.019122149	0.009645528	0.021870737	65%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	N_2O	567.421657	638.8013455	6%	119%	1.192759666	0.008041284	0.00959132	0.021747823	67%
4.C.2 Land converted to Grassland – Drained organic soil	CO_2	0.0008613	275.3924023	55%	19%	0.582513519	0.015441388	0.008994817	0.020395284	69%
3.G. Liming	CO_2	371.4186667	19.68633333	2%	50%	0.50039984	0.017078055	0.008545856	0.019377287	71%
3.D.1. Direct N_2O emissions from managed soils	N_2O	1962.775641	1429.497775	2%	50%	0.50039984	0.015929951	0.007971345	0.018074613	73%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
4.A.1 Forest land remaining forest land - Controlled burning	CO_2	256.17754	88.88382	92%	6%	0.921954446	0.007556763	0.006966991	0.015797293	74%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	56.12604453	149.8529208	5%	119%	1.18618464	0.005654839	0.006707683	0.015209325	76%
1.A.4.b Residential - Solid Fuels	CO_2	605.8184	50.2326	2%	20%	0.200997512	0.026839764	0.005394726	0.012232262	77%
4.B.2 Land converted to Cropland – Drained organic soil	CO_2	12.45566667	89.507	114%	18%	1.153272843	0.004408979	0.005084756	0.011529422	78%
4.E.2 Land converted to Settlements – Organic soils	CO_2	3.765666667	166.1761669	47%	18%	0.504887829	0.009133267	0.004611275	0.010455828	79%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798.2058686	26.17773966	2%	11%	0.111074685	0.037606387	0.004177118	0.009471399	80%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1007.294341	155.5621374	2%	10%	0.10198039	0.040587128	0.004139091	0.009385176	81%
4.E.2 Land converted to Settlements – Mineral soils	CO_2	1.399566667	107.2922807	22%	60%	0.638992989	0.005947435	0.00380037	0.008617142	82%
3.D.2 Indirect N_2O Emissions from managed soils	N_2O	377.2229002	196.0440499	2%	50%	0.50039984	0.007473695	0.003739836	0.008479885	83%
2.A.2. Lime Production	CO_2	148.8573814	0.459881348	2%	50%	0.50039984	0.007261158	0.003633482	0.008238734	84%
4.B.1 Land converted to Cropland – Carbon stock change – dead organic matter	CO_2	147.0542333	8.696233333	53%		0.5337	0.006711072	0.003581699	0.008121318	84%
5.A.2. Unmanaged Waste Disposal Sites	CH_4	392.8311633	227.8019525	7%	52%	0.524690385	0.006457073	0.003387964	0.007682034	85%
1.A.2.g Other - Liquid Fuels	CO_2	795.7039841	104.8142275	2%	10%	0.10198039	0.033074715	0.003372972	0.007648041	86%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	102.28152	2.2704	2%	50%	0.50039984	0.004879636	0.002441769	0.005536585	87%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
4.B.1 Cropland remaining Cropland – Drained organic soil	CO_2	2761.364974	2598.776785	13%	18%	0.22703524	0.01053932	0.002392797	0.005425544	87%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2644.318679	1575.698976	2%	5%	0.053851648	0.041095605	0.002213066	0.005018013	88%
4.C.1 Grassland remaining Grassland – Drained organic soil	CO_2	924.832656	684.0066031	26%	19%	0.319336437	0.006920197	0.002209871	0.005010769	88%
5.D.1 Domestic Wastewater	CH_4	207.775	109.5074001	45%	30%	0.540832691	0.004030959	0.002180075	0.004943207	89%
1.A.3.b Road Transportation - Diesel Oil	CO_2	616.1359677	1880.266	2%	2%	0.028284271	0.075266324	0.002128853	0.004827065	89%
4.B.2 Land converted to Cropland – Mineral soil	CO_2	6.935133333	48.7498	64%	61%	0.888776828	0.002393941	0.002127679	0.004824402	90%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	218.053	16.555	2%	20%	0.200997512	0.009745995	0.001958921	0.004441752	90%
4.C.1 Grassland remaining Grassland – Carbon stock change – living biomass	CO_2	-19.17968712	-42.87716154	5%	122%	1.222015155	0.001465256	0.001790565	0.004060014	90%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	695.0757089	320.5751539	2%	11%	0.108754816	0.016050852	0.001745607	0.003958075	91%
4.E.2 Land converted to Settlements – Carbon stock change – dead organic matter	CO_2	45.65085251	197.4969716	20%		0.196	0.008839059	0.001732456	0.003928254	91%
2.A.1. Cement Production	CO_2	370.8039966	555.775815	10%	5%	0.111803399	0.013010919	0.001454665	0.003298378	91%
1.A.3.b Road Transportation - Gasoline	CO_2	1723.750448	613.35806	2%	2%	0.028284271	0.049990547	0.001413946	0.00320605	92%
2.A.4. Other process uses of carbonates	CO_2	69.184752	10.8326905	2%	50%	0.50039984	0.002779372	0.001390797	0.003153561	92%
1.A.2.c Chemicals - Liquid Fuels	CO_2	276.6786727	10.10088453	2%	10%	0.10198039	0.012977756	0.001323477	0.003000915	92%
3.B.5 Indirect N_2O emissions from Manure Management	N_2O	137.5202478	41.93797066	2%	30%	0.300665928	0.004380474	0.001317059	0.002986364	93%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	273.5769252	20.35027526	2%	10%	0.10198039	0.012251227	0.001249385	0.002832916	93%
4.D.1 Wetlands remaining Wetlands – Carbon stock change –organic soils	CO_2	277.2	277.2	24%	55%	0.604211503	0.001973145	0.001192197	0.002703244	93%
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	16.4292	118.6284	2%	20%	0.200997512	0.005847321	0.001175297	0.002664925	94%
4.B.1 Cropland remaining Cropland – Carbon stock change – living biomass	CO_2	-6.124066667	-8.288426667	3%	701%	7.007048237	0.000164949	0.001155805	0.002620729	94%
3.B.2.1 Manure Management - Cattle	N_2O	120.6657672	42.94734024	25%	20%	0.320156212	0.003498808	0.001120165	0.002539917	94%
1.A.2.g Other - Gaseous Fuels	CO_2	524.168965	91.04761992	2%	5%	0.053851648	0.020554294	0.001106883	0.002509799	94%
1.A.4.b Residential - Solid Fuels	CH_4	48.03	3.9825	2%	50%	0.50039984	0.002127888	0.001064795	0.002414368	95%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	103.071464	2.2704	2%	20%	0.200997512	0.004918305	0.000988567	0.002241525	95%
4.E.2 Lands converted to settlements, Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	0.910565999	40.47931849	20%	38%	0.424817149	0.002225127	0.000945272	0.002143356	95%
1.B.2.b Natural Gas	CH_4	177.238	109.190125	32%	0%	0.322375	0.002553886	0.000823309	0.001866811	95%
1.A.3.c Railways - Liquid Fuels	N_2O	61.20060747	24.62371876	2%	50%	0.50039984	0.001615256	0.000808274	0.001832719	95%
1.A.3.c Railways - Liquid Fuels	CO_2	531.37994	213.786	2%	5%	0.053851648	0.014025269	0.000755284	0.001712567	96%
5.D.2 Industrial Wastewater	CH_4	137.025	138.525	64%	30%	0.706823882	0.001059467	0.000748857	0.001697994	96%
1.A.4.b Residential - Liquid Fuels	CO_2	329.9110639	157.1324033	2%	10%	0.10198039	0.007339463	0.000748481	0.001697143	96%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
4.A.1 Forest land remaining forest land - Controlled burning	CH_4	25.2045	8.745	92%	36%	0.987927123	0.000743486	0.00073451	0.001665464	96%
1.A.1.a Public Electricity and Heat Production - Peat	CO_2	142.826737	0	2%	10%	0.10198039	0.006991729	0.000713019	0.001616734	96%
2.C.1 Iron and Steel Production	CO_2	52.59606386	0.01036233	5%	25%	0.254950976	0.002574129	0.000656277	0.001488074	96%
3.B.1.3 Manure Management - Swaine	CH_4	65.37841625	20.64571937	25%	20%	0.320156212	0.002042819	0.000654021	0.00148296	96%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234.4643123	0.705374886	2%	5%	0.053851648	0.011438069	0.000615959	0.001396655	97%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	314.4838285	73.41324777	2%	5%	0.053851648	0.011278448	0.000607363	0.001377164	97%
1.A.2.a Iron and Steel - Other fossil fuels	CO_2	61.3521	0	2%	20%	0.200997512	0.00300334	0.000603664	0.001368777	97%
3.B.2.3 Manure Management - Swaine	N_2O	40.75322335	5.647103039	25%	20%	0.320156212	0.001678336	0.00053733	0.001218368	97%
1.A.2.g Other - Biomass Fuels	N_2O	0.455344	17.42704	5%	50%	0.502493781	0.000954855	0.000479809	0.001087942	97%
3.B.1.1 Manure Management - Cattle	CH_4	110.9670107	70.59473241	25%	20%	0.320156212	0.001473823	0.000471853	0.001069903	97%
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	93.25228881	0	2%	10%	0.10198039	0.004564935	0.000465534	0.001055574	97%
4.C. Grassland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	69.98791354	72.89522859	24%	58%	0.62938462	0.000661198	0.000416148	0.000943594	97%
1.A.3.b Road Transportation - Diesel Oil	N_2O	5.593827044	19.44722022	2%	50%	0.50039984	0.000816586	0.00040862	0.000926524	98%
5.D.1 Domestic Wastewater	N_2O	24.687214	16.53660558	140%	30%	1.431782106	0.000281283	0.000402736	0.000913184	98%
1.A.3.b Road Transportation - LPG	CO_2	36.95737306	165.2425801	2%	5%	0.053851648	0.007456102	0.000401523	0.000910434	98%

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4.B.2 Land converted to cropland, Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	0.590489444	4.882747284	64%	151%	1.639033023	0.000244873	0.000401355	0.000910051	98%
4.B. Cropland remaining cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	125.0975756	119.0448062	13%	71%	0.722349638	0.000551078	0.000398071	0.000902605	98%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	149.4154681	5.263181843	2%	5%	0.053851648	0.007019154	0.000377993	0.00085708	98%
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, dead wood	CO_2	-1.612112333	-83.797142	8%		0.0802	0.004619643	0.000370495	0.000840079	98%
3.A.3 Enteric Fermentation - Swine	CH_4	52.54125	13.1025	2%	20%	0.200997512	0.001837361	0.000369305	0.00083738	98%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CO_2	73.83865681	0	2%	10%	0.10198039	0.003614588	0.000368617	0.00083582	98%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	0.519712	13.38625669	5%	50%	0.502493781	0.000725135	0.000364376	0.000826203	98%
1.A.4.a Commercial/Institutional - Peat	CO_2	66.54499789	1.136164465	2%	11%	0.110909091	0.00319384	0.000354226	0.000803189	98%
2.D.1 Lubricant Use	CO_2	23.25102433	8.297813333	2%	50%	0.50039984	0.000672933	0.000336735	0.00076353	98%
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, litter	CO_2	-1.3821621	-71.8444518	8%		0.0802	0.003960705	0.000317649	0.000720252	99%
1.A.2.g Other - Biomass Fuels	CH_4	0.2865	10.965	5%	50%	0.502493781	0.00060079	0.000301893	0.000684527	99%

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3.A.2 Enteric Fermentation - Sheep	CH_4	32.92	18.5	2%	50%	0.50039984	0.00057421	0.000287335	0.000651516	99%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	0.327	8.434081116	5%	50%	0.502493781	0.000456897	0.000229588	0.000520579	99%
1.A.3.b Road Transportation - Gasoline	CH_4	17.15516309	2.207274532	2%	30%	0.300665928	0.000716025	0.000215284	0.000488146	99%
1.A.4.b Residential - Peat	CO_2	42.27150449	0	2%	10%	0.10198039	0.002069297	0.000211028	0.000478494	99%
1.A.2.g Other - Solid Fuels	CO_2	27.263264	5.4868	2%	20%	0.200997512	0.001026957	0.000206416	0.000468037	99%
4.A.1 Forest land remaining forest land - wildfires	CH_4	2.525	9.198	37%	36%	0.51623638	0.000392133	0.000202433	0.000459007	99%
1.B.2.c Venting and Flaring	CH_4	70.344325	26.126175	10%	0%	0.1	0.001978621	0.000197862	0.000448642	99%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	8.109	0.18	2%	50%	0.50039984	0.000386863	0.000193586	0.000438947	99%
1.A.3.b Road Transportation - Gasoline	N_2O	13.07410741	4.606850327	2%	50%	0.50039984	0.000381701	0.000191003	0.00043309	99%
3.B.2.4 Manure Management - Other livestock	N_2O	22.98598703	11.52240459	25%	30%	0.390512484	0.000479153	0.000187115	0.000424274	99%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174.2220665	93.81485986	2%	5%	0.053851648	0.00326835	0.000176006	0.000399085	99%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	7.1626684	0.0057514	2%	50%	0.50039984	0.000350308	0.000175294	0.00039747	99%
4.D.1. Wetlands, Peat extraction from lands, organic soils	CO_2	1016.928	899.740705	24%		0.2423	0.000667854	0.000161821	0.000366921	99%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	334.0088098	238.7965288	2%	5%	0.053851648	0.002961097	0.00015946	0.000361567	99%
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	6.66618252	0.181929	2%	50%	0.50039984	0.000316126	0.000158189	0.000358686	99%
4.D.1. Wetlands, Peat extraction from lands, organic soils	CH_4	28.53444375	28.53444375	24%	71%	0.751152641	0.000203112	0.000152568	0.00034594	99%

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1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	9.15	2.625286653	5%	50%	0.502493781	0.000300714	0.000151107	0.000342627	99%
1.A.4.b Residential - Biomass Fuels	CH_4	96.42474185	101.6540154	10%	10%	0.141421356	0.000979572	0.000138532	0.000314115	99%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	43.26924002	33.54418198	2%	50%	0.50039984	0.000237294	0.000118742	0.000269242	99%
1.A.4.b Residential - Gaseous Fuels	CO_2	219.6011945	230.7118474	2%	5%	0.053851648	0.002186131	0.000117727	0.000266939	99%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	5.286318275	0.590724755	2%	50%	0.50039984	0.000225656	0.000112918	0.000256037	99%
5.B.1. Composting	CH_4	23.90918253	22.4652	29%	100%	1.041201229	8.92235E-05	9.28997E-05	0.000210645	99%
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	3.72829	0.10175	2%	50%	0.50039984	0.000176804	8.84727E-05	0.000200607	100%
4.A.1 Forest land remaining forest land - Controlled burning	N_2O	2.95616	1.02512	92%		0.92	8.72323E-05	8.02538E-05	0.000181971	100%
1.A.3.b Road Transportation - LPG	N_2O	0.163685304	2.934347457	2%	50%	0.50039984	0.000156518	7.83216E-05	0.00017759	100%
1.A.4.b Residential - Peat	CH_4	3.1875	0	2%	50%	0.50039984	0.000156036	7.80805E-05	0.000177043	100%
3.A.4 Enteric Fermentation - Other livestock	CH_4	18.090525	13.021775	2%	50%	0.50039984	0.000155437	7.77809E-05	0.000176364	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	15.54739345	0.397748377	2%	10%	0.10198039	0.000738782	7.53413E-05	0.000170832	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CO_2	3.0225	0	2%	50%	0.50039984	0.000147959	7.40387E-05	0.000167879	100%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	3.00505	0.002425	2%	50%	0.50039984	0.000146969	7.35432E-05	0.000166755	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	3.495	0.649625	2%	50%	0.50039984	0.000134664	6.73859E-05	0.000152794	100%
3.B.1.4 Manure Management - Other livestock	CH_4	12.4845375	7.840283798	25%	30%	0.390512484	0.00017154	6.69884E-05	0.000151893	100%

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1.A.4.b Residential - Solid Fuels	N_2O	2.862588	0.237357	2%	50%	0.50039984	0.000126822	6.34618E-05	0.000143896	100%
3.H. Urea Application	CO_2	7.7088	4.726333333	20%	50%	0.538516481	0.000112357	6.05059E-05	0.000137194	100%
5.B.1. Composting	N_2O	17.09984734	16.06711104	29%	90%	0.945568612	6.38127E-05	6.03393E-05	0.000136816	100%
4.D.1 Wetlands remaining Wetlands – Carbon stock change – dead organic matter	CO_2	-13.80988549	-29.46614791	6%		0.059	0.000976157	5.75933E-05	0.00013059	100%
1.A.2.g Other - Liquid Fuels	CH_4	2.26531	0.173975	2%	50%	0.50039984	0.000101138	5.06093E-05	0.000114754	100%
1.A.4.b Residential - Biomass Fuels	N_2O	8.94447	10.597476	10%	30%	0.316227766	0.000156353	4.94432E-05	0.00011211	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	2.411706848	0.369840648	2%	50%	0.50039984	9.73219E-05	4.86999E-05	0.000110424	100%
1.A.3.b Road Transportation - Gaseous Fuels	CO_2	17.6165255	0	2%	5%	0.053851648	0.000862373	4.64402E-05	0.000105301	100%
1.A.2.g Other - Liquid Fuels	N_2O	2.149772	0.252487056	2%	50%	0.50039984	9.10796E-05	4.55762E-05	0.000103342	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1.87891384	0.0437464	2%	50%	0.50039984	8.95247E-05	4.47981E-05	0.000101577	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	0.008344	1.509107769	5%	50%	0.502493781	8.42082E-05	4.23141E-05	9.5945E-05	100%
2.D.3. Solvent Use	CO_2	41.0641984	32.19721064	2%	20%	0.200997512	0.000204878	4.11799E-05	9.33733E-05	100%
5.D.2 Industrial Wastewater	N_2O	2.341428614	0.115643072	23%	30%	0.378021163	0.000108135	4.08772E-05	9.26869E-05	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	0.1006644	1.5198	2%	50%	0.50039984	8.02884E-05	4.01763E-05	9.10977E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	1.774375	0.127125	2%	50%	0.50039984	7.97321E-05	3.9898E-05	9.04666E-05	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	0.8332289	12.58	2%	5%	0.053851648	0.00066458	3.57887E-05	8.11491E-05	100%
4.D.1. Wetlands, Peat extraction from lands, organic soils	N_2O	3.793114158	3.793114158	24%	112%	1.145909809	2.69999E-05	3.09394E-05	7.01535E-05	100%
2.A.3. Glass production	CO_2	0.355752064	0.942744575	2%	86%	0.860232527	3.54453E-05	3.04912E-05	6.91373E-05	100%

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1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CO_2	3.0786	0	2%	20%	0.200997512	0.000150705	3.02914E-05	6.86841E-05	100%
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.00525	0.949410006	5%	50%	0.502493781	5.2977E-05	2.66206E-05	6.03609E-05	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO_2	2.692316	0	2%	20%	0.200997512	0.000131796	2.64906E-05	6.00661E-05	100%
4.E.1 Settlements remaining Settlements – Carbon stock change – dead organic matter	CO_2	-6.10842148	-10.61212032	9%		0.0867	0.000296006	2.56637E-05	5.81911E-05	100%
1.A.2.a Iron and Steel - Other fossil fuels	N_2O	0.997704	0	2%	50%	0.50039984	4.88401E-05	2.44396E-05	5.54155E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	1.45424	0.431444174	5%	50%	0.502493781	4.69974E-05	2.36159E-05	5.35478E-05	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	1.030335	0.078225	2%	50%	0.50039984	4.60514E-05	2.30441E-05	5.22513E-05	100%
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	39.135	34.97326278	5%	50%	0.502493781	4.52166E-05	2.2721E-05	5.15188E-05	100%
1.A.3.b Road Transportation - LPG	CH_4	0.124565463	0.863788568	2%	50%	0.50039984	4.23354E-05	2.11846E-05	4.8035E-05	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.78871	0.02035	2%	50%	0.50039984	3.74683E-05	1.87491E-05	4.25127E-05	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	44.69904433	45.0354735	2%	5%	0.053851648	0.000337037	1.815E-05	4.11542E-05	100%
1.A.3.b Road Transportation - Gaseous Fuels	CH_4	0.7015	0	2%	50%	0.50039984	3.43402E-05	1.71838E-05	3.89634E-05	100%
4.A.1 Forest land remaining forest land - wildfires	N_2O	0.295616	1.078462	37%		0.37	4.59989E-05	1.70196E-05	3.85911E-05	100%
4.C.1 Grassland remaining Grassland, wildfires	N_2O	0.053992802	0.663123844	10%	48%	0.490306027	3.45387E-05	1.69345E-05	3.83982E-05	100%

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1.A.2.c Chemicals - Liquid Fuels	N_2O	0.65129688	0.0069732	2%	50%	0.50039984	3.14916E-05	1.57584E-05	3.57314E-05	100%
1.A.2.a Iron and Steel - Other fossil fuels	CH_4	0.62775	0	2%	50%	0.50039984	3.07299E-05	1.53773E-05	3.48671E-05	100%
1.A.1.a Public Electricity and Heat Production - Peat	N_2O	0.615519	0	2%	50%	0.50039984	3.01312E-05	1.50777E-05	3.41878E-05	100%
1.A.4.b Residential - Liquid Fuels	CH_4	0.868375	1.276125	2%	50%	0.50039984	2.9044E-05	1.45336E-05	3.29542E-05	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.64092648	0.04917	2%	50%	0.50039984	2.8618E-05	1.43204E-05	3.24708E-05	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	N_2O	0.07599	0.560538	2%	50%	0.50039984	2.77098E-05	1.3866E-05	3.14404E-05	100%
3.B.2.2 Manure Management - Sheep	N_2O	1.824479542	2.221483039	25%	30%	0.390512484	3.52471E-05	1.37644E-05	3.12102E-05	100%
4.C.1 Grassland remaining Grassland – Carbon stock change – dead organic matter	CO_2	-4.284491677	-8.55723594	5%		0.0498	0.000270073	1.34496E-05	3.04964E-05	100%
4.C.1 Grassland remaining Grassland, wildfires	CH_4	0.049609865	0.609294045	10%	39%	0.402616443	3.1735E-05	1.2777E-05	2.89712E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.4832964	0.010728	2%	50%	0.50039984	2.30571E-05	1.15377E-05	2.61612E-05	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0.47777148	0.010728	2%	50%	0.50039984	2.27866E-05	1.14024E-05	2.58544E-05	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	1.4367772	0.865392	2%	50%	0.50039984	2.18108E-05	1.09141E-05	2.47472E-05	100%
1.A.2.c Chemicals - Gaseous Fuels	CO_2	23.42449305	17.14603569	2%	5%	0.053851648	0.000185299	9.97864E-06	2.2626E-05	100%
1.A.3.c Railways - Liquid Fuels	CH_4	0.745009038	0.299750179	2%	50%	0.50039984	1.96629E-05	9.8393E-06	2.23101E-05	100%
1.A.3.b Road Transportation - Lubricants	CO_2	3.4629	4.554798669	10%	5%	0.111803399	8.58728E-05	9.60087E-06	2.17695E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.423011	0.0303066	2%	50%	0.50039984	1.90081E-05	9.51167E-06	2.15672E-05	100%

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1.A.3.a Domestic Aviation - Jet kerosene	CO_2	0.054819072	3.13427	2%	5%	0.053851648	0.000173057	9.31941E-06	2.11313E-05	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	1.20535	0.726	2%	50%	0.50039984	1.82976E-05	9.15613E-06	2.07611E-05	100%
5.C.1 Waste Incineration	N_2O	4.847024532	4.3807102	43%	100%	1.08853112	8.35519E-06	9.09488E-06	2.06222E-05	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.271776	0.556962	5%	50%	0.502493781	1.79251E-05	9.00725E-06	2.04235E-05	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	N_2O	0.3177723	0	2%	50%	0.50039984	1.55558E-05	7.7841E-06	1.765E-05	100%
1.A.4.a Commercial/Institutional - Peat	N_2O	0.2955862	0.004619	2%	50%	0.50039984	1.42107E-05	7.11103E-06	1.61239E-05	100%
1.A.3.b Road Transportation - Gaseous Fuels	N_2O	0.27267	0	2%	50%	0.50039984	1.33479E-05	6.67928E-06	1.51449E-05	100%
1.A.3.b Road Transportation - Diesel Oil	CH_4	1.108041461	1.356526416	2%	30%	0.300665928	2.18199E-05	6.5605E-06	1.48756E-05	100%
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.273195	0.004725	2%	50%	0.50039984	1.31087E-05	6.55957E-06	1.48735E-05	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.268845	0.020625	2%	50%	0.50039984	1.20042E-05	6.00689E-06	1.36203E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CH_4	0.2325	0	2%	50%	0.50039984	1.13815E-05	5.69528E-06	1.29138E-05	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.171	0.3505	5%	50%	0.502493781	1.12819E-05	5.66908E-06	1.28543E-05	100%
1.A.2.g Other - Gaseous Fuels	N_2O	0.28480456	0.0500044	2%	50%	0.50039984	1.11381E-05	5.57351E-06	1.26377E-05	100%
1.A.2.a Iron and Steel - Liquid Fuels	N_2O	0.2179572	0	2%	50%	0.50039984	1.06696E-05	5.33904E-06	1.2106E-05	100%
3.B.1.2 Manure Management - Sheep	CH_4	0.78185	0.439375	25%	30%	0.390512484	1.36375E-05	5.32561E-06	1.20755E-05	100%
5.C.1 Waste Incineration	CO_2	0.810707594	0.56263867	43%	40%	0.587281874	8.13867E-06	4.77969E-06	1.08377E-05	100%
1.A.2.g Other - Gaseous Fuels	CH_4	0.23893	0.04195	2%	50%	0.50039984	9.34406E-06	4.67577E-06	1.06021E-05	100%
1.A.4.b Residential - Peat	N_2O	0.1860712	0	2%	50%	0.50039984	9.10865E-06	4.55797E-06	1.0335E-05	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
1.A.4.a Commercial/Institutional - Peat	CH_4	0.168	0.00275	2%	50%	0.50039984	8.06983E-06	4.03814E-06	9.15628E-06	100%
1.A.4.a Commercial/Institutional - Biomass Fuels	N_2O	6.219856	5.564080248	5%	50%	0.502493781	7.50395E-06	3.77069E-06	8.54984E-06	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0.76125	0.550125	2%	50%	0.50039984	6.41924E-06	3.21219E-06	7.28347E-06	100%
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.127395	0.0003874	2%	50%	0.50039984	6.21458E-06	3.10978E-06	7.05126E-06	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.1708732	0.0403194	2%	50%	0.50039984	6.10394E-06	3.05441E-06	6.92572E-06	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	24.7792529	21.16428627	2%	10%	0.10198039	2.63117E-05	2.68327E-06	6.08419E-06	100%
1.A.4.b Residential - Gaseous Fuels	CH_4	0.5005	0.5315	2%	50%	0.50039984	5.30081E-06	2.65253E-06	6.01447E-06	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.106875	0.000325	2%	50%	0.50039984	5.21358E-06	2.60887E-06	5.91549E-06	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.14335	0.033825	2%	50%	0.50039984	5.12075E-06	2.56242E-06	5.81017E-06	100%
1.A.2.g Other - Solid Fuels	N_2O	0.12419448	0.025926	2%	50%	0.50039984	4.62595E-06	2.31482E-06	5.24874E-06	100%
1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.172771761	0.3465	20%	5%	0.206155281	1.09709E-05	2.2617E-06	5.12829E-06	100%
1.A.2.a Iron and Steel - Liquid Fuels	CH_4	0.091425	0	2%	50%	0.50039984	4.47548E-06	2.23953E-06	5.07802E-06	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.08118414	0.0028906	2%	50%	0.50039984	3.81209E-06	1.90757E-06	4.32532E-06	100%
2.D.3.b Road paving with asphalt	CO_2	0.001463305	0.054450618	20%	60%	0.632455532	2.98145E-06	1.88563E-06	4.27558E-06	100%
2.D.3.c Asphalt roofing	CO_2	0.002972338	0.049156808	20%	60%	0.632455532	2.61075E-06	1.65118E-06	3.74397E-06	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0.0681075	0.002425	2%	50%	0.50039984	3.19806E-06	1.60031E-06	3.62862E-06	100%
2.G.3. N_2O from product uses	N_2O	1.30226	2.01448	2%	2%	0.028284271	4.92043E-05	1.39171E-06	3.15562E-06	100%
1.A.4.b Residential - Liquid Fuels	N_2O	0.4500694	0.344594088	2%	50%	0.50039984	2.71042E-06	1.35629E-06	3.07532E-06	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.057625	0.004375	2%	50%	0.50039984	2.57558E-06	1.28882E-06	2.92233E-06	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	N_2O	0.050064	0	2%	50%	0.50039984	2.45076E-06	1.22636E-06	2.78071E-06	100%
2.C.1 Iron and Steel Production	CH_4	0.06875	1.15638E-05	10%	25%	0.26925824	3.36484E-06	9.0601E-07	2.05433E-06	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.0362964	0.0004768	2%	50%	0.50039984	1.75007E-06	8.75733E-07	1.98568E-06	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.09466268	0.0515242	2%	50%	0.50039984	1.74498E-06	8.73189E-07	1.97991E-06	100%
1.A.1.a Public Electricity and Heat Production - Peat	CH_4	0.034425	0	2%	50%	0.50039984	1.68519E-06	8.43269E-07	1.91207E-06	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.011005031	0.28	2%	5%	0.053851648	1.51611E-05	8.16448E-07	1.85125E-06	100%
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.000453151	0.029353	2%	50%	0.50039984	1.62366E-06	8.12479E-07	1.84225E-06	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.00425	0.03135	2%	50%	0.50039984	1.54977E-06	7.75503E-07	1.75841E-06	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CH_4	0.0315	0	2%	50%	0.50039984	1.542E-06	7.71619E-07	1.74961E-06	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.181482	0.1311498	2%	50%	0.50039984	1.53035E-06	7.65786E-07	1.73638E-06	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.079415	0.043225	2%	50%	0.50039984	1.46391E-06	7.32541E-07	1.661E-06	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.026721	0.0006	2%	50%	0.50039984	1.27442E-06	6.37719E-07	1.44599E-06	100%
1.A.4.b Residential - Gaseous Fuels	N_2O	0.1193192	0.1267096	2%	50%	0.50039984	1.26371E-06	6.32362E-07	1.43385E-06	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.001126	0.017	2%	50%	0.50039984	8.9808E-07	4.49399E-07	1.01899E-06	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CH_4	0.0177725	0	2%	50%	0.50039984	8.70009E-07	4.35352E-07	9.87139E-07	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.015225	0.00025	2%	50%	0.50039984	7.31284E-07	3.65935E-07	8.29738E-07	100%
1.A.3.b Road Transportation - Lubricants	N_2O	0.02384	0.032918912	10%	50%	0.509901951	6.78757E-07	3.46099E-07	7.84762E-07	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	N_2O	0.013857	0	2%	50%	0.50039984	6.78335E-07	3.39439E-07	7.6966E-07	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N_2O	0.01272162	0	2%	50%	0.50039984	6.22755E-07	3.11627E-07	7.06597E-07	100%
1.A.3.b Road Transportation - Lubricants	CH_4	0.02475	0.014988474	10%	50%	0.509901951	3.71161E-07	1.89256E-07	4.29128E-07	100%
4.B.1 Cropland remaining Cropland – Carbon stock change – dead organic matter	CO_2	-1.368033333	-1.2914	3%		0.026	5.44095E-06	1.41465E-07	3.20764E-07	100%
1.A.2.g Other - Solid Fuels	CH_4	0.006946	0.00145	2%	50%	0.50039984	2.58722E-07	1.29464E-07	2.93554E-07	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0.05379496	0.0511368	2%	50%	0.50039984	2.33875E-07	1.17031E-07	2.65361E-07	100%
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.00295205	0.005924494	20%	50%	0.538516481	1.8768E-07	1.01069E-07	2.29168E-07	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0.024287	0.024734	2%	50%	0.50039984	1.97942E-07	9.90499E-08	2.24591E-07	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.020375	0.02075	2%	50%	0.50039984	1.66058E-07	8.30956E-08	1.88415E-07	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	9.36998E-05	0.002384	2%	50%	0.50039984	1.29086E-07	6.45944E-08	1.46464E-07	100%
1.B.2.b Natural Gas	CO_2	0.008686	0.011105	32%	0%	0.322375	1.97463E-07	6.36571E-08	1.44339E-07	100%
1.A.3.a Domestic Aviation - Jet kerosene	CH_4	0.000009504	0.0021375	2%	50%	0.50039984	1.19386E-07	5.97406E-08	1.35459E-07	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.01272758	0.0094168	2%	50%	0.50039984	9.50411E-08	4.75585E-08	1.07837E-07	100%
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0.0106775	0.0079	2%	50%	0.50039984	7.97324E-08	3.98981E-08	9.04669E-08	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CH_4	0.02314	0.02145	2%	50%	0.50039984	6.9954E-08	3.5005E-08	7.9372E-08	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH_4	0.0007115	0	2%	50%	0.50039984	3.48297E-08	1.74288E-08	3.95189E-08	100%
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.000219506	0.000440227	20%	50%	0.538516481	1.39385E-08	7.50609E-09	1.70197E-08	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CH_4	1.96519E-06	0.00005	2%	50%	0.50039984	2.70733E-09	1.35475E-09	3.07182E-09	100%
1.B.2.c Venting and Flaring	CO_2	0.002806	0.002657	10%	0%	0.1	1.16189E-08	1.16189E-09	2.63453E-09	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	CH_4	0	0.2955	5%	50%	0.502493781		0	0	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	N_2O	0	0.469648	5%	50%	0.502493781		0	0	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CO_2	0	3.906691677	2%	5%	0.053851648		0	0	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CH_4	0	0.0018	2%	50%	0.50039984		0	0	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	N_2O	0	0.0021456	2%	50%	0.50039984		0	0	100%
1.A.2.c Chemicals - Peat	CO_2	0	1.12172959	2%	11%	0.110909091		0	0	100%
1.A.2.c Chemicals - Biomass Fuels	CH_4	0	0.211451058	5%	50%	0.502493781		0	0	100%
1.A.2.c Chemicals - Peat	CH_4	0	0.000521299	2%	50%	0.50039984		0	0	100%
1.A.2.c Chemicals - Biomass Fuels	N_2O	0	0.334983061	5%	50%	0.502493781		0	0	100%
1.A.2.c Chemicals - Peat	N_2O	0	0.004850822	2%	50%	0.50039984		0	0	100%
1.A.2.d. Pulp, Paper and Print - Biomass	CH_4	0	0.00225	5%	50%	0.502493781		0	0	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
Fuels										
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	N_2O	0	0.003576	5%	50%	0.502493781		0	0	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CO_2	0	2.1257	2%	20%	0.200997512		0	0	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CH_4	0	0.02175	2%	50%	0.50039984		0	0	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	N_2O	0	0.034568	2%	50%	0.50039984		0	0	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CO_2	0	107.5693	2%	2%	0.028284271		0	0	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CH_4	0	0.937280723	2%	50%	0.50039984		0	0	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	N_2O	0	1.489651495	2%	50%	0.50039984		0	0	100%
1.A.2.g Other - Peat	CO_2	0	1.331164465	2%	10%	0.10198039		0	0	100%
1.A.2.g Other - Peat	CH_4	0	0.000575	2%	50%	0.50039984		0	0	100%
1.A.2.g Other - Peat	N_2O	0	0.005811	2%	50%	0.50039984		0	0	100%
1.A.3.b Road Transportation - Biomass	CH_4	0	0.023009615	2%	50%	0.50039984		0	0	100%
1.A.3.b Road Transportation - Biomass	N_2O	0	0.349076786	2%	50%	0.50039984		0	0	100%
1.A.3.c. Railway Biomass Fuels	CH_4	0	0.0022825	2%	50%	0.50039984		0	0	100%
1.A.3.c. Railway Biomass Fuels	N_2O	0	0.0346276	2%	50%	0.50039984		0	0	100%
1.A.5.b Mobile - Liquid Fuels	CO_2	0	9.442494289	2%	50%	0.50039984		0	0	100%
1.A.5.b Mobile - Liquid Fuels	CH_4	0	0.018743571	2%	50%	0.50039984		0	0	100%
1.A.5.b Mobile - Liquid Fuels	N_2O	0	0.076423393	2%	50%	0.50039984		0	0	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
2.D.2 Paraffin wax use	CO_2	0	4.911573333	2%	100%	1.00019998		0	0	100%
2.D.3.d Urea Use	CO_2	0	0.817	20%	10%	0.223606798		0	0	100%
2.F.1. Refrigeration and air conditioning	HFCs	0	206.3769351	50%	50%	0.707106781		0	0	100%
2.F.2 Foam blowing agents	HFCs	0	0.961490119	50%	50%	0.707106781		0	0	100%
2.F.3. Fire Protection	HFCs	0	0.02767976	50%	50%	0.707106781		0	0	100%
2.F.4. Aerosols	HFCs	0	4.697766137	50%	50%	0.707106781		0	0	100%
2.G.1. Electrical equipment	SF6	0	8.577903643	2%	30%	0.300665928		0	0	100%
4.A.2 Land converted to Forest Land – grassland converted to forest land, Drained organic soil	CO_2	0	61.24812203	44%	25%	0.501982161		0	0	100%
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	0	22.06783674	5%	242%	2.420575931		0	0	100%
4.B.2 Wetlands converted to cropland, organic soil	CO_2	0	3.8236	114%	18%	1.153209092		0	0	100%
4.B.2 Settlements converted to cropland, mineral soils	CO_2	0	5.310433333	64%	60%	0.880556784		0	0	100%
4.E.1 Settlements remaining Settlements – Drained organic soils	CO_2	0	19.43012935	9%	18%	0.202860666		0	0	100%
4.E.2 Settlements remaining Settlements, Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	0	4.083489381	9%	38%	0.386743455		0	0	100%

IPCC category/Group	Gas	1990 emissions or removals (kt CO_2 eq)	2014 emissions or removals (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
5.A.1. Managed Waste Disposal on Land	CH_4	0	301.0244136	7%	52%	0.524690385		0	0	100%
TOTAL		17834.80	15573.52			162.446478	2.386613709	0.441024373	1	

A.1.12 Spreadsheet for the Approach 2 analysis for 2014 – trend assessment without LULUCF

IPCC category/Group	Gas	1990 emissions (kt CO_2 eq)	2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
3.D.1. Direct N_2O emissions from managed soils	N_2O	1962.77564	1429.497775	2%	50%	0.50039984	0.022119758	0.011068724	0.191920686	19%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778.531208	55.18201994	2%	50%	0.50039984	0.010719577	0.005364075	0.093007736	28%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3049.6213	2.456340066	2%	10%	0.10198039	0.05012911	0.005112186	0.088640237	37%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1410.78494	38.5022	2%	20%	0.200997512	0.021767108	0.004375135	0.075860494	45%
3.G. Liming	CO_2	371.418667	19.68633333	2%	50%	0.50039984	0.005366933	0.002685613	0.046565858	50%
5.D.2 Industrial Wastewater	CH_4	137.025	138.525	64%	30%	0.706823882	0.003019255	0.002134081	0.037002851	53%
1.A.3.b Road Transportation - Diesel Oil	CO_2	616.135968	1880.266	2%	2%	0.028284271	0.061464797	0.001738487	0.03014364	56%
2.A.1. Cement Production	CO_2	370.803997	555.775815	10%	5%	0.111803399	0.015060641	0.001683831	0.029195956	59%

IPCC category/Group	Gas	1990 emissions (kt CO_2 eq)	2014 emissions (kt CO_2 eq)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined Uncertainty	Trend assessment	Trend assessment with Uncertainty	% Contribution to Trend	Cumulative total of contribution to trend
1.A.4.b Residential - Solid Fuels	CO_2	605.8184	50.2326	2%	20%	0.200997512	0.008063761	0.001620796	0.028102994	62%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798.205869	26.17773966	2%	11%	0.111074685	0.012148244	0.001349362	0.023396604	64%
2.A.2. Lime Production	CO_2	148.857381	0.459881348	2%	50%	0.50039984	0.002433941	0.001217944	0.02111794	66%
5.A.2. Unmanaged Waste Disposal Sites	CH_4	392.831163	227.8019525	7%	52%	0.524690385	0.002206706	0.001157838	0.020075754	69%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1007.29434	155.5621374	2%	10%	0.10198039	0.010663894	0.001087508	0.018856311	70%
1.A.2.g Other - Liquid Fuels	CO_2	795.703984	104.8142275	2%	10%	0.10198039	0.0091121	0.000929255	0.016112368	72%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2644.31868	1575.698976	2%	5%	0.053851648	0.016463977	0.000886612	0.015372978	74%
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	16.4292	118.6284	2%	20%	0.200997512	0.004247505	0.000853738	0.014802971	75%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	102.28152	2.2704	2%	50%	0.50039984	0.001597952	0.000799615	0.01386453	76%
3.A.1 Enteric Fermentation - Cattle	CH_4	2117.98935	828.0431219	2%	20%	0.200997512	0.00334332	0.000671999	0.011651796	78%
3.D.2 Indirect N_2O Emissions from managed soils	N_2O	377.2229	196.0440499	2%	50%	0.50039984	0.001254222	0.000627613	0.010882181	79%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	218.053	16.555	2%	20%	0.200997512	0.002960492	0.000595051	0.010317603	80%
5.B.1. Composting	CH_4	23.9091825	22.4652	29%	100%	1.041201229	0.000461859	0.000480888	0.008338128	81%
1.A.2.c Chemicals - Liquid Fuels	CO_2	276.678673	10.10088453	2%	10%	0.10198039	0.004171779	0.00042544	0.007376702	81%
5.D.1 Domestic Wastewater	CH_4	207.775	109.5074001	45%	30%	0.540832691	0.000748947	0.000405055	0.007023255	82%

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1.B.2.b Natural Gas	CH_4	177.238	109.190125	32%	0%	0.322375	0.001239762	0.000399668	0.006929851	83%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	273.576925	20.35027526	2%	10%	0.10198039	0.003730341	0.000380422	0.006596133	83%
2.A.4. Other process uses of carbonates	CO_2	69.184752	10.8326905	2%	50%	0.50039984	0.000726796	0.000363688	0.006305997	84%
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	39.135	34.97326278	5%	50%	0.502493781	0.000687494	0.000345461	0.005989958	85%
1.A.2.g Other - Biomass Fuels	N_2O	0.455344	17.42704	5%	50%	0.502493781	0.000656226	0.000329749	0.005717526	85%
1.A.3.b Road Transportation - Diesel Oil	N_2O	5.59382704	19.44722022	2%	50%	0.50039984	0.000648543	0.000324531	0.005627043	86%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	103.071464	2.2704	2%	20%	0.200997512	0.001610961	0.000323799	0.005614357	86%
1.A.4.b Residential - Biomass Fuels	CH_4	96.4247418	101.6540154	10%	10%	0.141421356	0.002283615	0.000322952	0.005599666	87%
1.A.4.b Residential - Solid Fuels	CH_4	48.03	3.9825	2%	50%	0.50039984	0.000639305	0.000319908	0.005546885	87%
5.D.1 Domestic Wastewater	N_2O	24.687214	16.53660558	140%	30%	1.431782106	0.00022325	0.000319646	0.005542343	88%
5.B.1. Composting	N_2O	17.0998473	16.06711104	29%	90%	0.945568612	0.000330322	0.000312342	0.005415698	88%
1.A.3.b Road Transportation - LPG	CO_2	36.9573731	165.2425801	2%	5%	0.053851648	0.005684781	0.000306135	0.005308074	89%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	43.26924	33.54418198	2%	50%	0.50039984	0.000564981	0.000282717	0.004902025	89%
1.A.4.b Residential - Gaseous Fuels	CO_2	219.601194	230.7118474	2%	5%	0.053851648	0.005170368	0.000278433	0.00482775	90%
1.A.2.g Other - Gaseous Fuels	CO_2	524.168965	91.04761992	2%	5%	0.053851648	0.005164641	0.000278124	0.004822402	90%
3.B.1.1 Manure Management - Cattle	CH_4	110.967011	70.59473241	25%	20%	0.320156212	0.000861205	0.00027572	0.004780712	91%

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1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	0.519712	13.38625669	5%	50%	0.502493781	0.000501269	0.000251884	0.004367426	91%
1.A.1.a Public Electricity and Heat Production - Peat	CO_2	142.826737	0	2%	10%	0.10198039	0.002352141	0.000239872	0.004159147	92%
2.C.1 Iron and Steel Production	CO_2	52.5960639	0.01036233	5%	25%	0.254950976	0.000865783	0.000220732	0.003827278	92%
1.A.2.g Other - Biomass Fuels	CH_4	0.2865	10.965	5%	50%	0.502493781	0.000412894	0.000207477	0.003597437	93%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234.464312	0.705374886	2%	5%	0.053851648	0.003834409	0.000206489	0.003580318	93%
1.A.2.a Iron and Steel - Other fossil fuels	CO_2	61.3521	0	2%	20%	0.200997512	0.001010377	0.000203083	0.003521261	93%
3.B.5 Indirect N_2O emissions from Manure Management	N_2O	137.520248	41.93797066	2%	30%	0.300665928	0.000667506	0.000200696	0.003479873	94%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	334.00881	238.7965288	2%	5%	0.053851648	0.00359416	0.000193551	0.00335599	94%
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	0.327	8.434081116	5%	50%	0.502493781	0.000315834	0.000158705	0.002751784	94%
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	93.2522888	0	2%	10%	0.10198039	0.001535725	0.000156614	0.002715528	94%
3.B.2.3 Manure Management - Swaine	N_2O	40.7532233	5.647103039	25%	20%	0.320156212	0.000456069	0.000146013	0.002531727	95%
1.A.3.b Road Transportation - Gasoline	CO_2	1723.75045	613.35806	2%	2%	0.028284271	0.005027274	0.000142193	0.002465482	95%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	314.483828	73.41324777	2%	5%	0.053851648	0.002383064	0.000128332	0.002225149	95%

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1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CO_2	73.8386568	0	2%	10%	0.10198039	0.001216011	0.000124009	0.002150198	95%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	149.415468	5.263181843	2%	5%	0.053851648	0.002260194	0.000121715	0.002110421	96%
1.A.4.a Commercial/Institutional - Peat	CO_2	66.5449979	1.136164465	2%	11%	0.110909091	0.001052624	0.000116746	0.002024252	96%
3.B.2.1 Manure Management - Cattle	N_2O	120.665767	42.94734024	25%	20%	0.320156212	0.000351495	0.000112533	0.001951216	96%
2.D.3. Solvent Use	CO_2	41.0641984	32.19721064	2%	20%	0.200997512	0.000549994	0.000110548	0.001916784	96%
3.A.4 Enteric Fermentation - Other livestock	CH_4	18.090525	13.021775	2%	50%	0.50039984	0.000198022	9.90904E-05	0.001718129	96%
5.C.1 Waste Incineration	N_2O	4.84702453	4.3807102	43%	100%	1.08853112	8.70201E-05	9.47241E-05	0.001642422	97%
3.B.1.3 Manure Management - Swaine	CH_4	65.3784162	20.64571937	25%	20%	0.320156212	0.000290373	9.29647E-05	0.001611916	97%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	695.075709	320.5751539	2%	11%	0.108754816	0.000762546	8.29305E-05	0.001437933	97%
3.A.2 Enteric Fermentation - Sheep	CH_4	32.92	18.5	2%	50%	0.50039984	0.000162446	8.12882E-05	0.001409456	97%
1.A.4.b Residential - Biomass Fuels	N_2O	8.94447	10.597476	10%	30%	0.316227766	0.000256313	8.10531E-05	0.001405381	97%
3.A.3 Enteric Fermentation - Swine	CH_4	52.54125	13.1025	2%	20%	0.200997512	0.000366255	7.36163E-05	0.001276433	97%
1.A.4.b Residential - Peat	CO_2	42.2715045	0	2%	10%	0.10198039	0.000696148	7.09934E-05	0.001230956	97%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	8.109	0.18	2%	50%	0.50039984	0.000126688	6.33944E-05	0.001099196	97%
1.A.3.b Road Transportation - Gasoline	CH_4	17.1551631	2.207274532	2%	30%	0.300665928	0.000198454	5.96682E-05	0.001034588	98%

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1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	7.1626684	0.0057514	2%	50%	0.50039984	0.000117739	5.89167E-05	0.001021558	98%
1.A.4.b Residential - Liquid Fuels	CO_2	329.911064	157.1324033	2%	10%	0.10198039	0.000551392	5.62312E-05	0.000974992	98%
1.A.4.a Commercial/Institutional - Biomass Fuels	N_2O	6.219856	5.564080248	5%	50%	0.502493781	0.000109481	5.50137E-05	0.000953883	98%
1.A.3.b Road Transportation - LPG	N_2O	0.1636853	2.934347457	2%	50%	0.50039984	0.000109062	5.45744E-05	0.000946266	98%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	44.6990443	45.0354735	2%	5%	0.053851648	0.000979091	5.27257E-05	0.000914211	98%
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	6.66618252	0.181929	2%	50%	0.50039984	0.000102853	5.14676E-05	0.000892398	98%
1.A.2.g Other - Solid Fuels	CO_2	27.263264	5.4868	2%	20%	0.200997512	0.000240015	4.82424E-05	0.000836476	98%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	24.7792529	21.16428627	2%	10%	0.10198039	0.000397984	4.05866E-05	0.000703731	98%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174.222067	93.81485986	2%	5%	0.053851648	0.000703849	3.79034E-05	0.000657208	98%
3.B.1.4 Manure Management - Other livestock	CH_4	12.4845375	7.840283798	25%	30%	0.390512484	9.30028E-05	3.63187E-05	0.000629731	98%
1.A.3.c Railways - Liquid Fuels	N_2O	61.2006075	24.62371876	2%	50%	0.50039984	7.00651E-05	3.50606E-05	0.000607916	98%
2.D.1 Lubricant Use	CO_2	23.2510243	8.297813333	2%	50%	0.50039984	6.68796E-05	3.34665E-05	0.000580277	99%
1.A.3.c Railways - Liquid Fuels	CO_2	531.37994	213.786	2%	5%	0.053851648	0.000608793	3.27845E-05	0.000568451	99%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	5.28631828	0.590724755	2%	50%	0.50039984	6.45594E-05	3.23055E-05	0.000560146	99%

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1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	0.008344	1.509107769	5%	50%	0.502493781	5.73383E-05	2.88121E-05	0.000499574	99%
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	3.72829	0.10175	2%	50%	0.50039984	5.75241E-05	2.8785E-05	0.000499104	99%
3.H. Urea Application	CO_2	7.7088	4.726333333	20%	50%	0.538516481	5.30544E-05	2.85706E-05	0.000495387	99%
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	0.1006644	1.5198	2%	50%	0.50039984	5.62252E-05	2.81351E-05	0.000487834	99%
1.A.4.b Residential - Peat	CH_4	3.1875	0	2%	50%	0.50039984	5.24933E-05	2.62676E-05	0.000455455	99%
2.A.3. Glass production	CO_2	0.35575206	0.942744575	2%	86%	0.860232527	3.00466E-05	2.5847E-05	0.000448162	99%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	9.15	2.625286653	5%	50%	0.502493781	5.07003E-05	2.54766E-05	0.000441739	99%
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	0.8332289	12.58	2%	5%	0.053851648	0.000465399	2.50625E-05	0.000434559	99%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CO_2	3.0225	0	2%	50%	0.50039984	4.9776E-05	2.49079E-05	0.000431878	99%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	3.00505	0.002425	2%	50%	0.50039984	4.93963E-05	2.47179E-05	0.000428584	99%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	15.5473935	0.397748377	2%	10%	0.10198039	0.000240894	2.45664E-05	0.000425957	99%
3.B.2.4 Manure Management - Other livestock	N_2O	22.985987	11.52240459	25%	30%	0.390512484	6.02966E-05	2.35466E-05	0.000408275	99%
3.B.2.2 Manure Management - Sheep	N_2O	1.82447954	2.221483039	25%	30%	0.390512484	5.45608E-05	2.13067E-05	0.000369436	99%
1.A.3.b Road Transportation -	N_2O	13.0741074	4.606850327	2%	50%	0.50039984	3.98548E-05	1.99433E-05	0.000345797	99%

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Gasoline										
1.A.4.b Residential - Solid Fuels	N_2O	2.862588	0.237357	2%	50%	0.50039984	3.81026E-05	1.90665E-05	0.000330594	99%
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.00525	0.949410006	5%	50%	0.502493781	3.60727E-05	1.81263E-05	0.000314292	99%
1.A.4.b Residential - Liquid Fuels	CH_4	0.868375	1.276125	2%	50%	0.50039984	3.43015E-05	1.71645E-05	0.000297615	99%
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	3.495	0.649625	2%	50%	0.50039984	3.28158E-05	1.6421E-05	0.000284724	99%
1.B.2.c Venting and Flaring	CH_4	70.344325	26.126175	10%	0%	0.1	0.000163426	1.63426E-05	0.000283364	99%
1.A.3.b Road Transportation - Gaseous Fuels	CO_2	17.6165255	0	2%	5%	0.053851648	0.000290118	1.56233E-05	0.000270893	99%
1.A.3.b Road Transportation - LPG	CH_4	0.12456546	0.863788568	2%	50%	0.50039984	3.08468E-05	1.54357E-05	0.00026764	99%
1.A.2.g Other - Liquid Fuels	CH_4	2.26531	0.173975	2%	50%	0.50039984	3.06802E-05	1.53524E-05	0.000266195	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1.87891384	0.0437464	2%	50%	0.50039984	2.92768E-05	1.46501E-05	0.000254018	100%
1.A.2.c Chemicals - Gaseous Fuels	CO_2	23.424493	17.14603569	2%	5%	0.053851648	0.000267256	1.43922E-05	0.000249546	100%
1.A.3.b Road Transportation - Lubricants	CO_2	3.4629	4.554798669	10%	5%	0.111803399	0.000116445	1.30189E-05	0.000225735	100%
5.D.2 Industrial Wastewater	N_2O	2.34142861	0.115643072	23%	30%	0.378021163	3.41554E-05	1.29115E-05	0.000223872	100%
1.A.2.g Other - Liquid Fuels	N_2O	2.149772	0.252487056	2%	50%	0.50039984	2.57873E-05	1.2904E-05	0.000223742	100%
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	2.41170685	0.369840648	2%	50%	0.50039984	2.56315E-05	1.2826E-05	0.00022239	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	1.774375	0.127125	2%	50%	0.50039984	2.43796E-05	1.21996E-05	0.000211528	100%

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1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CO_2	3.0786	0	2%	20%	0.200997512	5.06999E-05	1.01906E-05	0.000176694	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	N_2O	0.07599	0.560538	2%	50%	0.50039984	2.00972E-05	1.00566E-05	0.000174372	100%
1.A.3.b Road Transportation - Diesel Oil	CH_4	1.10804146	1.356526416	2%	30%	0.300665928	3.34168E-05	1.00473E-05	0.00017421	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO_2	2.692316	0	2%	20%	0.200997512	4.43384E-05	8.9119E-06	0.000154524	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.271776	0.556962	5%	50%	0.502493781	1.67367E-05	8.41007E-06	0.000145822	100%
1.A.2.a Iron and Steel - Other fossil fuels	N_2O	0.997704	0	2%	50%	0.50039984	1.64307E-05	8.22191E-06	0.00014256	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	1.030335	0.078225	2%	50%	0.50039984	1.39888E-05	6.99999E-06	0.000121373	100%
1.A.3.a Domestic Aviation - Jet kerosene	CO_2	0.05481907	3.13427	2%	5%	0.053851648	0.000118469	6.37974E-06	0.000110618	100%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.78871	0.02035	2%	50%	0.50039984	1.22138E-05	6.11179E-06	0.000105972	100%
1.A.4.b Residential - Gaseous Fuels	CH_4	0.5005	0.5315	2%	50%	0.50039984	1.20002E-05	6.00489E-06	0.000104119	100%
1.A.3.b Road Transportation - Gaseous Fuels	CH_4	0.7015	0	2%	50%	0.50039984	1.15526E-05	5.78094E-06	0.000100236	100%
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.171	0.3505	5%	50%	0.502493781	1.0533E-05	5.29277E-06	9.17713E-05	100%
1.A.2.c Chemicals - Liquid Fuels	N_2O	0.65129688	0.0069732	2%	50%	0.50039984	1.04603E-05	5.23433E-06	9.07581E-05	100%

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1.A.2.a Iron and Steel - Other fossil fuels	CH_4	0.62775	0	2%	50%	0.50039984	1.03381E-05	5.17318E-06	8.96978E-05	100%
1.A.1.a Public Electricity and Heat Production - Peat	N_2O	0.615519	0	2%	50%	0.50039984	1.01367E-05	5.07239E-06	8.79502E-05	100%
5.C.1 Waste Incineration	CO_2	0.81070759	0.56263867	43%	40%	0.587281874	8.07747E-06	4.74375E-06	8.2252E-05	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	1.4367772	0.865392	2%	50%	0.50039984	9.29768E-06	4.65256E-06	8.06708E-05	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.64092648	0.04917	2%	50%	0.50039984	8.68241E-06	4.34468E-06	7.53324E-05	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0.76125	0.550125	2%	50%	0.50039984	8.41537E-06	4.21105E-06	7.30154E-05	100%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	1.20535	0.726	2%	50%	0.50039984	7.80007E-06	3.90315E-06	6.76768E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.4832964	0.010728	2%	50%	0.50039984	7.55058E-06	3.77831E-06	6.55121E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	1.45424	0.431444174	5%	50%	0.502493781	7.5172E-06	3.77735E-06	6.54954E-05	100%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0.47777148	0.010728	2%	50%	0.50039984	7.45959E-06	3.73278E-06	6.47227E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.423011	0.0303066	2%	50%	0.50039984	5.8121E-06	2.90837E-06	5.04283E-05	100%
1.A.4.b Residential - Liquid Fuels	N_2O	0.4500694	0.344594088	2%	50%	0.50039984	5.71221E-06	2.85839E-06	4.95617E-05	100%

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1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	N_2O	0.3177723	0	2%	50%	0.50039984	5.23323E-06	2.61871E-06	4.54058E-05	100%
1.A.4.a Commercial/Institutional - Peat	N_2O	0.2955862	0.004619	2%	50%	0.50039984	4.69194E-06	2.34785E-06	4.07093E-05	100%
1.A.3.b Road Transportation - Gaseous Fuels	N_2O	0.27267	0	2%	50%	0.50039984	4.49046E-06	2.24703E-06	3.89612E-05	100%
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.273195	0.004725	2%	50%	0.50039984	4.31915E-06	2.1613E-06	3.74749E-05	100%
1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.17277176	0.3465	20%	5%	0.206155281	1.03515E-05	2.13401E-06	3.70016E-05	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CH_4	0.2325	0	2%	50%	0.50039984	3.82892E-06	1.91599E-06	3.32214E-05	100%
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.268845	0.020625	2%	50%	0.50039984	3.64195E-06	1.82243E-06	3.15991E-05	100%
1.A.2.a Iron and Steel - Liquid Fuels	N_2O	0.2179572	0	2%	50%	0.50039984	3.58943E-06	1.79615E-06	3.11434E-05	100%
2.G.3. N_2O from product uses	N_2O	1.30226	2.01448	2%	2%	0.028284271	5.5277E-05	1.56347E-06	2.7109E-05	100%
1.A.4.b Residential - Peat	N_2O	0.1860712	0	2%	50%	0.50039984	3.06431E-06	1.53338E-06	2.65873E-05	100%
3.B.1.2 Manure Management - Sheep	CH_4	0.78185	0.439375	25%	30%	0.390512484	3.8581E-06	1.50664E-06	2.61236E-05	100%
1.A.4.b Residential - Gaseous Fuels	N_2O	0.1193192	0.1267096	2%	50%	0.50039984	2.86084E-06	1.43156E-06	2.48219E-05	100%
1.A.2.g Other - Gaseous Fuels	N_2O	0.28480456	0.0500044	2%	50%	0.50039984	2.78584E-06	1.39403E-06	2.41712E-05	100%
1.A.4.a Commercial/Institutional - Peat	CH_4	0.168	0.00275	2%	50%	0.50039984	2.66197E-06	1.33205E-06	2.30964E-05	100%
2.D.3.b Road paving with asphalt	CO_2	0.0014633	0.054450618	20%	60%	0.632455532	2.0497E-06	1.29635E-06	2.24773E-05	100%
1.A.2.g Other - Gaseous Fuels	CH_4	0.23893	0.04195	2%	50%	0.50039984	2.33711E-06	1.16949E-06	2.02778E-05	100%

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2.D.3.c Asphalt roofing	CO_2	0.00297234	0.049156808	20%	60%	0.632455532	1.82323E-06	1.15311E-06	1.99938E-05	100%
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.127395	0.0003874	2%	50%	0.50039984	2.08325E-06	1.04246E-06	1.80752E-05	100%
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.181482	0.1311498	2%	50%	0.50039984	2.00622E-06	1.00391E-06	1.74069E-05	100%
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.106875	0.000325	2%	50%	0.50039984	1.74769E-06	8.74545E-07	1.51637E-05	100%
1.A.2.a Iron and Steel - Liquid Fuels	CH_4	0.091425	0	2%	50%	0.50039984	1.50563E-06	7.53418E-07	1.30635E-05	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.1708732	0.0403194	2%	50%	0.50039984	1.27842E-06	6.39723E-07	1.10922E-05	100%
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.08118414	0.0028906	2%	50%	0.50039984	1.22689E-06	6.13935E-07	1.0645E-05	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.01100503	0.28	2%	5%	0.053851648	1.04828E-05	5.64517E-07	9.78816E-06	100%
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.00425	0.03135	2%	50%	0.50039984	1.124E-06	5.6245E-07	9.75233E-06	100%
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.00045315	0.029353	2%	50%	0.50039984	1.11047E-06	5.5568E-07	9.63495E-06	100%
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.14335	0.033825	2%	50%	0.50039984	1.0725E-06	5.3668E-07	9.3055E-06	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0.05379496	0.0511368	2%	50%	0.50039984	1.06167E-06	5.31259E-07	9.21151E-06	100%
1.A.2.g Other - Solid Fuels	N_2O	0.12419448	0.025926	2%	50%	0.50039984	1.05788E-06	5.29363E-07	9.17863E-06	100%

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1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0.0681075	0.002425	2%	50%	0.50039984	1.02927E-06	5.15046E-07	8.93039E-06	100%
1.A.3.b Road Transportation - Lubricants	N_2O	0.02384	0.032918912	10%	50%	0.509901951	8.61138E-07	4.39096E-07	7.61348E-06	100%
1.A.3.c Railways - Liquid Fuels	CH_4	0.74500904	0.299750179	2%	50%	0.50039984	8.52919E-07	4.26801E-07	7.4003E-06	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	N_2O	0.050064	0	2%	50%	0.50039984	8.24479E-07	4.12569E-07	7.15354E-06	100%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.057625	0.004375	2%	50%	0.50039984	7.82371E-07	3.91498E-07	6.78819E-06	100%
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.001126	0.017	2%	50%	0.50039984	6.28917E-07	3.1471E-07	5.45676E-06	100%
2.C.1 Iron and Steel Production	CH_4	0.06875	1.15638E-05	10%	25%	0.26925824	1.13177E-06	3.04738E-07	5.28385E-06	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.0362964	0.0004768	2%	50%	0.50039984	5.79588E-07	2.90026E-07	5.02876E-06	100%
1.A.1.a Public Electricity and Heat Production - Peat	CH_4	0.034425	0	2%	50%	0.50039984	5.66928E-07	2.83691E-07	4.91891E-06	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0.024287	0.024734	2%	50%	0.50039984	5.42046E-07	2.7124E-07	4.70303E-06	100%
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CH_4	0.0315	0	2%	50%	0.50039984	5.18757E-07	2.59586E-07	4.50097E-06	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.020375	0.02075	2%	50%	0.50039984	4.54737E-07	2.2755E-07	3.9455E-06	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries -	CH_4	0.02314	0.02145	2%	50%	0.50039984	4.35862E-07	2.18105E-07	3.78173E-06	100%

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Liquid Fuels										
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.026721	0.0006	2%	50%	0.50039984	4.17203E-07	2.08768E-07	3.61984E-06	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.09466268	0.0515242	2%	50%	0.50039984	4.03394E-07	2.01858E-07	3.50002E-06	100%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.079415	0.043225	2%	50%	0.50039984	3.38418E-07	1.69344E-07	2.93626E-06	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CH_4	0.0177725	0	2%	50%	0.50039984	2.92686E-07	1.4646E-07	2.53947E-06	100%
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.015225	0.00025	2%	50%	0.50039984	2.41211E-07	1.20702E-07	2.09285E-06	100%
1.A.4.c Agriculture/Forestry/Fisheries - Peat	N_2O	0.013857	0	2%	50%	0.50039984	2.28204E-07	1.14193E-07	1.98E-06	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N_2O	0.01272162	0	2%	50%	0.50039984	2.09506E-07	1.04837E-07	1.81776E-06	100%
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.00295205	0.005924494	20%	50%	0.538516481	1.77024E-07	9.53303E-08	1.65293E-06	100%
1.B.2.b Natural Gas	CO_2	0.008686	0.011105	32%	0%	0.322375	2.79899E-07	9.02323E-08	1.56454E-06	100%
1.A.3.b Road Transportation - Lubricants	CH_4	0.02475	0.014988474	10%	50%	0.509901951	1.63254E-07	8.32437E-08	1.44336E-06	100%
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.01272758	0.0094168	2%	50%	0.50039984	1.49043E-07	7.45812E-08	1.29316E-06	100%
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0.0106775	0.0079	2%	50%	0.50039984	1.25036E-07	6.25681E-08	1.08487E-06	100%

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1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	9.37E-05	0.002384	2%	50%	0.50039984	8.92537E-08	4.46625E-08	7.74404E-07	100%
1.A.3.a Domestic Aviation - Jet kerosene	CH_4	9.504E-06	0.0021375	2%	50%	0.50039984	8.12521E-08	4.06585E-08	7.04979E-07	100%
1.A.2.g Other - Solid Fuels	CH_4	0.006946	0.00145	2%	50%	0.50039984	5.91656E-08	2.96064E-08	5.13346E-07	100%
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.00021951	0.000440227	20%	50%	0.538516481	1.31515E-08	7.08231E-09	1.228E-07	100%
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH_4	0.0007115	0	2%	50%	0.50039984	1.17173E-08	5.86335E-09	1.01665E-07	100%
1.B.2.c Venting and Flaring	CO_2	0.002806	0.002657	10%	0%	0.1	5.49837E-08	5.49837E-09	9.53362E-08	100%
1.A.3.a Domestic Aviation - Aviation Gasoline	CH_4	1.9652E-06	0.00005	2%	50%	0.50039984	1.87193E-09	9.36714E-10	1.62417E-08	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	CH_4	0	0.2955	5%	50%	0.502493781		0	0	100%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	N_2O	0	0.469648	5%	50%	0.502493781		0	0	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CO_2	0	3.906691677	2%	5%	0.053851648		0	0	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CH_4	0	0.0018	2%	50%	0.50039984		0	0	100%
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	N_2O	0	0.0021456	2%	50%	0.50039984		0	0	100%
1.A.2.c Chemicals - Peat	CO_2	0	1.12172959	2%	11%	0.110909091		0	0	100%
1.A.2.c Chemicals - Biomass Fuels	CH_4	0	0.211451058	5%	50%	0.502493781		0	0	100%
1.A.2.c Chemicals - Peat	CH_4	0	0.000521299	2%	50%	0.50039984		0	0	100%

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1.A.2.c Chemicals - Biomass Fuels	N_2O	0	0.334983061	5%	50%	0.502493781		0	0	100%
1.A.2.c Chemicals - Peat	N_2O	0	0.004850822	2%	50%	0.50039984		0	0	100%
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	CH_4	0	0.00225	5%	50%	0.502493781		0	0	100%
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	N_2O	0	0.003576	5%	50%	0.502493781		0	0	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CO_2	0	2.1257	2%	20%	0.200997512		0	0	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CH_4	0	0.02175	2%	50%	0.50039984		0	0	100%
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	N_2O	0	0.034568	2%	50%	0.50039984		0	0	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CO_2	0	107.5693	2%	2%	0.028284271		0	0	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CH_4	0	0.937280723	2%	50%	0.50039984		0	0	100%
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	N_2O	0	1.489651495	2%	50%	0.50039984		0	0	100%
1.A.2.g Other - Peat	CO_2	0	1.331164465	2%	10%	0.10198039		0	0	100%
1.A.2.g Other - Peat	CH_4	0	0.000575	2%	50%	0.50039984		0	0	100%
1.A.2.g Other - Peat	N_2O	0	0.005811	2%	50%	0.50039984		0	0	100%
1.A.3.b Road Transportation -	CH_4	0	0.023009615	2%	50%	0.50039984		0	0	100%

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Biomass										
1.A.3.b Road Transportation - Biomass	N_2O	0	0.349076786	2%	50%	0.50039984		0	0	100%
1.A.3.c. Railway Biomass Fuels	CH_4	0	0.0022825	2%	50%	0.50039984		0	0	100%
1.A.3.c. Railway Biomass Fuels	N_2O	0	0.0346276	2%	50%	0.50039984		0	0	100%
1.A.5.b Mobile - Liquid Fuels	CO_2	0	9.442494289	2%	50%	0.50039984		0	0	100%
1.A.5.b Mobile - Liquid Fuels	CH_4	0	0.018743571	2%	50%	0.50039984		0	0	100%
1.A.5.b Mobile - Liquid Fuels	N_2O	0	0.076423393	2%	50%	0.50039984		0	0	100%
2.D.2 Paraffin wax use	CO_2	0	4.911573333	2%	100%	1.00019998		0	0	100%
2.D.3.d Urea Use	CO_2	0	0.817	20%	10%	0.223606798		0	0	100%
2.F.1. Refrigeration and air conditioning	HFCs	0	206.3769351	50%	50%	0.707106781		0	0	100%
2.F.2 Foam blowing agents	HFCs	0	0.961490119	50%	50%	0.707106781		0	0	100%
2.F.3. Fire Protection	HFCs	0	0.02767976	50%	50%	0.707106781		0	0	100%
2.F.4. Aerosols	HFCs	0	4.697766137	50%	50%	0.707106781		0	0	100%
2.G.1. Electrical equipment	SF6	0	8.577903643	2%	30%	0.300665928		0	0	100%
5.A.1. Managed Waste Disposal on Land	CH_4	0	301.0244136	7%	52%	0.524690385		0	0	100%
TOTAL		26256.43	11353.38			113.7834066	0.33861408	0.057673426	1	

Annex 2: Assessment of Uncertainty

A.2.1 Approach 1 uncertainty analysis for 2014 including LULUCF

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3049.621305	2.456340066	2%	10%	0.1020	0.0000	0.1489	0.0001	0.0149	0.0000	0.000221695
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	218.053	16.555	2%	20%	0.2010	0.0000	0.0097	0.0009	0.0019	0.0000	3.79914E-06
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2644.318679	1575.698976	2%	5%	0.0539	0.0000	0.0410	0.0884	0.0021	0.0025	1.04543E-05
1.A.1.a Public Electricity and Heat Production - Peat	CO_2	142.826737	0	2%	10%	0.1020	0.0000	0.0070	0.0000	0.0007	0.0000	4.88764E-07
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CO_2	3.0786	0	2%	20%	0.2010	0.0000	0.0002	0.0000	0.0000	0.0000	9.0848E-10
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	3.00505	0.002425	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0001	0.0000	5.39994E-09
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.057625	0.004375	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.65845E-12
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	1.20535	0.726	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	8.50264E-11
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	0.327	8.434081116	5%	50%	0.5025	0.0000	0.0005	0.0005	0.0002	0.0000	5.33069E-08
1.A.1.a Public Electricity and Heat Production - Peat	CH_4	0.034425	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	7.09967E-13
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CH_4	0.0315	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	5.94444E-13

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	7.1626684	0.0057514	2%	50%	0.5004	0.0000	0.0004	0.0000	0.0002	0.0000	3.06787E-08
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	1.030335	0.078225	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	5.30197E-10
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	1.4367772	0.865392	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.20811E-10
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	0.519712	13.38625669	5%	50%	0.5025	0.0000	0.0007	0.0008	0.0004	0.0001	1.34272E-07
1.A.1.a Public Electricity and Heat Production - Peat	N_2O	0.615519	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.26972E-10
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	N_2O	0.050064	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.50155E-12
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	24.7792529	21.16428627	2%	10%	0.1020	0.0000	0.0000	0.0012	0.0000	0.0000	1.13352E-09
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	44.69904433	45.0354735	2%	5%	0.0539	0.0000	0.0003	0.0025	0.0000	0.0001	5.38515E-09
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CO_2	73.83865681	0	2%	10%	0.1020	0.0000	0.0036	0.0000	0.0004	0.0000	1.30642E-07
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CH_4	0.02314	0.02145	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.38061E-15
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.020375	0.02075	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	7.97676E-15

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	CH_4	0	0.2955	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	7.00046E-11
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CH_4	0.0177725	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.89229E-13
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0.05379496	0.0511368	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.02513E-14
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0.024287	0.024734	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.13339E-14
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	N_2O	0	0.469648	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	1.7683E-10
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	N_2O	0.3177723	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	6.04954E-11
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	93.25228881	0	2%	10%	0.1020	0.0000	0.0046	0.0000	0.0005	0.0000	2.08364E-07
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234.4643123	0.705374886	2%	5%	0.0539	0.0000	0.0114	0.0000	0.0006	0.0000	3.26989E-07
1.A.2.a Iron and Steel - Other fossil fuels	CO_2	61.3521	0	2%	20%	0.2010	0.0000	0.0030	0.0000	0.0006	0.0000	3.60777E-07
1.A.2.a Iron and Steel - Liquid Fuels	CH_4	0.091425	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	5.00749E-12
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.106875	0.000325	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	6.79535E-12

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1.A.2.a Iron and Steel - Other fossil fuels	CH_4	0.62775	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.36082E-10
1.A.2.a Iron and Steel - Liquid Fuels	N_2O	0.2179572	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.84598E-11
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.127395	0.0003874	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	9.65526E-12
1.A.2.a Iron and Steel - Other fossil fuels	N_2O	0.997704	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	5.96339E-10
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CO_2	0	3.906691677	2%	5%	0.0539	0.0000	0.0002	0.0002	0.0000	0.0000	1.58345E-10
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CH_4	0	0.0018	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.55472E-15
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	N_2O	0	0.0021456	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.62991E-15
1.A.2.c Chemicals - Liquid Fuels	CO_2	276.6786727	10.10088453	2%	10%	0.1020	0.0000	0.0130	0.0006	0.0013	0.0000	1.68396E-06
1.A.2.c Chemicals - Gaseous Fuels	CO_2	23.42449305	17.14603569	2%	5%	0.0539	0.0000	0.0002	0.0010	0.0000	0.0000	8.25252E-10
1.A.2.c Chemicals - Peat	CO_2	0	1.12172959	2%	11%	0.1109	0.0000	0.0001	0.0001	0.0000	0.0000	5.02435E-11
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.273195	0.004725	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.29592E-11
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0.0106775	0.0079	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.74629E-15
1.A.2.c Chemicals - Biomass Fuels	CH_4	0	0.211451058	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	3.58452E-11
1.A.2.c Chemicals - Peat	CH_4	0	0.000521299	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.14275E-16
1.A.2.c Chemicals - Liquid Fuels	N_2O	0.65129688	0.0069732	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.47931E-10
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.01272758	0.0094168	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.48123E-15
1.A.2.c Chemicals - Biomass Fuels	N_2O	0	0.334983061	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	8.99616E-11

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1.A.2.c Chemicals - Peat	N_2O	0	0.004850822	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.85536E-14
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	15.54739345	0.397748377	2%	10%	0.1020	0.0000	0.0007	0.0000	0.0001	0.0000	5.45829E-09
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO_2	2.692316	0	2%	20%	0.2010	0.0000	0.0001	0.0000	0.0000	0.0000	6.94802E-10
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	149.4154681	5.263181843	2%	5%	0.0539	0.0000	0.0070	0.0003	0.0004	0.0000	1.2322E-07
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.015225	0.00025	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.33694E-13
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH_4	0.0007115	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.03277E-16
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0.0681075	0.002425	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.55692E-12
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	CH_4	0	0.00225	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	4.0586E-15
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.0362964	0.0004768	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	7.65683E-13
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N_2O	0.01272162	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	9.69561E-14
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.08118414	0.0028906	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.63303E-12
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	N_2O	0	0.003576	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	1.02519E-14
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798.2058686	26.17773966	2%	11%	0.1111	0.0000	0.0376	0.0015	0.0041	0.0000	1.68692E-05
1.A.2.e Food Processing, Beverages and Tobacco - Solid	CO_2	103.071464	2.2704	2%	20%	0.2010	0.0000	0.0049	0.0001	0.0010	0.0000	9.6749E-07

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
Fuels												
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174.2220665	93.81485986	2%	5%	0.0539	0.0000	0.0033	0.0053	0.0002	0.0001	4.88363E-08
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CO_2	0	2.1257	2%	20%	0.2010	0.0000	0.0001	0.0001	0.0000	0.0000	5.79609E-10
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.78871	0.02035	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.50969E-10
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.026721	0.0006	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.06036E-13
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.079415	0.043225	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	5.40458E-13
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.171	0.3505	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	3.37514E-11
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CH_4	0	0.02175	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.73007E-13
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1.87891384	0.0437464	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0000	0.0000	2.00367E-09
1.A.2.e Food Processing, Beverages and Tobacco - Solid	N_2O	0.47777148	0.010728	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.29807E-10

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
Fuels												
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.09466268	0.0515242	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	7.67917E-13
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.271776	0.556962	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	8.52036E-11
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	N_2O	0	0.034568	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	9.42209E-13
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	273.5769252	20.35027526	2%	10%	0.1020	0.0000	0.0122	0.0011	0.0012	0.0000	1.50151E-06
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	16.4292	118.6284	2%	20%	0.2010	0.0000	0.0058	0.0067	0.0012	0.0002	1.40302E-06
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	314.4838285	73.41324777	2%	5%	0.0539	0.0000	0.0113	0.0041	0.0006	0.0001	3.31452E-07
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CO_2	0	107.5693	2%	2%	0.0283	0.0000	0.0060	0.0060	0.0001	0.0002	4.36545E-08
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.268845	0.020625	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.60262E-11
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.00425	0.03135	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	6.02916E-13
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.14335	0.033825	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	6.55841E-12
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.00525	0.949410006	5%	50%	0.5025	0.0000	0.0001	0.0001	0.0000	0.0000	7.15811E-10
1.A.2.f Non-metallic Minerals -	CH_4	0	0.937280723	2%	50%	0.5004	0.0000	0.0001	0.0001	0.0000	0.0000	6.92689E-10

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Other Fossil Fuels												
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.64092648	0.04917	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.04753E-10
1.A.2.f Non-metallic Minerals - Solid Fuels	N_2O	0.07599	0.560538	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.92749E-10
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.1708732	0.0403194	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	9.31861E-12
1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	0.008344	1.509107769	5%	50%	0.5025	0.0000	0.0001	0.0001	0.0000	0.0000	1.80855E-09
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	N_2O	0	1.489651495	2%	50%	0.5004	0.0000	0.0001	0.0001	0.0000	0.0000	1.74972E-09
1.A.2.g Other - Liquid Fuels	CO_2	795.7039841	104.8142275	2%	10%	0.1020	0.0000	0.0331	0.0059	0.0033	0.0002	1.09572E-05
1.A.2.g Other - Solid Fuels	CO_2	27.263264	5.4868	2%	20%	0.2010	0.0000	0.0010	0.0003	0.0002	0.0000	4.22601E-08
1.A.2.g Other - Gaseous Fuels	CO_2	524.168965	91.04761992	2%	5%	0.0539	0.0000	0.0205	0.0051	0.0010	0.0001	1.07643E-06
1.A.2.g Other - Peat	CO_2	0	1.331164465	2%	10%	0.1020	0.0000	0.0001	0.0001	0.0000	0.0000	6.0167E-11
1.A.2.g Other - Liquid Fuels	CH_4	2.26531	0.173975	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0001	0.0000	2.55728E-09
1.A.2.g Other - Solid Fuels	CH_4	0.006946	0.00145	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.67395E-14
1.A.2.g Other - Gaseous Fuels	CH_4	0.23893	0.04195	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.18323E-11
1.A.2.g Other - Biomass Fuels	CH_4	0.2865	10.965	5%	50%	0.5025	0.0000	0.0006	0.0006	0.0003	0.0000	9.2127E-08
1.A.2.g Other - Peat	CH_4	0	0.000575	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.60696E-16
1.A.2.g Other - Liquid Fuels	N_2O	2.149772	0.252487056	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0000	0.0000	2.07403E-09
1.A.2.g Other - Solid Fuels	N_2O	0.12419448	0.025926	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	5.35153E-12
1.A.2.g Other - Gaseous Fuels	N_2O	0.28480456	0.0500044	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.10207E-11

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1.A.2.g Other - Biomass Fuels	N_2O	0.455344	17.42704	5%	50%	0.5025	0.0000	0.0010	0.0010	0.0005	0.0001	2.32711E-07
1.A.2.g Other - Peat	N_2O	0	0.005811	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.66257E-14
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.011005031	0.28	2%	5%	0.0539	0.0000	0.0000	0.0000	0.0000	0.0000	7.71831E-13
1.A.3.a Domestic Aviation - Jet kerosene	CO_2	0.054819072	3.13427	2%	5%	0.0539	0.0000	0.0002	0.0002	0.0000	0.0000	9.95796E-11
1.A.3.a Domestic Aviation - Aviation Gasoline	CH_4	1.96519E-06	0.00005	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.8387E-18
1.A.3.a Domestic Aviation - Jet kerosene	CH_4	0.000009504	0.0021375	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.57473E-15
1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	9.36998E-05	0.002384	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.18007E-15
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.000453151	0.029353	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	6.61234E-13
1.A.3.b Road Transportation - Gasoline	CO_2	1723.750448	613.35806	2%	2%	0.0283	0.0000	0.0499	0.0344	0.0010	0.0010	1.94391E-06
1.A.3.b Road Transportation - Diesel Oil	CO_2	616.1359677	1880.266	2%	2%	0.0283	0.0000	0.0752	0.1054	0.0015	0.0030	1.11564E-05
1.A.3.b Road Transportation - LPG	CO_2	36.95737306	165.2425801	2%	5%	0.0539	0.0000	0.0075	0.0093	0.0004	0.0003	2.07654E-07
1.A.3.b Road Transportation - Lubricants	CO_2	3.4629	4.554798669	10%	5%	0.1118	0.0000	0.0001	0.0003	0.0000	0.0000	1.32292E-09
1.A.3.b Road Transportation - Gaseous Fuels	CO_2	17.6165255	0	2%	5%	0.0539	0.0000	0.0009	0.0000	0.0000	0.0000	1.85918E-09
1.A.3.b Road Transportation - Gasoline	CH_4	17.15516309	2.207274532	2%	30%	0.3007	0.0000	0.0007	0.0001	0.0002	0.0000	4.61537E-08
1.A.3.b Road Transportation -	CH_4	1.108041461	1.356526416	2%	30%	0.3007	0.0000	0.0000	0.0001	0.0000	0.0000	4.74779E-11

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Diesel Oil												
1.A.3.b Road Transportation - LPG	CH_4	0.124565463	0.863788568	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.49948E-10
1.A.3.b Road Transportation - Lubricants	CH_4	0.02475	0.014988474	10%	50%	0.5099	0.0000	0.0000	0.0000	0.0000	0.0000	4.85661E-14
1.A.3.b Road Transportation - Gaseous Fuels	CH_4	0.7015	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.94812E-10
1.A.3.b Road Transportation - Biomass	CH_4	0	0.023009615	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.17462E-13
1.A.3.b Road Transportation - Gasoline	N_2O	13.07410741	4.606850327	2%	50%	0.5004	0.0000	0.0004	0.0003	0.0002	0.0000	3.64768E-08
1.A.3.b Road Transportation - Diesel Oil	N_2O	5.593827044	19.44722022	2%	50%	0.5004	0.0000	0.0008	0.0011	0.0004	0.0000	1.67653E-07
1.A.3.b Road Transportation - LPG	N_2O	0.163685304	2.934347457	2%	50%	0.5004	0.0000	0.0002	0.0002	0.0001	0.0000	6.14612E-09
1.A.3.b Road Transportation - Lubricants	N_2O	0.02384	0.032918912	10%	50%	0.5099	0.0000	0.0000	0.0000	0.0000	0.0000	1.83316E-13
1.A.3.b Road Transportation - Gaseous Fuels	N_2O	0.27267	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.45415E-11
1.A.3.b Road Transportation - Biomass	N_2O	0	0.349076786	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	9.60817E-11
1.A.3.c Railways - Liquid Fuels	CO_2	531.37994	213.786	2%	5%	0.0539	0.0000	0.0140	0.0120	0.0007	0.0003	6.0643E-07
1.A.3.c Railways - Liquid Fuels	CH_4	0.745009038	0.299750179	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	9.68832E-11
1.A.3.c. Railway Biomass Fuels	CH_4	0	0.0022825	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.1079E-15
1.A.3.c Railways - Liquid Fuels	N_2O	61.20060747	24.62371876	2%	50%	0.5004	0.0000	0.0016	0.0014	0.0008	0.0000	6.53743E-07
1.A.3.c. Railway Biomass Fuels	N_2O	0	0.0346276	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	9.45461E-13

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1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.172771761	0.3465	20%	5%	0.2062	0.0000	0.0000	0.0000	0.0000	0.0000	3.04982E-11
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	0.8332289	12.58	2%	5%	0.0539	0.0000	0.0007	0.0007	0.0000	0.0000	1.5022E-09
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.00295205	0.005924494	20%	50%	0.5385	0.0000	0.0000	0.0000	0.0000	0.0000	1.7634E-14
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.001126	0.017	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.02364E-13
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.000219506	0.000440227	20%	50%	0.5385	0.0000	0.0000	0.0000	0.0000	0.0000	9.73135E-17
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	0.1006644	1.5198	2%	50%	0.5004	0.0000	0.0001	0.0001	0.0000	0.0000	1.61737E-09
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1007.294341	155.5621374	2%	10%	0.1020	0.0000	0.0406	0.0087	0.0041	0.0002	1.65154E-05
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1410.784936	38.5022	2%	20%	0.2010	0.0000	0.0668	0.0022	0.0134	0.0001	0.000178759
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	334.0088098	238.7965288	2%	5%	0.0539	0.0000	0.0030	0.0134	0.0001	0.0004	1.65334E-07
1.A.4.a Commercial/Institutional - Peat	CO_2	66.54499789	1.136164465	2%	11%	0.1109	0.0000	0.0032	0.0001	0.0003	0.0000	1.2139E-07
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	3.495	0.649625	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0001	0.0000	4.53465E-09
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	3.72829	0.10175	2%	50%	0.5004	0.0000	0.0002	0.0000	0.0001	0.0000	7.81491E-09
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0.76125	0.550125	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.10628E-11
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	39.135	34.97326278	5%	50%	0.5025	0.0000	0.0000	0.0020	0.0000	0.0001	1.97382E-08

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1.A.4.a Commercial/Institutional - Peat	CH_4	0.168	0.00275	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.62806E-11
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	2.411706848	0.369840648	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0000	0.0000	2.36823E-09
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	6.66618252	0.181929	2%	50%	0.5004	0.0000	0.0003	0.0000	0.0002	0.0000	2.49837E-08
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.181482	0.1311498	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	6.28752E-13
1.A.4.a Commercial/Institutional - Biomass Fuels	N_2O	6.219856	5.564080248	5%	50%	0.5025	0.0000	0.0000	0.0003	0.0000	0.0000	5.0074E-10
1.A.4.a Commercial/Institutional - Peat	N_2O	0.2955862	0.004619	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	5.0486E-11
1.A.4.b Residential - Liquid Fuels	CO_2	329.9110639	157.1324033	2%	10%	0.1020	0.0000	0.0073	0.0088	0.0007	0.0002	6.00578E-07
1.A.4.b Residential - Solid Fuels	CO_2	605.8184	50.2326	2%	20%	0.2010	0.0000	0.0268	0.0028	0.0054	0.0001	2.88017E-05
1.A.4.b Residential - Gaseous Fuels	CO_2	219.6011945	230.7118474	2%	5%	0.0539	0.0000	0.0022	0.0129	0.0001	0.0004	1.4582E-07
1.A.4.b Residential - Peat	CO_2	42.27150449	0	2%	10%	0.1020	0.0000	0.0021	0.0000	0.0002	0.0000	4.28179E-08
1.A.4.b Residential - Liquid Fuels	CH_4	0.868375	1.276125	2%	50%	0.5004	0.0000	0.0000	0.0001	0.0000	0.0000	2.14984E-10
1.A.4.b Residential - Solid Fuels	CH_4	48.03	3.9825	2%	50%	0.5004	0.0000	0.0021	0.0002	0.0011	0.0000	1.13196E-06
1.A.4.b Residential - Gaseous Fuels	CH_4	0.5005	0.5315	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	7.73515E-12
1.A.4.b Residential - Biomass Fuels	CH_4	96.42474185	101.6540154	10%	10%	0.1414	0.0000	0.0010	0.0057	0.0001	0.0008	6.5935E-07
1.A.4.b Residential - Peat	CH_4	3.1875	0	2%	50%	0.5004	0.0000	0.0002	0.0000	0.0001	0.0000	6.0868E-09
1.A.4.b Residential - Liquid Fuels	N_2O	0.4500694	0.344594088	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.13525E-12

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1.A.4.b Residential - Solid Fuels	N_2O	2.862588	0.237357	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0001	0.0000	4.02109E-09
1.A.4.b Residential - Gaseous Fuels	N_2O	0.1193192	0.1267096	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.39624E-13
1.A.4.b Residential - Biomass Fuels	N_2O	8.94447	10.597476	10%	30%	0.3162	0.0000	0.0002	0.0006	0.0000	0.0001	9.26179E-09
1.A.4.b Residential - Peat	N_2O	0.1860712	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.07419E-11
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	695.0757089	320.5751539	2%	11%	0.1088	0.0000	0.0160	0.0180	0.0017	0.0005	3.20028E-06
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	102.28152	2.2704	2%	50%	0.5004	0.0000	0.0049	0.0001	0.0024	0.0000	5.95204E-06
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778.5312078	55.18201994	2%	50%	0.5004	0.0000	0.0350	0.0031	0.0175	0.0001	0.000306287
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CO_2	3.0225	0	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0001	0.0000	5.47295E-09
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	5.286318275	0.590724755	2%	50%	0.5004	0.0000	0.0002	0.0000	0.0001	0.0000	1.2731E-08
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	8.109	0.18	2%	50%	0.5004	0.0000	0.0004	0.0000	0.0002	0.0000	3.74155E-08
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	1.774375	0.127125	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0000	0.0000	1.58934E-09

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1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	9.15	2.625286653	5%	50%	0.5025	0.0000	0.0003	0.0001	0.0002	0.0000	2.27153E-08
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CH_4	0.2325	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.23844E-11
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	43.26924002	33.54418198	2%	50%	0.5004	0.0000	0.0002	0.0019	0.0001	0.0001	1.69065E-08
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.4832964	0.010728	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.32907E-10
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.423011	0.0303066	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	9.03297E-11
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	1.45424	0.431444174	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	5.55113E-10
1.A.4.c Agriculture/Forestry/Fisheries - Peat	N_2O	0.013857	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.15035E-13
1.A.5.b Mobile - Liquid Fuels	CO_2	0	9.442494289	2%	50%	0.5004	0.0000	0.0005	0.0005	0.0003	0.0000	7.03027E-08
1.A.5.b Mobile - Liquid Fuels	CH_4	0	0.018743571	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.77015E-13
1.A.5.b Mobile - Liquid Fuels	N_2O	0	0.076423393	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.60523E-12
1.B.2.b Natural Gas	CO_2	0.008686	0.011105	32%	0%	0.3224	0.0000	0.0000	0.0000	0.0000	0.0000	8.05863E-14
1.B.2.b Natural Gas	CH_4	177.238	109.190125	32%	0%	0.3224	0.0000	0.0026	0.0061	0.0000	0.0028	7.79095E-06

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1.B.2.c Venting and Flaring	CO_2	0.002806	0.002657	10%	0%	0.1000	0.0000	0.0000	0.0000	0.0000	0.0000	4.43899E-16
1.B.2.c Venting and Flaring	CH_4	70.344325	26.126175	10%	0%	0.1000	0.0000	0.0020	0.0015	0.0000	0.0002	4.29193E-08
2.A.1. Cement Production	CO_2	370.8039966	555.775815	10%	5%	0.1118	0.0000	0.0130	0.0312	0.0007	0.0044	1.98453E-05
2.A.2. Lime Production	CO_2	148.8573814	0.459881348	2%	50%	0.5004	0.0000	0.0073	0.0000	0.0036	0.0000	1.31789E-05
2.A.3. Glass production	CO_2	0.355752064	0.942744575	2%	86%	0.8602	0.0000	0.0000	0.0001	0.0000	0.0000	9.31448E-10
2.A.4. Other process uses of carbonates	CO_2	69.184752	10.8326905	2%	50%	0.5004	0.0000	0.0028	0.0006	0.0014	0.0000	1.93137E-06
2.C.1 Iron and Steel Production	CO_2	52.59606386	0.01036233	5%	25%	0.2550	0.0000	0.0026	0.0000	0.0006	0.0000	4.14109E-07
2.C.1 Iron and Steel Production	CH_4	0.06875	1.15638E-05	10%	25%	0.2693	0.0000	0.0000	0.0000	0.0000	0.0000	7.07633E-13
2.D.1 Lubricant Use	CO_2	23.25102433	8.297813333	2%	50%	0.5004	0.0000	0.0007	0.0005	0.0003	0.0000	1.1338E-07
2.D.2 Paraffin wax use	CO_2	0	4.911573333	2%	100%	1.0002	0.0000	0.0003	0.0003	0.0003	0.0000	7.59031E-08
2.D.3.b Road paving with asphalt	CO_2	0.001463305	0.054450618	20%	60%	0.6325	0.0000	0.0000	0.0000	0.0000	0.0000	3.94576E-12
2.D.3.c Asphalt roofing	CO_2	0.002972338	0.049156808	20%	60%	0.6325	0.0000	0.0000	0.0000	0.0000	0.0000	3.06152E-12
2.D.3. Solvent Use	CO_2	41.0641984	32.19721064	2%	20%	0.2010	0.0000	0.0002	0.0018	0.0000	0.0001	4.28626E-09
2.D.3.d Urea Use	CO_2	0	0.817	20%	10%	0.2236	0.0000	0.0000	0.0000	0.0000	0.0000	1.88868E-10
2.F.1. Refrigeration and air conditioning	HFCs	0	206.3769351	50%	50%	0.7071	0.0001	0.0116	0.0116	0.0058	0.0082	0.000100428
2.F.2 Foam blowing agents	HFCs	0	0.961490119	50%	50%	0.7071	0.0000	0.0001	0.0001	0.0000	0.0000	2.17983E-09
2.F.3. Fire Protection	HFCs	0	0.02767976	50%	50%	0.7071	0.0000	0.0000	0.0000	0.0000	0.0000	1.80658E-12
2.F.4. Aerosols	HFCs	0	4.697766137	50%	50%	0.7071	0.0000	0.0003	0.0003	0.0001	0.0002	5.20374E-08
2.G.1. Electrical equipment	SF6	0	8.577903643	2%	30%	0.3007	0.0000	0.0005	0.0005	0.0001	0.0000	2.10048E-08

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
2.G.3. N2O from product uses	N_2O	1.30226	2.01448	2%	2%	0.0283	0.0000	0.0000	0.0001	0.0000	0.0000	1.11752E-11
3.A.1 Enteric Fermentation - Cattle	CH_4	2117.989353	828.0431219	2%	20%	0.2010	0.0001	0.0572	0.0464	0.0114	0.0013	0.000132525
3.A.2 Enteric Fermentation - Sheep	CH_4	32.92	18.5	2%	50%	0.5004	0.0000	0.0006	0.0010	0.0003	0.0000	8.32871E-08
3.A.3 Enteric Fermentation - Swine	CH_4	52.54125	13.1025	2%	20%	0.2010	0.0000	0.0018	0.0007	0.0004	0.0000	1.3546E-07
3.A.4 Enteric Fermentation - Other livestock	CH_4	18.090525	13.021775	2%	50%	0.5004	0.0000	0.0002	0.0007	0.0001	0.0000	6.46656E-09
3.B.1.1 Manure Management - Cattle	CH_4	110.9670107	70.59473241	25%	20%	0.3202	0.0000	0.0015	0.0040	0.0003	0.0014	2.04539E-06
3.B.2.1 Manure Management - Cattle	N_2O	120.6657672	42.94734024	25%	20%	0.3202	0.0000	0.0035	0.0024	0.0007	0.0009	1.21446E-06
3.B.1.2 Manure Management - Sheep	CH_4	0.78185	0.439375	25%	30%	0.3905	0.0000	0.0000	0.0000	0.0000	0.0000	9.26051E-11
3.B.2.2 Manure Management - Sheep	N_2O	1.824479542	2.221483039	25%	30%	0.3905	0.0000	0.0000	0.0001	0.0000	0.0000	2.05121E-09
3.B.1.3 Manure Management - Swaine	CH_4	65.37841625	20.64571937	25%	20%	0.3202	0.0000	0.0020	0.0012	0.0004	0.0004	3.34422E-07
3.B.2.3 Manure Management - Swaine	N_2O	40.75322335	5.647103039	25%	20%	0.3202	0.0000	0.0017	0.0003	0.0003	0.0001	1.252E-07
3.B.1.4 Manure Management - Other livestock	CH_4	12.4845375	7.840283798	25%	30%	0.3905	0.0000	0.0002	0.0004	0.0001	0.0002	2.68054E-08
3.B.2.4 Manure Management - Other livestock	N_2O	22.98598703	11.52240459	25%	30%	0.3905	0.0000	0.0005	0.0006	0.0001	0.0002	7.2838E-08
3.B.5 Indirect N2O emissions from Manure Management	N_2O	137.5202478	41.93797066	2%	30%	0.3007	0.0000	0.0044	0.0024	0.0013	0.0001	1.73113E-06
3.D.1. Direct N2O emissions from managed soils	N_2O	1962.775641	1429.497775	2%	50%	0.5004	0.0021	0.0159	0.0802	0.0080	0.0023	6.8441E-05

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
3.D.2 Indirect N2O Emissions from managed soils	N_2O	377.2229002	196.0440499	2%	50%	0.5004	0.0000	0.0075	0.0110	0.0037	0.0003	1.40548E-05
3.G. Liming	CO_2	371.4186667	19.68633333	2%	50%	0.5004	0.0000	0.0171	0.0011	0.0085	0.0000	7.28856E-05
3.H. Urea Application	CO_2	7.7088	4.726333333	20%	50%	0.5385	0.0000	0.0001	0.0003	0.0001	0.0001	8.77434E-09
4.A.1 Forest Land remaining Forest Land – Carbon stock change, living biomass	CO_2	-19117.24262	-529.091989	2%	3%	0.0323	0.0000	0.9160	0.0297	0.0256	0.0007	0.000658261
4.A.1 Forest Land remaining Forest Land – Carbon stock change, dead wood	CO_2	77.31120783	-3792.439229	2%	5%	0.0499	0.0001	0.2164	0.2126	0.0102	0.0048	0.000127788
4.A.1 Forest Land remaining Forest Land – Drained organic soil	CO_2	4125.54896	4583.280676	5%	25%	0.2555	0.0057	0.0549	0.2570	0.0137	0.0192	0.000556639
4.A.2 Land converted to Forest Land – Carbon stock change, grassland converted to forest land	CO_2	-0.15774	-341.1744233	8%	50%	0.5044	0.0001	0.0191	0.0191	0.0095	0.0022	9.53919E-05
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, dead wood	CO_2	-1.612112333	-83.797142	8%		0.0802	0.0000	0.0046	0.0047	0.0000	0.0005	2.83993E-07
4.A.2 Land Converted to Forest Land – grassland converted to forest land, carbon stock change, litter	CO_2	-1.3821621	-71.8444518	8%		0.0802	0.0000	0.0040	0.0040	0.0000	0.0005	2.08755E-07
4.A.2 Land converted to Forest Land – grassland converted to forest land, Drained organic soil	CO_2	0	61.24812203	44%	25%	0.5020	0.0000	0.0034	0.0034	0.0009	0.0021	5.20667E-06

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
4.A.1 Forest land remaining forest land - Controlled burning	CO_2	256.17754	88.88382	92%	6%	0.9220	0.0000	0.0076	0.0050	0.0005	0.0065	4.22513E-05
4.A.1 Forest land remaining forest land - Controlled burning	CH_4	25.2045	8.745	92%	36%	0.9879	0.0000	0.0007	0.0005	0.0003	0.0006	4.78639E-07
4.A.1 Forest land remaining forest land - Controlled burning	N_2O	2.95616	1.02512	92%		0.9200	0.0000	0.0001	0.0001	0.0000	0.0001	5.59276E-09
4.A.1 Forest land remaining forest land - wildfires	CH_4	2.525	9.198	37%	36%	0.5162	0.0000	0.0004	0.0005	0.0001	0.0003	9.27551E-08
4.A.1 Forest land remaining forest land - wildfires	N_2O	0.295616	1.078462	37%		0.3700	0.0000	0.0000	0.0001	0.0000	0.0000	1.00118E-09
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CO_2	0	22.06783674	5%	242%	2.4206	0.0000	0.0012	0.0012	0.0030	0.0001	8.975E-06
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	56.12604453	149.8529208	5%	119%	1.1862	0.0001	0.0057	0.0084	0.0067	0.0006	4.5297E-05
4.A.1. Forest land, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	N_2O	567.421657	638.8013455	6%	119%	1.1928	0.0024	0.0080	0.0358	0.0096	0.0032	0.000101831
4.B.1 Cropland remaining Cropland – Carbon stock change – living biomass	CO_2	-6.124066667	-8.288426667	3%	701%	7.0070	0.0000	0.0002	0.0005	0.0012	0.0000	1.33617E-06
4.B.1 Cropland remaining Cropland – Carbon stock change – dead organic matter	CO_2	-1.368033333	-1.2914	3%		0.0260	0.0000	0.0000	0.0001	0.0000	0.0000	7.08875E-12

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
4.B.1 Cropland remaining Cropland – Drained organic soil	CO_2	2761.364974	2598.776785	13%	18%	0.2270	0.0014	0.0105	0.1457	0.0019	0.0274	0.000754926
4.B.2 Land converted to Cropland – Carbon stock change, forest land converted to cropland	CO_2	373.3561333	21.17573333	53%	161%	1.6933	0.0000	0.0171	0.0012	0.0275	0.0009	0.000754684
4.B.1 Land converted to Cropland – Carbon stock change – dead organic matter	CO_2	147.0542333	8.696233333	53%		0.5337	0.0000	0.0067	0.0005	0.0000	0.0004	1.35443E-07
4.B.2 Land converted to Cropland –Mineral soil	CO_2	6.935133333	48.7498	64%	61%	0.8888	0.0000	0.0024	0.0027	0.0015	0.0025	8.35363E-06
4.B.2 Land converted to Cropland – Drained organic soil	CO_2	12.45566667	89.507	114%	18%	1.1533	0.0000	0.0044	0.0050	0.0008	0.0081	6.59533E-05
4.B.2 Wetlands converted to cropland, organic soil	CO_2	0	3.8236	114%	18%	1.1532	0.0000	0.0002	0.0002	0.0000	0.0003	1.20704E-07
4.B.2 Settlements converted to cropland, mineral soils	CO_2	0	5.310433333	64%	60%	0.8806	0.0000	0.0003	0.0003	0.0002	0.0003	1.05574E-07
4.B. Cropland remaining cropland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	125.0975756	119.0448062	13%	71%	0.7223	0.0000	0.0006	0.0067	0.0004	0.0013	1.72932E-06
4.B.2 Land converted to cropland, Direct nitrous oxide (N2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or	N_2O	0.590489444	4.882747284	64%	151%	1.6390	0.0000	0.0002	0.0003	0.0004	0.0002	1.98448E-07

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
management of mineral soils												
4.C.1 Grassland remaining Grassland – Carbon stock change – living biomass	CO_2	-19.17968712	-42.87716154	5%	122%	1.2220	0.0000	0.0015	0.0024	0.0018	0.0002	3.22954E-06
4.C.1 Grassland remaining Grassland – Carbon stock change – dead organic matter	CO_2	-4.284491677	-8.55723594	5%		0.0498	0.0000	0.0003	0.0005	0.0000	0.0000	1.1419E-09
4.C.1 Grassland remaining Grassland – Drained organic soil	CO_2	924.832656	684.0066031	26%	19%	0.3193	0.0002	0.0069	0.0384	0.0013	0.0140	0.000196621
4.C.2 Land converted to Grassland –Mineral soil	CO_2	-0.0030613	-495.2573527	10%	61%	0.6201	0.0004	0.0278	0.0278	0.0170	0.0039	0.000304122
4.C.2 Land converted to Grassland – Drained organic soil	CO_2	0.0008613	275.3924023	55%	19%	0.5825	0.0001	0.0154	0.0154	0.0029	0.0120	0.000153297
4.C. Grassland, Emissions and removals from drainage and rewetting and other management of organic and mineral soils	CH_4	69.98791354	72.89522859	24%	58%	0.6294	0.0000	0.0007	0.0041	0.0004	0.0014	2.10429E-06
4.C.1 Grassland remaining Grassland, wildfires	CH_4	0.049609865	0.609294045	10%	39%	0.4026	0.0000	0.0000	0.0000	0.0000	0.0000	1.76524E-10
4.C.1 Grassland remaining Grassland, wildfires	N_2O	0.053992802	0.663123844	10%	48%	0.4903	0.0000	0.0000	0.0000	0.0000	0.0000	3.02499E-10
4.D.1 Wetlands remaining Wetlands – Carbon stock change – living biomass	CO_2	-65.31052768	-165.2320183	6%	435%	4.3521	0.0021	0.0061	0.0093	0.0264	0.0008	0.000697828

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
4.D.1 Wetlands remaining Wetlands – Carbon stock change – dead organic matter	CO_2	-13.80988549	-29.46614791	6%		0.0590	0.0000	0.0010	0.0017	0.0000	0.0001	1.90043E-08
4.D.1 Wetlands remaining Wetlands – Carbon stock change – organic soils	CO_2	277.2	277.2	24%	55%	0.6042	0.0001	0.0020	0.0155	0.0011	0.0053	2.95581E-05
4.D.1. Wetlands, Peat extraction from lands, organic soils	CO_2	1016.928	899.740705	24%		0.2423	0.0002	0.0007	0.0504	0.0000	0.0173	0.000298843
4.D.1. Wetlands, Peat extraction from lands, organic soils	CH_4	28.53444375	28.53444375	24%	71%	0.7512	0.0000	0.0002	0.0016	0.0001	0.0005	3.21425E-07
4.D.1. Wetlands, Peat extraction from lands, organic soils	N_2O	3.793114158	3.793114158	24%	112%	1.1459	0.0000	0.0000	0.0002	0.0000	0.0001	6.22573E-09
4.E.1 Settlements remaining Settlements – Carbon stock change – living biomass	CO_2	-48.28378427	-108.185671	9%	389%	3.8957	0.0007	0.0037	0.0061	0.0144	0.0007	0.000208496
4.E.1 Settlements remaining Settlements – Carbon stock change – dead organic matter	CO_2	-6.10842148	-10.61212032	9%		0.0867	0.0000	0.0003	0.0006	0.0000	0.0001	5.32284E-09
4.E.1 Settlements remaining Settlements – Drained organic soils	CO_2	0	19.43012935	9%	18%	0.2029	0.0000	0.0011	0.0011	0.0002	0.0001	5.77668E-08
4.E.2 Land converted to Settlements – Carbon stock change – living biomass	CO_2	115.9029234	480.9177105	20%	295%	2.9525	0.0083	0.0213	0.0270	0.0627	0.0075	0.003989798
4.E.2 Land converted to Settlements – Carbon stock change – dead organic matter	CO_2	45.65085251	197.4969716	20%		0.1960	0.0000	0.0088	0.0111	0.0000	0.0031	9.42181E-06
4.E.2 Land converted to	CO_2	1.399566667	107.2922807	22%	60%	0.6390	0.0000	0.0059	0.0060	0.0036	0.0019	1.62309E-05

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
Settlements – Mineral soils												
4.E.2 Land converted to Settlements – Organic soils	CO_2	3.765666667	166.1761669	47%	18%	0.5049	0.0000	0.0091	0.0093	0.0017	0.0062	4.12272E-05
4.E.2 Lands converted to settlements, Direct nitrous oxide (N2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	0.910565999	40.47931849	20%	38%	0.4248	0.0000	0.0022	0.0023	0.0008	0.0006	1.09914E-06
4.E.2 Settlements remaining Settlements, Direct nitrous oxide (N2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils	N_2O	0	4.083489381	9%	38%	0.3867	0.0000	0.0002	0.0002	0.0001	0.0000	8.23522E-09
4. G. Harvested wood products	CO_2	-166.3561979	-1817.58	15%	0%	0.1500	0.0003	0.0938	0.1019	0.0000	0.0216	0.000467381
5.A.1. Managed Waste Disposal on Land	CH_4	0	301.0244136	7%	52%	0.5247	0.0001	0.0169	0.0169	0.0088	0.0017	7.98257E-05
5.A.2. Unmanaged Waste Disposal Sites	CH_4	392.8311633	227.8019525	7%	52%	0.5247	0.0001	0.0065	0.0128	0.0034	0.0013	1.28679E-05
5.B.1. Composting	CH_4	23.90918253	22.4652	29%	100%	1.0412	0.0000	0.0001	0.0013	0.0001	0.0005	2.74842E-07
5.B.1. Composting	N_2O	17.09984734	16.06711104	29%	90%	0.9456	0.0000	0.0001	0.0009	0.0001	0.0004	1.39811E-07
5.C.1 Waste Incineration	CO_2	0.810707594	0.56263867	43%	40%	0.5873	0.0000	0.0000	0.0000	0.0000	0.0000	3.7864E-10

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
5.C.1 Waste Incineration	N_2O	4.847024532	4.3807102	43%	100%	1.0885	0.0000	0.0000	0.0002	0.0000	0.0001	2.23812E-08
5.D.1 Domestic Wastewater	CH_4	207.775	109.5074001	45%	30%	0.5408	0.0000	0.0040	0.0061	0.0012	0.0039	1.67311E-05
5.D.1 Domestic Wastewater	N_2O	24.687214	16.53660558	140%	30%	1.4318	0.0000	0.0003	0.0009	0.0001	0.0018	3.37728E-06
5.D.2 Industrial Wastewater	CH_4	137.025	138.525	64%	30%	0.7068	0.0000	0.0011	0.0078	0.0003	0.0070	4.95227E-05
5.D.2 Industrial Wastewater	N_2O	2.341428614	0.115643072	23%	30%	0.3780	0.0000	0.0001	0.0000	0.0000	0.0000	1.05682E-09
Total		17834.80	15573.52				0.0253					0.0111
Total Uncertainties						Uncertainty in total inventory %:	16%				Trend uncertainty %:	11%

A.2.2 Approach 1 uncertainty analysis for 2014 excluding LULUCF

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3049.621305	2.456340066	2%	10%	0.1020	0.0000	0.0501	0.0001	0.0050	0.0000	2.5071E-05
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	218.053	16.555	2%	20%	0.2010	0.0000	0.0030	0.0006	0.0006	0.0000	3.5084E-07
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2644.318679	1575.698976	2%	5%	0.0539	0.0001	0.0164	0.0600	0.0008	0.0017	3.55744E-06
1.A.1.a Public Electricity and Heat Production - Peat	CO_2	142.826737	0	2%	10%	0.1020	0.0000	0.0024	0.0000	0.0002	0.0000	5.53196E-08
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	CO_2	3.0786	0	2%	20%	0.2010	0.0000	0.0001	0.0000	0.0000	0.0000	1.02819E-10
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	3.00505	0.002425	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	6.09997E-10
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0.057625	0.004375	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.53048E-13
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	1.20535	0.726	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.58219E-11
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	0.327	8.434081116	5%	50%	0.5025	0.0000	0.0003	0.0003	0.0002	0.0000	2.54537E-08
1.A.1.a Public Electricity and Heat Production - Peat	CH_4	0.034425	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	8.03518E-14
1.A.1.a Public Electricity and Heat Production - Other fossil	CH_4	0.0315	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	6.72773E-14

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
fuels												
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	7.1626684	0.0057514	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0001	0.0000	3.46562E-09
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	1.030335	0.078225	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.89286E-11
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	1.4367772	0.865392	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.24807E-11
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	0.519712	13.38625669	5%	50%	0.5025	0.0000	0.0005	0.0005	0.0003	0.0000	6.41172E-08
1.A.1.a Public Electricity and Heat Production - Peat	N_2O	0.615519	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.5688E-11
1.A.1.a Public Electricity and Heat Production - Other fossil fuels	N_2O	0.050064	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.69941E-13
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	24.7792529	21.16428627	2%	10%	0.1020	0.0000	0.0004	0.0008	0.0000	0.0000	2.10367E-09
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	44.69904433	45.0354735	2%	5%	0.0539	0.0000	0.0010	0.0017	0.0000	0.0000	4.75004E-09
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CO_2	73.83865681	0	2%	10%	0.1020	0.0000	0.0012	0.0000	0.0001	0.0000	1.4786E-08
1.A.1.c Manufacture of Solid Fuels and Other Energy	CH_4	0.02314	0.02145	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.80278E-14

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Industries - Liquid Fuels												
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0.020375	0.02075	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	5.21961E-14
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	CH_4	0	0.2955	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	3.22986E-11
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	CH_4	0.0177725	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.14163E-14
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0.05379496	0.0511368	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.8482E-13
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0.024287	0.024734	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	7.41635E-14
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	N_2O	0	0.469648	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	8.15856E-11
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Peat	N_2O	0.3177723	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	6.84667E-12
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	93.25228881	0	2%	10%	0.1020	0.0000	0.0015	0.0000	0.0002	0.0000	2.35828E-08
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234.4643123	0.705374886	2%	5%	0.0539	0.0000	0.0038	0.0000	0.0002	0.0000	3.67507E-08
1.A.2.a Iron and Steel - Other	CO_2	61.3521	0	2%	20%	0.2010	0.0000	0.0010	0.0000	0.0002	0.0000	4.08325E-08

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fossil fuels												
1.A.2.a Iron and Steel - Liquid Fuels	CH_4	0.091425	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	5.66732E-13
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0.106875	0.000325	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	7.63607E-13
1.A.2.a Iron and Steel - Other fossil fuels	CH_4	0.62775	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.6719E-11
1.A.2.a Iron and Steel - Liquid Fuels	N_2O	0.2179572	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.22099E-12
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0.127395	0.0003874	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.08498E-12
1.A.2.a Iron and Steel - Other fossil fuels	N_2O	0.997704	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	6.74918E-11
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CO_2	0	3.906691677	2%	5%	0.0539	0.0000	0.0001	0.0001	0.0000	0.0000	7.30568E-11
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CH_4	0	0.0018	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.17869E-15
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	N_2O	0	0.0021456	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.67476E-15
1.A.2.c Chemicals - Liquid Fuels	CO_2	276.6786727	10.10088453	2%	10%	0.1020	0.0000	0.0042	0.0004	0.0004	0.0000	1.74119E-07
1.A.2.c Chemicals - Gaseous Fuels	CO_2	23.42449305	17.14603569	2%	5%	0.0539	0.0000	0.0003	0.0007	0.0000	0.0000	5.19712E-10
1.A.2.c Chemicals - Peat	CO_2	0	1.12172959	2%	11%	0.1109	0.0000	0.0000	0.0000	0.0000	0.0000	2.31812E-11
1.A.2.c Chemicals - Liquid Fuels	CH_4	0.273195	0.004725	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.6638E-12
1.A.2.c Chemicals - Gaseous	CH_4	0.0106775	0.0079	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.98094E-15

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Fuels												
1.A.2.c Chemicals - Biomass Fuels	CH_4	0	0.211451058	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	1.65382E-11
1.A.2.c Chemicals - Peat	CH_4	0	0.000521299	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	9.88619E-17
1.A.2.c Chemicals - Liquid Fuels	N_2O	0.65129688	0.0069732	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.73545E-11
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0.01272758	0.0094168	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	5.65638E-15
1.A.2.c Chemicals - Biomass Fuels	N_2O	0	0.334983061	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	4.15063E-11
1.A.2.c Chemicals - Peat	N_2O	0	0.004850822	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	8.56025E-15
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	15.54739345	0.397748377	2%	10%	0.1020	0.0000	0.0002	0.0000	0.0000	0.0000	5.80474E-10
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO_2	2.692316	0	2%	20%	0.2010	0.0000	0.0000	0.0000	0.0000	0.0000	7.86355E-11
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	149.4154681	5.263181843	2%	5%	0.0539	0.0000	0.0023	0.0002	0.0001	0.0000	1.28019E-08
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0.015225	0.00025	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.45458E-14
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH_4	0.0007115	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.43239E-17
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0.0681075	0.002425	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.64856E-13
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	CH_4	0	0.00225	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	1.87255E-15
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0.0362964	0.0004768	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	8.39807E-14

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1.A.2.d. Pulp, Paper and Print - Solid Fuels	N_2O	0.01272162	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.09732E-14
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0.08118414	0.0028906	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.76324E-13
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	N_2O	0	0.003576	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	4.73003E-15
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798.2058686	26.17773966	2%	11%	0.1111	0.0000	0.0121	0.0010	0.0013	0.0000	1.76147E-06
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	103.071464	2.2704	2%	20%	0.2010	0.0000	0.0016	0.0001	0.0003	0.0000	1.03806E-07
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174.2220665	93.81485986	2%	5%	0.0539	0.0000	0.0007	0.0036	0.0000	0.0001	1.14515E-08
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CO_2	0	2.1257	2%	20%	0.2010	0.0000	0.0001	0.0001	0.0000	0.0000	2.67419E-10
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0.78871	0.02035	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.72948E-11
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0.026721	0.0006	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.3515E-14
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0.079415	0.043225	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.07998E-14

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1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0.171	0.3505	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	2.8627E-11
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	CH_4	0	0.02175	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.72097E-13
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1.87891384	0.0437464	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.14284E-10
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0.47777148	0.010728	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.39115E-11
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0.09466268	0.0515242	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.37623E-14
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0.271776	0.556962	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	7.22788E-11
1.A.2.e Food Processing, Beverages and Tobacco - Other Fossil Fuels	N_2O	0	0.034568	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.34715E-13
1.A.2.f Non-metallic Minerals - Liquid Fuels	CO_2	273.5769252	20.35027526	2%	10%	0.1020	0.0000	0.0037	0.0008	0.0004	0.0000	1.39606E-07
1.A.2.f Non-metallic Minerals - Solid Fuels	CO_2	16.4292	118.6284	2%	20%	0.2010	0.0000	0.0042	0.0045	0.0008	0.0001	7.37973E-07
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CO_2	314.4838285	73.41324777	2%	5%	0.0539	0.0000	0.0024	0.0028	0.0001	0.0001	2.04482E-08
1.A.2.f Non-metallic Minerals -	CO_2	0	107.5693	2%	2%	0.0283	0.0000	0.0041	0.0041	0.0001	0.0001	2.01412E-08

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Other Fossil Fuels												
1.A.2.f Non-metallic Minerals - Liquid Fuels	CH_4	0.268845	0.020625	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.31644E-12
1.A.2.f Non-metallic Minerals - Solid Fuels	CH_4	0.00425	0.03135	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.16986E-13
1.A.2.f Non-metallic Minerals - Gaseous Fuels	CH_4	0.14335	0.033825	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.88893E-13
1.A.2.f Non-metallic Minerals - Biomass Fuels	CH_4	0.00525	0.949410006	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	3.31847E-10
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	CH_4	0	0.937280723	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.19592E-10
1.A.2.f Non-metallic Minerals - Liquid Fuels	N_2O	0.64092648	0.04917	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.88489E-11
1.A.2.f Non-metallic Minerals - Solid Fuels	N_2O	0.07599	0.560538	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.01339E-10
1.A.2.f Non-metallic Minerals - Gaseous Fuels	N_2O	0.1708732	0.0403194	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.10478E-13
1.A.2.f Non-metallic Minerals - Biomass Fuels	N_2O	0.008344	1.509107769	5%	50%	0.5025	0.0000	0.0001	0.0001	0.0000	0.0000	8.38438E-10
1.A.2.f Non-metallic Minerals - Other Fossil Fuels	N_2O	0	1.489651495	2%	50%	0.5004	0.0000	0.0001	0.0001	0.0000	0.0000	8.07282E-10
1.A.2.g Other - Liquid Fuels	CO_2	795.7039841	104.8142275	2%	10%	0.1020	0.0000	0.0091	0.0040	0.0009	0.0001	8.42549E-07
1.A.2.g Other - Solid Fuels	CO_2	27.263264	5.4868	2%	20%	0.2010	0.0000	0.0002	0.0002	0.0000	0.0000	2.33918E-09
1.A.2.g Other - Gaseous Fuels	CO_2	524.168965	91.04761992	2%	5%	0.0539	0.0000	0.0052	0.0035	0.0003	0.0001	7.62768E-08
1.A.2.g Other - Peat	CO_2	0	1.331164465	2%	10%	0.1020	0.0000	0.0001	0.0001	0.0000	0.0000	2.77598E-11
1.A.2.g Other - Liquid Fuels	CH_4	2.26531	0.173975	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.35354E-10

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1.A.2.g Other - Solid Fuels	CH_4	0.006946	0.00145	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	8.77581E-16
1.A.2.g Other - Gaseous Fuels	CH_4	0.23893	0.04195	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.36757E-12
1.A.2.g Other - Biomass Fuels	CH_4	0.2865	10.965	5%	50%	0.5025	0.0000	0.0004	0.0004	0.0002	0.0000	4.34923E-08
1.A.2.g Other - Peat	CH_4	0	0.000575	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.2028E-16
1.A.2.g Other - Liquid Fuels	N_2O	2.149772	0.252487056	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.6632E-10
1.A.2.g Other - Solid Fuels	N_2O	0.12419448	0.025926	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.80558E-13
1.A.2.g Other - Gaseous Fuels	N_2O	0.28480456	0.0500044	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.94313E-12
1.A.2.g Other - Biomass Fuels	N_2O	0.455344	17.42704	5%	50%	0.5025	0.0000	0.0007	0.0007	0.0003	0.0000	1.09861E-07
1.A.2.g Other - Peat	N_2O	0	0.005811	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.22845E-14
1.A.3.a Domestic Aviation - Aviation Gasoline	CO_2	0.011005031	0.28	2%	5%	0.0539	0.0000	0.0000	0.0000	0.0000	0.0000	3.65701E-13
1.A.3.a Domestic Aviation - Jet kerosene	CO_2	0.054819072	3.13427	2%	5%	0.0539	0.0000	0.0001	0.0001	0.0000	0.0000	4.64867E-11
1.A.3.a Domestic Aviation - Aviation Gasoline	CH_4	1.96519E-06	0.00005	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	8.78933E-19
1.A.3.a Domestic Aviation - Jet kerosene	CH_4	0.000009504	0.0021375	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.65578E-15
1.A.3.a Domestic Aviation - Aviation Gasoline	N_2O	9.36998E-05	0.002384	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.99815E-15
1.A.3.a Domestic Aviation - Jet kerosene	N_2O	0.000453151	0.029353	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.09287E-13
1.A.3.b Road Transportation - Gasoline	CO_2	1723.750448	613.35806	2%	2%	0.0283	0.0000	0.0050	0.0234	0.0001	0.0007	4.46659E-07
1.A.3.b Road Transportation - Diesel Oil	CO_2	616.1359677	1880.266	2%	2%	0.0283	0.0000	0.0615	0.0716	0.0012	0.0020	5.61304E-06

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1.A.3.b Road Transportation - LPG	CO_2	36.95737306	165.2425801	2%	5%	0.0539	0.0000	0.0057	0.0063	0.0003	0.0002	1.12475E-07
1.A.3.b Road Transportation - Lubricants	CO_2	3.4629	4.554798669	10%	5%	0.1118	0.0000	0.0001	0.0002	0.0000	0.0000	6.3576E-10
1.A.3.b Road Transportation - Gaseous Fuels	CO_2	17.6165255	0	2%	5%	0.0539	0.0000	0.0003	0.0000	0.0000	0.0000	2.10418E-10
1.A.3.b Road Transportation - Gasoline	CH_4	17.15516309	2.207274532	2%	30%	0.3007	0.0000	0.0002	0.0001	0.0001	0.0000	3.55015E-09
1.A.3.b Road Transportation - Diesel Oil	CH_4	1.108041461	1.356526416	2%	30%	0.3007	0.0000	0.0000	0.0001	0.0000	0.0000	1.02636E-10
1.A.3.b Road Transportation - LPG	CH_4	0.124565463	0.863788568	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.38746E-10
1.A.3.b Road Transportation - Lubricants	CH_4	0.02475	0.014988474	10%	50%	0.5099	0.0000	0.0000	0.0000	0.0000	0.0000	1.31804E-14
1.A.3.b Road Transportation - Gaseous Fuels	CH_4	0.7015	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.33659E-11
1.A.3.b Road Transportation - Biomass	CH_4	0	0.023009615	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.92608E-13
1.A.3.b Road Transportation - Gasoline	N_2O	13.07410741	4.606850327	2%	50%	0.5004	0.0000	0.0000	0.0002	0.0000	0.0000	4.21725E-10
1.A.3.b Road Transportation - Diesel Oil	N_2O	5.593827044	19.44722022	2%	50%	0.5004	0.0000	0.0006	0.0007	0.0003	0.0000	1.0559E-07
1.A.3.b Road Transportation - LPG	N_2O	0.163685304	2.934347457	2%	50%	0.5004	0.0000	0.0001	0.0001	0.0001	0.0000	2.9836E-09
1.A.3.b Road Transportation - Lubricants	N_2O	0.02384	0.032918912	10%	50%	0.5099	0.0000	0.0000	0.0000	0.0000	0.0000	2.16827E-13
1.A.3.b Road Transportation - Gaseous Fuels	N_2O	0.27267	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	5.04106E-12

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1.A.3.b Road Transportation - Biomass	N_2O	0	0.349076786	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.433E-11
1.A.3.c Railways - Liquid Fuels	CO_2	531.37994	213.786	2%	5%	0.0539	0.0000	0.0006	0.0081	0.0000	0.0002	5.3963E-08
1.A.3.c Railways - Liquid Fuels	CH_4	0.745009038	0.299750179	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.86132E-13
1.A.3.c. Railway Biomass Fuels	CH_4	0	0.0022825	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.8953E-15
1.A.3.c Railways - Liquid Fuels	N_2O	61.20060747	24.62371876	2%	50%	0.5004	0.0000	0.0001	0.0009	0.0000	0.0000	1.93082E-09
1.A.3.c. Railway Biomass Fuels	N_2O	0	0.0346276	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	4.36215E-13
1.A.3.d Domestic Naviagtion - Gasoline	CO_2	0.172771761	0.3465	20%	5%	0.2062	0.0000	0.0000	0.0000	0.0000	0.0000	1.42003E-11
1.A.3.d Domestic Naviagtion - Diesel Oil	CO_2	0.8332289	12.58	2%	5%	0.0539	0.0000	0.0005	0.0005	0.0000	0.0000	7.25135E-10
1.A.3.d Domestic Naviagtion - Gasoline	CH_4	0.00295205	0.005924494	20%	50%	0.5385	0.0000	0.0000	0.0000	0.0000	0.0000	1.19074E-14
1.A.3.d Domestic Naviagtion - Diesel Oil	CH_4	0.001126	0.017	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	9.92195E-14
1.A.3.d Domestic Naviagtion - Gasoline	N_2O	0.000219506	0.000440227	20%	50%	0.5385	0.0000	0.0000	0.0000	0.0000	0.0000	6.57297E-17
1.A.3.d Domestic Naviagtion - Diesel Oil	N_2O	0.1006644	1.5198	2%	50%	0.5004	0.0000	0.0001	0.0001	0.0000	0.0000	7.92998E-10
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1007.294341	155.5621374	2%	10%	0.1020	0.0000	0.0107	0.0059	0.0011	0.0002	1.1644E-06
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1410.784936	38.5022	2%	20%	0.2010	0.0000	0.0218	0.0015	0.0044	0.0000	1.89337E-05
1.A.4.a	CO_2	334.0088098	238.7965288	2%	5%	0.0539	0.0000	0.0036	0.0091	0.0002	0.0003	9.84588E-08

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Commercial/Institutional - Gaseous Fuels												
1.A.4.a Commercial/Institutional - Peat	CO_2	66.54499789	1.136164465	2%	11%	0.1109	0.0000	0.0011	0.0000	0.0001	0.0000	1.31871E-08
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	3.495	0.649625	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.69709E-10
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	3.72829	0.10175	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0000	0.0000	8.27264E-10
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0.76125	0.550125	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.80558E-11
1.A.4.a Commercial/Institutional - Biomass Fuels	CH_4	39.135	34.97326278	5%	50%	0.5025	0.0000	0.0007	0.0013	0.0003	0.0001	1.27029E-07
1.A.4.a Commercial/Institutional - Peat	CH_4	0.168	0.00275	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.77153E-12
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	2.411706848	0.369840648	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.64401E-10
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	6.66618252	0.181929	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0001	0.0000	2.64471E-09
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0.181482	0.1311498	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.02619E-12
1.A.4.a	N_2O	6.219856	5.564080248	5%	50%	0.5025	0.0000	0.0001	0.0002	0.0001	0.0000	3.22106E-09

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Commercial/Institutional - Biomass Fuels												
1.A.4.a Commercial/Institutional - Peat	N_2O	0.2955862	0.004619	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	5.5036E-12
1.A.4.b Residential - Liquid Fuels	CO_2	329.9110639	157.1324033	2%	10%	0.1020	0.0000	0.0006	0.0060	0.0001	0.0002	3.16912E-08
1.A.4.b Residential - Solid Fuels	CO_2	605.8184	50.2326	2%	20%	0.2010	0.0000	0.0081	0.0019	0.0016	0.0001	2.6027E-06
1.A.4.b Residential - Gaseous Fuels	CO_2	219.6011945	230.7118474	2%	5%	0.0539	0.0000	0.0052	0.0088	0.0003	0.0002	1.28588E-07
1.A.4.b Residential - Peat	CO_2	42.27150449	0	2%	10%	0.1020	0.0000	0.0007	0.0000	0.0001	0.0000	4.84606E-09
1.A.4.b Residential - Liquid Fuels	CH_4	0.868375	1.276125	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.96039E-10
1.A.4.b Residential - Solid Fuels	CH_4	48.03	3.9825	2%	50%	0.5004	0.0000	0.0006	0.0002	0.0003	0.0000	1.02192E-07
1.A.4.b Residential - Gaseous Fuels	CH_4	0.5005	0.5315	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.63289E-11
1.A.4.b Residential - Biomass Fuels	CH_4	96.42474185	101.6540154	10%	10%	0.1414	0.0000	0.0023	0.0039	0.0002	0.0005	3.51929E-07
1.A.4.b Residential - Peat	CH_4	3.1875	0	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0000	0.0000	6.88885E-10
1.A.4.b Residential - Liquid Fuels	N_2O	0.4500694	0.344594088	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	8.29514E-12
1.A.4.b Residential - Solid Fuels	N_2O	2.862588	0.237357	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.63016E-10
1.A.4.b Residential - Gaseous Fuels	N_2O	0.1193192	0.1267096	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.06474E-12
1.A.4.b Residential - Biomass	N_2O	8.94447	10.597476	10%	30%	0.3162	0.0000	0.0003	0.0004	0.0001	0.0001	9.1707E-09

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Fuels												
1.A.4.b Residential - Peat	N_2O	0.1860712	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.3475E-12
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	695.0757089	320.5751539	2%	11%	0.1088	0.0000	0.0008	0.0122	0.0001	0.0003	1.25897E-07
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	102.28152	2.2704	2%	50%	0.5004	0.0000	0.0016	0.0001	0.0008	0.0000	6.38319E-07
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778.5312078	55.18201994	2%	50%	0.5004	0.0000	0.0107	0.0021	0.0054	0.0001	2.87138E-05
1.A.4.c Agriculture/Forestry/Fisheries - Peat	CO_2	3.0225	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	6.19411E-10
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	5.286318275	0.590724755	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0000	0.0000	1.04238E-09
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	8.109	0.18	2%	50%	0.5004	0.0000	0.0001	0.0000	0.0001	0.0000	4.01245E-09
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	1.774375	0.127125	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.4861E-10
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	9.15	2.625286653	5%	50%	0.5025	0.0000	0.0001	0.0001	0.0000	0.0000	6.92612E-10
1.A.4.c Agriculture/Forestry/Fisheries -	CH_4	0.2325	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	3.66516E-12

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Peat												
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	43.26924002	33.54418198	2%	50%	0.5004	0.0000	0.0006	0.0013	0.0003	0.0000	8.11041E-08
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0.4832964	0.010728	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.42529E-11
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0.423011	0.0303066	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	8.44619E-12
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	1.45424	0.431444174	5%	50%	0.5025	0.0000	0.0000	0.0000	0.0000	0.0000	1.54771E-11
1.A.4.c Agriculture/Forestry/Fisheries - Peat	N_2O	0.013857	0	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.30193E-14
1.A.5.b Mobile - Liquid Fuels	CO_2	0	9.442494289	2%	50%	0.5004	0.0000	0.0004	0.0004	0.0002	0.0000	3.24362E-08
1.A.5.b Mobile - Liquid Fuels	CH_4	0	0.018743571	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	1.27809E-13
1.A.5.b Mobile - Liquid Fuels	N_2O	0	0.076423393	2%	50%	0.5004	0.0000	0.0000	0.0000	0.0000	0.0000	2.12475E-12
1.B.2.b Natural Gas	CO_2	0.008686	0.011105	32%	0%	0.3224	0.0000	0.0000	0.0000	0.0000	0.0000	3.71808E-14
1.B.2.b Natural Gas	CH_4	177.238	109.190125	32%	0%	0.3224	0.0000	0.0012	0.0042	0.0000	0.0019	3.59458E-06
1.B.2.c Venting and Flaring	CO_2	0.002806	0.002657	10%	0%	0.1000	0.0000	0.0000	0.0000	0.0000	0.0000	2.04805E-16
1.B.2.c Venting and Flaring	CH_4	70.344325	26.126175	10%	0%	0.1000	0.0000	0.0002	0.0010	0.0000	0.0001	1.9802E-08
2.A.1. Cement Production	CO_2	370.8039966	555.775815	10%	5%	0.1118	0.0000	0.0151	0.0212	0.0008	0.0030	9.52792E-06
2.A.2. Lime Production	CO_2	148.8573814	0.459881348	2%	50%	0.5004	0.0000	0.0024	0.0000	0.0012	0.0000	1.48085E-06

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2.A.3. Glass production	CO_2	0.355752064	0.942744575	2%	86%	0.8602	0.0000	0.0000	0.0000	0.0000	0.0000	6.6874E-10
2.A.4. Other process uses of carbonates	CO_2	69.184752	10.8326905	2%	50%	0.5004	0.0000	0.0007	0.0004	0.0004	0.0000	1.32187E-07
2.C.1 Iron and Steel Production	CO_2	52.59606386	0.01036233	5%	25%	0.2550	0.0000	0.0009	0.0000	0.0002	0.0000	4.68469E-08
2.C.1 Iron and Steel Production	CH_4	0.06875	1.15638E-05	10%	25%	0.2693	0.0000	0.0000	0.0000	0.0000	0.0000	8.00562E-14
2.D.1 Lubricant Use	CO_2	23.25102433	8.297813333	2%	50%	0.5004	0.0000	0.0001	0.0003	0.0000	0.0000	1.1981E-09
2.D.2 Paraffin wax use	CO_2	0	4.911573333	2%	100%	1.0002	0.0000	0.0002	0.0002	0.0002	0.0000	3.50201E-08
2.D.3.b Road paving with asphalt	CO_2	0.001463305	0.054450618	20%	60%	0.6325	0.0000	0.0000	0.0000	0.0000	0.0000	1.85651E-12
2.D.3.c Asphalt roofing	CO_2	0.002972338	0.049156808	20%	60%	0.6325	0.0000	0.0000	0.0000	0.0000	0.0000	1.47711E-12
2.D.3. Solvent Use	CO_2	41.0641984	32.19721064	2%	20%	0.2010	0.0000	0.0005	0.0012	0.0001	0.0000	1.33023E-08
2.D.3.d Urea Use	CO_2	0	0.817	20%	10%	0.2236	0.0000	0.0000	0.0000	0.0000	0.0000	8.71395E-11
2.F.1. Refrigeration and air conditioning	HFCs	0	206.3769351	50%	50%	0.7071	0.0002	0.0079	0.0079	0.0039	0.0056	4.63353E-05
2.F.2 Foam blowing agents	HFCs	0	0.961490119	50%	50%	0.7071	0.0000	0.0000	0.0000	0.0000	0.0000	1.00573E-09
2.F.3. Fire Protection	HFCs	0	0.02767976	50%	50%	0.7071	0.0000	0.0000	0.0000	0.0000	0.0000	8.33517E-13
2.F.4. Aerosols	HFCs	0	4.697766137	50%	50%	0.7071	0.0000	0.0002	0.0002	0.0001	0.0001	2.40089E-08
2.G.1. Electrical equipment	SF6	0	8.577903643	2%	30%	0.3007	0.0000	0.0003	0.0003	0.0001	0.0000	9.69118E-09
2.G.3. N2O from product uses	N_2O	1.30226	2.01448	2%	2%	0.0283	0.0000	0.0001	0.0001	0.0000	0.0000	5.93139E-12
3.A.1 Enteric Fermentation - Cattle	CH_4	2117.989353	828.0431219	2%	20%	0.2010	0.0002	0.0033	0.0315	0.0007	0.0009	1.24205E-06
3.A.2 Enteric Fermentation - Sheep	CH_4	32.92	18.5	2%	50%	0.5004	0.0000	0.0002	0.0007	0.0001	0.0000	6.9942E-09

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3.A.3 Enteric Fermentation - Swine	CH_4	52.54125	13.1025	2%	20%	0.2010	0.0000	0.0004	0.0005	0.0001	0.0000	5.5647E-09
3.A.4 Enteric Fermentation - Other livestock	CH_4	18.090525	13.021775	2%	50%	0.5004	0.0000	0.0002	0.0005	0.0001	0.0000	9.99985E-09
3.B.1.1 Manure Management - Cattle	CH_4	110.9670107	70.59473241	25%	20%	0.3202	0.0000	0.0009	0.0027	0.0002	0.0010	9.33279E-07
3.B.2.1 Manure Management - Cattle	N_2O	120.6657672	42.94734024	25%	20%	0.3202	0.0000	0.0004	0.0016	0.0001	0.0006	3.39376E-07
3.B.1.2 Manure Management - Sheep	CH_4	0.78185	0.439375	25%	30%	0.3905	0.0000	0.0000	0.0000	0.0000	0.0000	3.6343E-11
3.B.2.2 Manure Management - Sheep	N_2O	1.824479542	2.221483039	25%	30%	0.3905	0.0000	0.0001	0.0001	0.0000	0.0000	1.16272E-09
3.B.1.3 Manure Management - Swaine	CH_4	65.37841625	20.64571937	25%	20%	0.3202	0.0000	0.0003	0.0008	0.0001	0.0003	8.06581E-08
3.B.2.3 Manure Management - Swaine	N_2O	40.75322335	5.647103039	25%	20%	0.3202	0.0000	0.0005	0.0002	0.0001	0.0001	1.41019E-08
3.B.1.4 Manure Management - Other livestock	CH_4	12.4845375	7.840283798	25%	30%	0.3905	0.0000	0.0001	0.0003	0.0000	0.0001	1.1924E-08
3.B.2.4 Manure Management - Other livestock	N_2O	22.98598703	11.52240459	25%	30%	0.3905	0.0000	0.0001	0.0004	0.0000	0.0002	2.43999E-08
3.B.5 Indirect N2O emissions from Manure Management	N_2O	137.5202478	41.93797066	2%	30%	0.3007	0.0000	0.0007	0.0016	0.0002	0.0000	4.21375E-08
3.D.1. Direct N2O emissions from managed soils	N_2O	1962.775641	1429.497775	2%	50%	0.5004	0.0040	0.0221	0.0544	0.0111	0.0015	0.00012451
3.D.2 Indirect N2O Emissions from managed soils	N_2O	377.2229002	196.0440499	2%	50%	0.5004	0.0001	0.0013	0.0075	0.0006	0.0002	4.37755E-07
3.G. Liming	CO_2	371.4186667	19.68633333	2%	50%	0.5004	0.0000	0.0054	0.0007	0.0027	0.0000	7.19941E-06

IPCC category/Group	Gas	Base year emissions or removals	Year 2014 emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
3.H. Urea Application	CO_2	7.7088	4.726333333	20%	50%	0.5385	0.0000	0.0001	0.0002	0.0000	0.0001	3.29588E-09
5.A.1. Managed Waste Disposal on Land	CH_4	0	301.0244136	7%	52%	0.5247	0.0002	0.0115	0.0115	0.0060	0.0011	3.68299E-05
5.A.2. Unmanaged Waste Disposal Sites	CH_4	392.8311633	227.8019525	7%	52%	0.5247	0.0001	0.0022	0.0087	0.0011	0.0009	2.05402E-06
5.B.1. Composting	CH_4	23.90918253	22.4652	29%	100%	1.0412	0.0000	0.0005	0.0009	0.0005	0.0004	3.36443E-07
5.B.1. Composting	N_2O	17.09984734	16.06711104	29%	90%	0.9456	0.0000	0.0003	0.0006	0.0003	0.0003	1.51364E-07
5.C.1 Waste Incineration	CO_2	0.810707594	0.56263867	43%	40%	0.5873	0.0000	0.0000	0.0000	0.0000	0.0000	1.80246E-10
5.C.1 Waste Incineration	N_2O	4.847024532	4.3807102	43%	100%	1.0885	0.0000	0.0001	0.0002	0.0001	0.0001	1.78665E-08
5.D.1 Domestic Wastewater	CH_4	207.775	109.5074001	45%	30%	0.5408	0.0000	0.0007	0.0042	0.0002	0.0027	7.0953E-06
5.D.1 Domestic Wastewater	N_2O	24.687214	16.53660558	140%	30%	1.4318	0.0000	0.0002	0.0006	0.0001	0.0012	1.5594E-06
5.D.2 Industrial Wastewater	CH_4	137.025	138.525	64%	30%			0.0030				
5.D.2 Industrial Wastewater	N_2O	2.341428614	0.115643072	23%	30%	0.3780	0.0000	0.0000	0.0000	0.0000	0.0000	1.07046E-10
Total		26256.4348	11353.3840				0.0049					0.0003
Total Uncertainties						Uncertainty in total inventory %:	7%				Trend uncertainty %:	2%

Annex 3: Other Detailed methodological descriptions for individual source or sink categories, including for KP-LULUCF activities

A.3.1 Energy (excluding Transport sector)

Fuel	NCV	Sulphur content (%)																			
		1990-95	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Diesel	42.49	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
RFO	40.6	2	2	2.12	2.10	2.00	2.08	1.98	1.96	2.02	1.38	1.23	0.99	1.21	0.91	0.79	0.91	0.97	0.94	0.80	0.84
Gasoline	43.97	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.005	0.005	0.005	0.001	0.001	0.001	0.001	0.001	0.001
Jet fuel	43.2	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
Other liquids	41.86	0.650	0.607	0.595	0.583	0.570	0.558	0.546	0.533	0.521	0.509	0.497	0.484	0.472	0.460	0.447	0.435	0.423	0.410	0.398	0.386
LPG	45.54	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029
Shale oil	39.35	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Coal	26.22	1.8	1.8	1.47	1.37	1.06	0.90	0.87	0.78	0.66	0.67	0.72	0.66	0.52	0.45	0.46	0.39	0.41	0.50	0.44	0.48
Coke	26.79	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Oil shale	9.2	1.6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	10.05	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
RFO (marine)	40.6	2	2	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1	1	1	1	1
Wood	6.7	0.0150	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Natural gas	Changes annually	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029
		EF (kt/PJ)																			
Diesel		0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.047	0.047	0.047	0.047	0.047	0.047	0.047
RFO		0.966	0.966	1.024	1.012	0.968	1.003	0.957	0.948	0.976	0.665	0.596	0.479	0.583	0.441	0.382	0.442	0.467	0.456	0.389	0.405
Gasoline		0.00682	0.00682	0.00682	0.00682	0.00682	0.00682	0.00682	0.00682	0.00682	0.00682	0.00682	0.00227	0.00227	0.00227	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
Jet fuel		0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
Other liquids		0.311	0.290	0.284	0.278	0.272	0.267	0.261	0.255	0.249	0.243	0.237	0.231	0.225	0.220	0.214	0.208	0.202	0.196	0.190	0.184
LPG		0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013	0.00013
Shale oil		0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407
Coal		1.138	1.138	0.928	0.865	0.673	0.567	0.551	0.493	0.451	0.459	0.498	0.454	0.357	0.308	0.318	0.266	0.280	0.342	0.328	0.359
Coke		0.410	0.410	0.410	0.410	0.410	0.410	0.410	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403
Oil shale		3.13	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat		0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507	0.507
RFO (marine)		0.966	0.966	0.966	0.724	0.724	0.724	0.724	0.724	0.724	0.724	0.724	0.724	0.724	0.724	0.724	0.483	0.483	0.483	0.483	0.483
Wood		0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
Natural gas		0.00017	0.00018	0.00018	0.00018	0.00018	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017

Notes:
Gasoline, diesel oil – EU legislation
RFO – EU legislation, average value from database Nr.2-Air
Other liquids – average value from database Nr.2-Air
Coal – average value from database Nr.2-Air
Shale oil – Luik, H. "Coal, oil shale, natural bitumen, heavy oil and peat" Vol. II *Chemicals and Other products from Shale Oil*
Oil shale – Gavrilova, O., Randla, T., Vallner, L., Strandberg, M., Vilu, R. 2005. "Life Cycle Analysis of the Estonian Oil Shale Industry"
Peat, peat briquettes – Latvian Peat Producers Association
Wood – Zandersons, J, Žūriņš, A., Rižikovs, J., Dobele, G., Latvian Institute of Wood chemistry "Feasibility of processing and utilisation of used up railway sleepers"
Natural gas – allowed content of mercaptan (3 mg/m^3)

Fuel consumption in Energy sector (stationary combustion), TJ

1.A.1 Energy Industries

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1.A.1. Energy Industries																									
Total	**94337**	**88210**	**73651**	**57391**	**53160**	**50514**	**51326**	**52637**	**54187**	**48325**	**42657**	**44355**	**43268**	**43796**	**41000**	**40407**	**41916**	**39400**	**38929**	**37897**	**45595**	**42380**	**40380**	**46022**	**43785**
Liquid Fuels	40437	33253	28441	27170	30859	20519	27333	17437	20662	17491	7900	5235	5033	3576	3055	2365	1511	1389	905	1194	918	848	662	466	319
Solid Fuels	2305	1736	1935	2106	1366	1395	740	541	455	398	371	398	285	209	210	183	105	341	446	472	419	419	513	424	175
Peat	2088	2343	2814	3007	2841	3430	2974	3083	2157	1275	2351	1230	1005	663	70	60	30	29	20	10	11	9	NO	40	NO
Gaseous Fuels	49029	50288	39788	24246	16770	24107	18644	28165	26802	25464	28803	33510	32497	34074	32371	33306	35181	32613	32650	31236	38687	35607	31872	33926	29870
Biomass	436	590	673	862	1324	1063	1634	3412	4111	3697	3232	3940	4406	5245	5206	4464	5089	5028	4908	4956	5531	5494	7333	11166	13421
Other Fossil Fuels	42	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	42	29	88	29	NO	NO	NO	29	29	3	NO	NO	NO
1.A.1.a. Public Electricity and Heat Production																									
Total	**92472**	**86689**	**71901**	**55946**	**51496**	**48590**	**48499**	**51233**	**50453**	**44329**	**39919**	**42931**	**41998**	**42183**	**39348**	**39061**	**40483**	**38378**	**37639**	**36780**	**44274**	**40852**	**39004**	**44542**	**42275**
Liquid Fuels	40098	33002	28190	26919	30426	20266	26110	17107	18116	14486	6350	5065	4821	3406	2843	2153	1299	1219	693	1031	705	593	492	211	33
Solid Fuels	2305	1736	1935	2106	1366	1395	740	541	427	370	371	398	285	209	210	183	105	341	446	472	419	419	513	424	175
Peat	1377	1703	1945	2437	2246	2703	2403	2600	1764	1046	1970	1125	995	653	60	40	20	20	20	10	11	9	NO	40	NO
Gaseous Fuels	48214	49658	39158	23622	16134	23163	17612	27599	26069	24831	27996	32633	31691	33199	31499	32434	34242	32043	31845	30739	37812	34664	30895	32997	29040
Biomass	436	590	673	862	1324	1063	1634	3386	4077	3596	3232	3668	4164	4687	4648	4222	4817	4755	4635	4499	5298	5164	7104	10870	13027
Other Fossil Fuels	42	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	42	29	88	29	NO	NO	NO	29	29	3	NO	NO	NO
Diesel oil	5524	5226	3824	935	382	85	42	297	85	85	127	42	42	42	42	42	42	43	43	16	15	25	127	94	22
RFO	32561	26147	23183	24563	30044	20016	25984	16768	17905	14007	5279	4425	4425	3207	2801	2111	1218	1137	650	1015	690	568	365	113	10
LPG	46	46	46	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	4	1
Other liquid	1967	1583	1137	1421	NO	126	84	42	126	NO	NO	126	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	39	NO	NO	NO	394	944	472	354	157	NO	NO	39	39	NO	NO	NO	NO	NO	NO	NO
Coal	2305	1736	1935	2106	1366	1395	740	541	427	370	371	398	285	209	210	183	105	341	446	472	419	419	513	424	175
Peat briquettes	31	15	15	15	15	77	62	77	15	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1	NO	NO	NO	NO
Peat	1346	1688	1930	2422	2231	2626	2341	2523	1749	1046	1970	1125	995	653	60	40	20	20	20	10	10	9	NO	40	NO
Natural gas	48214	49658	39158	23622	16134	23163	17612	27599	26069	24831	27996	32633	31691	33199	31499	32434	34242	32043	31845	30739	37812	34664	30895	32997	29040
Wood	436	590	673	831	1300	1045	1595	3363	4060	3558	3191	3617	4097	4644	4570	4132	4741	4675	4556	4390	5120	4635	5793	9198	11184
Sludge gas	NO	NO	NO	31	24	18	39	23	17	38	41	51	67	43	78	90	76	80	79	100	114	100	105	97	91
Landfill gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	9	18	22	22	14	15
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	37	355	1145	1561	1737
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	8	52	39	NO	NO
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1	NO	NO	NO	NO
Waste oils	42	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	42	29	88	29	NO	NO	NO	29	29	3	NO	NO	NO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries																									
Total	**1865**	**1521**	**1750**	**1445**	**1664**	**1924**	**2826**	**1405**	**3734**	**3996**	**2738**	**1424**	**1270**	**1613**	**1652**	**1346**	**1433**	**1022**	**1290**	**1117**	**1321**	**1528**	**1376**	**1480**	**1510**
Liquid Fuels	339	251	251	251	433	253	1223	330	2546	3005	1550	170	212	170	212	212	212	170	212	163	213	255	170	255	286
Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	28	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	711	640	869	570	595	727	571	483	393	229	381	105	10	10	10	20	10	9	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	815	630	630	624	636	944	1032	566	733	633	807	877	806	875	872	872	939	570	805	497	875	943	977	929	830
Biomass	NO	NO	NO	NO	NO	NO	NO	26	34	101	NO	272	242	558	558	242	272	273	273	457	233	330	229	296	394
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	212	170	170	170	170	212	127	127	127	212	127	170	212	170	212	212	212	170	212	163	213	255	170	255	286
RFO	81	81	81	81	81	41	1096	203	487	731	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	46	NO	NO	NO	182	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	216	346	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	1716	1716	1423	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	NO	NO	NO	NO	NO	NO	NO	NO	28	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	711	640	869	570	595	727	571	483	393	229	381	105	10	10	10	20	10	9	NO	NO	NO	NO	NO	NO	NO
Natural gas	815	630	630	624	636	944	1032	566	733	633	807	877	806	875	872	872	939	570	805	497	875	943	977	929	830
Wood	NO	NO	NO	NO	NO	NO	NO	26	34	101	NO	272	242	558	558	242	272	273	273	457	233	330	229	296	394

1.A.2 Manufacturing Industries and Construction

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1.A.2 Manufacturing Industries and Construction																									
Total	58640	45567	38083	32982	29888	29837	29430	28709	26228	24129	20526	20910	21411	21329	22992	24014	25616	24380	23176	22377	26693	25255	27930	26005	26913
Liquid Fuels	29747	20311	17430	17082	16545	16745	16344	16010	12910	11400	7575	4681	3966	4417	4277	2866	4075	3847	3076	2946	3500	2298	2649	2576	2254
Solid Fuels	1545	882	968	1639	1444	650	592	450	393	421	252	252	253	262	236	971	1394	1967	1997	1363	1861	2229	2149	1406	1336
Peat	NO	20	10	NO	15	15	15	25	25	15	NO	NO	NO	NO	10	NO	NO	NO	NO	NO	14	2	2	24	24
Gaseous Fuels	25894	23752	19059	12482	9783	10014	9815	9484	9712	9080	9873	11583	12838	12729	13157	13680	13395	12881	11836	9261	10537	7578	7952	6259	5258
Biomass	617	603	616	1779	2101	2414	2664	2740	3188	3186	2733	3926	3487	3391	4795	5584	6462	5415	5895	8674	10319	12399	14301	14624	16763
Other Fossil Fuels	837	NO	NO	NO	NO	NO	NO	NO	NO	26	94	469	866	530	517	914	290	270	372	133	462	749	877	1115	1279
Gasoline	880	220	220	220	132	44	132	88	88	44	44	44	69	44	88	88	88	88	88	44	44	44	44	44	43
Diesel oil	5564	5606	4034	3779	1611	1485	1315	1740	1655	1527	1484	1357	1231	1187	1357	1400	1527	1997	1657	1530	1359	1785	1997	1996	1722
RFO	22532	14007	12871	12504	14127	14413	14129	12993	9947	8446	3411	1625	1178	813	487	529	529	451	366	366	335	162	203	81	31
LPG	46	46	46	46	46	91	137	137	46	92	46	46	46	46	92	92	137	137	91	91	91	228	366	413	423
Jet fuel	NO	NO	NO	NO	NO	NO	43	86	43	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other kerosene	432	432	259	86	43	86	86	129	43	43	43	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	293	NO	NO	447	586	586	502	837	1088	1130	1130	1215	1047	1214	1047	210	1089	963	795	711	1005	NO	NO	42	35

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Petroleum coke	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	198	956	1088	429	627	132	NO	165	627	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	39	NO	NO	NO	118	1417	394	197	157	118	118	78	79	79	39	39	79	39	NO	NO
Coal	1280	882	968	1534	1365	597	539	397	367	368	226	226	226	235	209	917	1362	1967	1997	1363	1861	2229	2067	1379	1336
Coke	237	NO	NO	105	79	53	53	53	26	53	26	26	27	27	27	54	32	NO	NO	NO	NO	NO	NO	NO	NO
Anthracite	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	82	27	NO
Oil shale	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	15	15	15	15	15	15	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	4	NO	NO	4	4
Peat	NO	20	10	NO	NO	NO	NO	10	10	NO	NO	NO	NO	NO	10	NO	NO	NO	NO	NO	10	2	2	20	20
Natural gas	25894	23752	19059	12482	9783	10014	9815	9484	9712	9080	9873	11583	12838	12729	13157	13680	13395	12881	11836	9261	10537	7578	7952	6259	5258
Wood	617	603	616	1779	2101	2414	2664	2740	3188	3176	2696	3856	3393	3309	4706	5535	6425	5387	5797	8633	9801	11187	12921	13530	15368
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	3	2	1	8	8	1	4	2	4
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	18	125	57	125
Municipal wastes (biomass fraction)	NO	NO	NO	NO	NO	NO	NO	NO	NO	10	37	70	94	82	89	49	34	26	98	33	510	1193	1250	1035	1266
Waste oils	837	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	293	628	322	293	789	205	205	234	88	58	85	58	29	29
Industrial wastes (used tires)	NO	NO	NO	NO	NO	NO	NO	NO	NO	26	94	176	238	208	224	125	85	65	58	15	84	331	242	379	335
Municipal wastes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	80	30	320	332	577	707	915
1.A.2.a. Iron and Steel																									
Total	6331	4649	4157	3651	4019	3065	3282	5079	5083	4991	5076	5142	4861	4932	5016	4804	5059	5081	4738	4187	4870	1207	1633	583	13
Liquid Fuels	1219	1016	732	731	912	705	785	1162	1088	1130	1172	1042	963	963	963	126	963	963	917	792	1006	NO	NO	NO	NO
Solid Fuels	NO	NO	NO	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	27	27	5	NO	NO	NO	26	27	184	32	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	4275	3633	3425	2892	3107	2360	2497	3917	3995	3861	3904	4058	3898	3969	4026	4125	4091	4118	3821	3395	3838	1180	1449	551	13
Biomass	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other Fossil Fuels	837	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	NO	NO	526	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	42	42	42	NO	42	NO	NO	NO	NO	NO	42	NO	NO	NO	NO	42	NO	NO	NO	NO	1	NO	NO	NO	NO
RFO	1177	974	690	284	284	203	325	325	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	122	81	NO	NO	NO	NO	NO
Other liquid	NO	NO	NO	447	586	502	460	837	1088	1130	1130	963	963	963	963	84	963	963	795	711	1005	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	79	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	NO	NO	NO	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	26	27	102	5	NO
Coke	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	27	27	5	NO	NO	NO	NO	NO	NO	NO	NO
Anthracite	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	82	27	NO
Natural gas	4275	3633	3425	2892	3107	2360	2497	3917	3995	3861	3904	4058	3898	3969	4026	4125	4091	4118	3821	3395	3838	1180	1449	551	13
Waste oils	837	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	NO	NO	526	NO	NO	NO	NO	NO	NO	NO	NO	NO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1.A.2.b. Non-Ferrous Metals																									
Total	NO	NO	NO	NO	NO	NO	NO	NO	53	100	168	232	269	302	269	203	204	201	134	101	135	172	173	138	72
Liquid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	NO	NO	NO	NO	NO	NO	NO	NO	2	3	NO	NO
Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	2	1	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NO	NO	NO	NO	NO	NO	NO	53	100	168	190	269	302	269	203	204	201	134	101	135	168	168	138	72
Biomass	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1	NO	NO
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	NO	NO	NO	NO	NO	NO	NO	NO	2	3	NO	NO
Coal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	2	1	NO	NO
Natural gas	NO	NO	NO	NO	NO	NO	NO	NO	53	100	168	190	269	302	269	203	204	201	134	101	135	168	168	138	72
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1	NO	NO
1.A.2.c. Chemicals																									
Total	4070	2642	2098	3638	3977	5645	4160	3529	643	580	486	479	469	449	452	471	539	455	854	773	888	724	807	804	880
Liquid Fuels	3643	2059	1684	2963	3249	4547	3451	3207	325	164	122	164	162	122	NO	NO	NO	NO	124	126	94	131	154	137	159
Solid Fuels	NO	NO	NO	28	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	20	11
Gaseous Fuels	427	584	414	643	693	1090	696	302	298	362	317	269	278	308	405	442	480	381	513	518	606	404	371	385	316
Biomass	NO	NO	NO	4	7	7	13	20	20	54	47	46	29	19	47	29	59	74	188	130	188	188	282	262	394
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	29	NO	NO	NO	NO	NO	NO
Diesel oil	127	127	85	NO	42	NO	NO	NO	NO	42	NO	NO	NO	NO	NO	NO	NO	NO	43	85	85	85	17	NO	15
RFO	3127	1543	1340	2963	3207	4547	3451	3207	325	122	122	122	162	122	NO	NO	NO	NO	81	41	9	NO	NO	NO	NO
LPG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	46	137	137	144
Other kerosene	389	389	259	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	NO	NO	NO	28	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	20	10
Natural gas	427	584	414	643	693	1090	696	302	298	362	317	269	278	308	405	442	480	381	513	518	606	404	371	385	316
Wood	NO	NO	NO	4	7	7	13	20	20	54	47	46	29	19	47	29	56	72	187	127	187	169	210	208	278
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	3	2	1	3	1	1	NO	NO	1
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	18	72	54	115
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	29	NO	NO	NO	NO	NO	NO
1.A.2.d. Pulp, Paper and Print																									
Total	2956	2827	2562	953	330	326	194	181	142	168	124	176	182	214	213	255	281	217	208	264	260	223	176	200	106
Liquid Fuels	203	162	122	122	41	81	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	3	14	6	NO	6

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Solid Fuels	28	28	28	113	56	56	56	57	28	28	NO	28	28	26	26	26	26	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	2724	2637	2412	653	45	101	118	104	94	100	101	135	134	168	167	202	235	201	201	101	101	101	68	103	97
Biomass	NO	NO	NO	65	188	87	20	20	20	40	23	13	20	20	20	27	20	16	7	163	156	108	102	97	3
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	3	14	6	NO	2
RFO	203	162	122	122	41	81	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	4
Coal	28	28	28	113	56	56	56	57	28	28	NO	28	28	26	26	26	26	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	2724	2637	2412	653	45	101	118	104	94	100	101	135	134	168	167	202	235	201	201	101	101	101	68	103	97
Wood	NO	NO	NO	65	188	87	20	20	20	40	23	13	20	20	20	27	20	16	7	163	156	108	102	97	3
1.A.2.e. Food Processing, Beverages and Tobacco																									
Total	15020	11250	10442	11139	8145	8394	9317	8809	8443	7299	6167	5366	5452	4763	5219	5315	5131	4254	3351	3086	2908	2694	2911	2789	2637
Liquid Fuels	10547	7700	7046	6807	4419	4693	5429	5205	5238	4133	2970	1651	1442	1034	873	912	916	673	420	586	566	376	500	475	378
Solid Fuels	1069	598	655	594	565	309	309	252	168	224	140	140	141	158	105	132	106	79	79	52	52	16	27	25	24
Peat	NO	NO	NO	NO	15	NO	NO	15	15	15	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	3	NO	NO	NO	NO
Gaseous Fuels	3177	2722	2511	3500	2829	3065	3250	3013	2694	2578	2607	2775	2985	2764	3238	3149	3249	2684	2370	1930	1919	1886	1819	1808	1729
Biomass	228	231	230	238	316	327	330	325	328	349	450	800	842	719	916	1034	772	701	394	488	339	360	536	452	477
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	88	88	88	88	117	88	30	29	56	29	29	29
Diesel oil	3229	3229	3102	3229	765	552	510	807	722	552	552	467	340	340	340	297	255	213	212	212	170	85	121	170	152
RFO	7105	4425	3898	3532	3654	4060	4791	4223	4384	3492	1745	975	893	609	406	406	447	329	122	244	285	121	203	81	31
LPG	46	46	46	46	NO	NO	NO	46	46	46	NO	46	46	46	46	46	91	91	46	91	72	91	137	182	160
Jet fuel	NO	NO	NO	NO	NO	NO	43	86	43	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other kerosene	NO	NO	NO	NO	NO	NO	43	43	43	43	43	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	167	NO	NO	NO	NO	42	42	NO	NO	NO	NO	84	84	NO	42	84	84	NO	NO	NO	NO	NO	NO	42	35
Shale oil	NO	NO	NO	NO	NO	39	NO	NO	NO	NO	630	79	79	39	39	79	39	40	40	39	39	79	39	NO	NO
Coal	911	598	655	541	512	256	256	199	142	171	114	114	114	131	105	105	79	79	79	52	52	16	27	25	24
Coke	158	NO	NO	53	53	53	53	53	26	53	26	26	27	27	NO	27	27	NO	NO	NO	NO	NO	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	15	NO	NO	15	15	15	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	3	NO	NO	NO	NO
Natural gas	3177	2722	2511	3500	2829	3065	3250	3013	2694	2578	2607	2775	2985	2764	3238	3149	3249	2684	2370	1930	1919	1886	1819	1808	1729
Wood	228	231	230	238	316	327	330	325	328	349	450	800	842	719	916	1034	772	701	394	483	333	360	535	449	467
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	5	6	NO	1	0	NO
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	3	10
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	88	88	88	88	117	88	30	29	56	29	29	29

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1.A.2.f. Non-metallic minerals																									
Total	9496	5911	5584	2962	3998	4052	3941	3145	3045	3071	2512	2797	3673	3903	3648	4271	4296	4484	4307	2694	4555	5271	5573	5062	5400
Liquid Fuels	3585	1307	1301	1260	3057	2562	2519	2396	1912	2274	1521	482	358	1367	1209	764	920	379	207	293	864	298	291	297	275
Solid Fuels	170	85	114	199	171	114	57	85	28	28	28	28	28	26	26	682	1127	1809	1888	1285	1757	2136	1910	1299	1254
Peat	NO	NO	NO	NO	NO	NO	NO	10	10	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	5734	4513	4163	1476	750	1282	1345	634	1066	698	808	1821	2352	1884	1845	2381	1878	1979	1782	942	1010	977	1280	1344	1353
Biomass	7	6	6	27	20	94	20	20	29	44	61	82	111	184	139	144	169	165	175	100	520	1196	1273	1035	1269
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	26	94	385	824	442	429	300	202	153	255	74	404	664	819	1086	1250
Diesel oil	127	127	42	42	169	84	42	42	85	85	42	42	42	42	42	255	212	127	127	128	237	298	291	297	275
RFO	3289	1137	1259	1218	2842	2436	2477	2354	1827	2071	731	162	NO	NO	NO	41	NO	81	41	NO	NO	NO	NO	NO	NO
LPG	NO	NO	NO	NO	46	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other kerosene	43	43	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	126	NO	NO	NO	NO	42	NO	NO	NO	NO	NO	42	NO	251	NO	NO	42	NO	NO	NO	NO	NO	NO	NO	NO
Petroleum coke	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	198	956	1088	429	627	132	NO	165	627	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	118	748	236	118	118	79	39	39	39	39	NO	NO	NO	NO	NO	NO
Coal	142	85	114	199	171	114	57	85	28	28	28	28	28	26	26	682	1127	1809	1888	1285	1757	2136	1910	1299	1254
Oil shale	28	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	10	10	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	5734	4513	4163	1476	750	1282	1345	634	1066	698	808	1821	2352	1884	1845	2381	1878	1979	1782	942	1010	977	1280	1344	1353
Wood	7	6	6	27	20	94	20	20	29	34	24	12	17	102	50	95	135	139	77	67	10	3	23	NO	NO
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	3
Municipal wastes (biomass fraction)	NO	NO	NO	NO	NO	NO	NO	NO	NO	10	37	70	94	82	89	49	34	26	98	33	510	1193	1250	1035	1266
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	209	586	234	205	175	117	88	117	29	NO	NO	NO	NO	NO
Industrial wastes (used tires)	NO	NO	NO	NO	NO	NO	NO	NO	NO	26	94	176	238	208	224	125	85	65	58	15	84	331	242	379	335
Municipal wastes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	80	30	320	332	577	707	915
1.A.2.g. Other																									
Total	20768	18288	13240	10639	9420	8356	8536	7965	8819	7920	5993	6718	6504	6766	8175	8695	10106	9688	9583	11272	13077	14964	16657	16429	17805
Liquid Fuels	10551	8067	6546	5199	4867	4156	4160	4039	4347	3699	1790	1300	1041	931	1233	1064	1276	1832	1408	1149	967	1477	1695	1667	1436
Solid Fuels	278	171	171	677	623	170	169	56	169	141	84	56	56	52	52	104	130	79	30	26	26	47	27	50	58
Peat	NO	20	10	NO	NO	15	15	NO	NO	NO	NO	NO	NO	NO	10	NO	NO	NO	NO	NO	11	2	2	4	13
Gaseous Fuels	9557	9664	6134	3318	2360	2115	1910	1515	1512	1380	1968	2335	2922	3334	3208	3177	3258	3318	3014	2275	2928	2862	2797	1930	1678
Biomass	382	366	380	1445	1570	1899	2281	2355	2791	2699	2152	2985	2485	2449	3673	4350	5442	4459	5132	7793	9116	10547	12107	12778	14620
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	NO	NO	NO	NO	NO	NO	29	29	29	29	NO	NO
Gasoline	880	220	220	220	132	44	132	88	88	44	44	44	69	44	88	88	88	88	88	44	44	44	44	44	43

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Diesel oil	2039	2081	763	508	593	849	763	891	848	848	848	806	849	805	975	806	1060	1657	1275	1105	863	1301	1559	1529	1278
RFO	7632	5766	5563	4385	4099	3086	3085	2883	3411	2761	813	366	123	82	82	82	82	41	NO	NO	41	41	NO	NO	NO
LPG	NO	NO	NO	NO	NO	91	137	91	NO	46	46	NO	NO	NO	46	46	46	46	45	NO	19	91	92	94	115
Other kerosene	NO	NO	NO	86	43	86	43	86	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	84	NO	NO	42	42	NO	NO	NO	NO	NO	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	39	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	199	171	171	625	597	170	169	56	169	141	84	56	56	52	52	104	130	79	30	26	26	47	27	50	58
Coke	79	NO	NO	52	26	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	NO	15	15	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1	NO	NO	4	3
Peat	NO	20	10	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	10	NO	NO	NO	NO	NO	10	2	2	NO	10
Natural gas	9557	9664	6134	3318	2360	2115	1910	1515	1512	1380	1968	2335	2922	3334	3208	3177	3258	3318	3014	2275	2928	2862	2797	1930	1678
Wood	382	366	380	1445	1570	1899	2281	2355	2791	2699	2152	2985	2485	2449	3673	4350	5442	4459	5132	7793	9115	10547	12051	12776	14620
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1	NO	2	2	NO
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	54	NO	NO
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	NO	NO	NO	NO	NO	NO	29	29	29	29	NO	NO

1.A.4 Other Sectors

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1.A.4 Other Sectors																									
Total	102092	108961	83730	77831	64625	60182	61263	56261	52470	52089	49117	54029	53828	57273	59428	59055	58857	59344	55403	58823	52940	51629	53940	50148	49247
Liquid Fuels	27829	32499	24223	21319	14008	8817	8761	7849	6947	7439	6888	7363	6919	7887	7936	7807	8456	7888	7114	7778	8334	8351	8351	8476	8753
Solid Fuels	22398	19894	15853	13347	9363	5180	5521	4639	3330	2817	2162	2988	2390	2203	2150	2045	1940	1940	1783	1574	2098	1861	983	1075	962
Peat	1128	880	1030	617	515	391	506	357	266	66	41	15	NO	10	NO	20	40	61	31	16	21	32	32	NO	11
Gaseous Fuels	24289	24628	11751	9338	7002	7150	6732	5434	5670	5865	6218	7061	8098	8795	9651	9632	9983	11027	10959	10241	11819	10343	10477	9809	9670
Biomass	26448	31060	30873	33210	33737	38643	39743	37983	36257	35902	33808	36561	36295	38321	39574	39523	38380	38399	35487	39215	30659	31042	34097	30788	29851
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	126	58	117	29	58	29	29	NO	8	NO	NO	NO	NO
Gasoline	1672	176	176	176	352	88	176	176	88	132	264	220	195	220	220	308	352	352	308	308	308	440	395	440	354
Diesel oil	16189	22860	16189	14574	6840	5267	5098	4248	3611	4419	4589	5099	4886	5651	5863	5566	6288	6288	5566	6365	6942	6902	6896	6981	7234
RFO	6415	6292	5318	3897	4507	1664	1990	1706	1340	1218	772	772	569	528	447	527	406	40	80	41	44	5	NO	NO	NO
LPG	2961	2869	2368	2413	2050	1366	1367	1503	1822	1412	1184	1230	1185	1321	1321	1367	1367	1184	1139	1047	1023	1002	1055	1055	1165
Jet fuel	NO	NO	NO	NO	NO	86	43	173	43	130	NO	NO	NO	NO	43	NO	43	24	21	17	17	2	4	NO	NO
Other kerosene	215	302	172	259	259	346	86	43	43	86	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	377	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	42	84	167	42	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	79	NO	NO	NO	NO	39	NO	NO	NO	NO	NO	NO	NO	NO	NO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Coal	22398	19894	15853	13347	9363	5180	5521	4639	3330	2817	2162	2988	2390	2203	2150	2045	1940	1940	1783	1574	2098	1861	983	1075	962
Peat briquettes	836	588	728	527	294	309	355	247	186	46	31	15	NO	NO	NO	NO	NO	1	1	6	1	3	4	NO	1
Peat	292	292	302	90	221	82	150	110	80	20	10	NO	NO	10	NO	20	40	60	30	10	20	29	28	NO	10
Natural gas	24289	24628	11751	9338	7002	7150	6732	5434	5670	5865	6218	7061	8098	8795	9651	9632	9983	11027	10959	10241	11819	10343	10477	9809	9670
Wood	26448	31060	30873	33210	33737	38643	39743	37983	36257	35902	33808	36561	36249	38159	39302	39211	38080	38067	35123	38811	30222	30442	33226	29652	28585
Charcoal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	30	60	30	45	60	60	60	60	59	90	90
Landfill gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	46	162	242	251	259	271	290	314	314	327	326	357	333
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	91	358	523	673
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	11	16	14	29	59	43	38	58	99
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	5	79	90	108	71
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	126	58	117	29	58	29	29	NO	8	NO	NO	NO	NO
1.A.4.a. Commercial/Institutional																									
Total	40346	40142	34150	27786	17464	16517	16581	14795	12297	13125	11356	12366	13179	13856	15142	14292	14964	15997	13248	12578	13329	11772	12744	12526	12018
Liquid Fuels	13453	16642	11910	10556	5308	2890	2758	2459	2017	2346	1715	1928	1818	2207	2167	1860	2289	1902	1596	1586	1619	1397	1859	1939	2129
Solid Fuels	14913	11413	10872	7854	4297	2903	3272	2732	2419	2049	1565	1536	1423	1338	1285	1049	1075	1075	918	735	1023	891	354	519	407
Peat	672	517	620	288	326	114	250	163	71	15	31	15	NO	10	NO	20	40	61	31	16	1	32	32	NO	11
Gaseous Fuels	6090	6408	5466	3579	1903	2328	2271	1805	2175	2536	3054	3347	4103	4278	4680	4598	4851	5676	5679	5415	5623	5055	4952	4477	4401
Biomass	5218	5162	5282	5508	5630	8282	8029	7636	5615	6179	4991	5497	5709	5965	6894	6737	6651	7253	4995	4826	5054	4398	5547	5591	5070
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	126	58	117	29	58	29	29	NO	8	NO	NO	NO	NO
Gasoline	44	44	44	44	220	NO	88	88	44	88	88	77	46	44	44	44	44	44	44	44	44	88	44	88	44
Diesel oil	8116	11515	7436	7478	1529	1189	1147	552	340	935	1020	1190	1317	1530	1657	1275	1700	1657	1360	1393	1418	1251	1713	1755	1924
RFO	4953	4953	4344	2679	3248	1177	1300	1421	1137	974	528	528	325	284	244	365	365	40	80	41	41	2	NO	NO	NO
LPG	46	NO	NO	182	137	91	137	182	410	91	NO	91	46	182	137	137	137	137	91	91	99	54	98	96	161
Jet fuel	NO	NO	NO	NO	NO	86	43	173	43	130	NO	NO	NO	NO	43	NO	43	24	21	17	17	2	4	NO	NO
Other kerosene	43	130	86	173	173	346	43	43	43	86	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	251	NO	NO	NO	NO	NO	NO	NO	NO	42	NO	42	84	167	42	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	79	NO	NO	NO	NO	39	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	14913	11413	10872	7854	4297	2903	3272	2732	2419	2049	1565	1536	1423	1338	1285	1049	1075	1075	918	735	1023	891	354	519	407
Peat briquettes	511	356	449	248	155	62	139	93	31	15	31	15	NO	NO	NO	NO	NO	1	1	6	1	3	4	NO	1
Peat	161	161	171	40	171	52	110	70	40	NO	NO	NO	NO	10	NO	20	40	60	30	10	NO	29	28	NO	10
Natural gas	6090	6408	5466	3579	1903	2328	2271	1805	2175	2536	3054	3347	4103	4278	4680	4598	4851	5676	5679	5415	5623	5055	4952	4477	4401
Wood	5218	5162	5282	5508	5630	8282	8029	7636	5615	6179	4991	5497	5663	5803	6652	6485	6381	6966	4691	4482	4680	3997	5163	5087	4603
Landfill gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	46	162	242	251	259	271	290	314	314	327	326	357	333
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	49	69

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	11	16	14	29	57	43	24	44	53
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	4	31	34	54	12
Waste oils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	42	126	58	117	29	58	29	29	NO	8	NO	NO	NO	NO
1.A.4.b. Residential																									
Total	35751	42489	39047	40790	38562	37659	38588	36043	35336	34027	32851	36298	35666	37702	38261	38948	37955	37271	37067	40809	33561	33797	35117	31228	30846
Liquid Fuels	4908	5671	5003	4010	2848	1402	1272	1363	1454	1406	1443	1441	1441	1398	1443	1577	1621	1438	1393	2025	2237	2229	2236	2237	2283
Solid Fuels	6404	7542	4440	5037	4411	1821	1964	1708	797	683	512	1338	854	787	787	944	813	813	813	813	1049	944	577	530	531
Peat	425	332	379	258	144	252	241	179	195	51	10	NO	NO	NO	NO	NO	NO	NO	NO	NO	20	NO	NO	NO	NO
Gaseous Fuels	4004	4275	4905	5089	4359	4181	3762	3063	2896	2829	2659	3001	3293	3667	3958	4193	4326	4587	4693	4304	5219	4480	4481	4266	4252
Biomass	20010	24669	24320	26396	26800	30003	31349	29730	29994	29058	28227	30518	30078	31850	32073	32234	31195	30433	30168	33667	25036	26144	27823	24195	23780
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gasoline	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	132	132	132	132	132	220	264	264	264	264	264	264	263	264	264
Diesel oil	1912	2762	2592	1827	892	127	42	42	42	85	127	170	170	127	127	127	127	127	127	850	1062	1062	1062	1062	1062
RFO	41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	2869	2823	2368	2140	1913	1275	1230	1321	1412	1321	1184	1139	1139	1139	1184	1230	1230	1047	1002	911	911	903	911	911	957
Other kerosene	86	86	43	43	43	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	6404	7542	4440	5037	4411	1821	1964	1708	797	683	512	1338	854	787	787	944	813	813	813	813	1049	944	577	530	531
Peat briquettes	294	201	248	248	124	232	201	139	155	31	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	131	131	131	10	20	20	40	40	40	20	10	NO	NO	NO	NO	NO	NO	NO	NO	NO	20	NO	NO	NO	NO
Natural gas	4004	4275	4905	5089	4359	4181	3762	3063	2896	2829	2659	3001	3293	3667	3958	4193	4326	4587	4693	4304	5219	4480	4481	4266	4252
Wood	20010	24669	24320	26396	26800	30003	31349	29730	29994	29058	28227	30518	30078	31850	32043	32174	31165	30388	30108	33607	24974	26084	27764	24105	23690
Charcoal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	30	60	30	45	60	60	60	60	59	90	90
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	2	NO	NO	NO	NO
1.A.4.c. Agriculture/Forestry/Fisheries																									
Total	25995	26331	10533	9255	8599	6005	6094	5424	4837	4937	4910	5365	4983	5716	6025	5815	5938	6077	5088	5436	6050	6059	6079	6394	6383
Liquid Fuels	9468	10186	7310	6752	5852	4526	4731	4027	3476	3687	3730	3994	3660	4282	4326	4370	4546	4548	4125	4167	4478	4725	4255	4300	4341
Solid Fuels	1081	939	541	456	655	456	285	199	114	85	85	113	113	78	78	52	52	52	52	26	26	26	52	26	24
Peat	31	31	31	71	45	25	15	15	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	14195	13945	1380	670	739	641	699	566	599	500	505	712	702	850	1014	841	806	764	587	521	977	808	1044	1066	1017
Biomass	1220	1229	1271	1306	1307	358	365	617	648	665	590	546	508	506	607	552	534	713	324	722	569	500	727	1002	1001
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gasoline	1628	132	132	132	132	88	88	88	44	44	44	11	17	44	44	44	44	44	NO	NO	NO	88	88	88	46
Diesel oil	6161	8583	6161	5269	4419	3951	3909	3654	3229	3399	3442	3739	3399	3994	4079	4164	4461	4504	4079	4122	4462	4589	4121	4164	4248
RFO	1421	1339	974	1217	1258	487	691	285	203	244	244	244	244	244	203	162	41	NO	NO	NO	3	3	NO	NO	NO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
LPG	46	46	NO	91	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	46	45	13	45	46	48	47
Other kerosene	86	86	43	43	43	NO	43	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	126	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	1081	939	541	456	655	456	285	199	114	85	85	113	113	78	78	52	52	52	52	26	26	26	52	26	24
Peat briquettes	31	31	31	31	15	15	15	15	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	40	30	10	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	14195	13945	1380	670	739	641	699	566	599	500	505	712	702	850	1014	841	806	764	587	521	977	808	1044	1066	1017
Wood	1220	1229	1271	1306	1307	358	365	617	648	665	590	546	508	506	607	552	534	713	324	722	568	361	299	460	292
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	91	358	474	604
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	14	14	46
Biodiesel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1	48	56	54	59

1.A.5 Other

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1.A.5 Other (Not elsewhere specified)																									
Total	NO	NO	NO	NO	NO	NO	3	1	3	2	2	2	94	84	131	104	103	39	47	73	107	98	100	88	128
Liquid Fuels	NO	NO	NO	NO	NO	NO	3	1	3	2	2	2	94	84	131	104	103	39	47	73	107	98	100	88	128
Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gaseous Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Biomass	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other Fossil Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gasoline	NO	NO	NO	NO	NO	NO	3	1	3	2	2	2	2	2	3	2	6	1	5	1	0	NO	NO	NO	NO
Diesel oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	75	65	111	77	73	14	21	49	87	80	79	63	105
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	17	17	17	24	24	24	21	23	20	18	21	24	23

Energy losses, statistical differences, transfers and secondary production of products in Energy sector, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Statistical differences																									
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1102	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gasoline	NO	NO	NO	NO	NO	NO	NO	NO	NO	6380	2508	2464	2948	747	528	264	440	NO	NO	132	835	883	510	309	352

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	346	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel	NO	NO	NO	255	2082	2719	425	1360	1232	2209	5141	1785	3569	3909	3782	4589	5949	5355	4334	7649	9634	5781	1360	2228	383
RFO	NO	1177	162	41	NO	NO	NO	NO	NO	650	974	NO	1421	325	284	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid fuels	167	122	122	81	84	42	126	167	126	42	42	42	NO	84	42	42	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	101	438	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	275	NO
Transfer																									
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	669	1102	826	79	NO	NO	NO	NO	NO
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	2636	4623	43	NO	NO	NO	NO	NO	NO	NO	NO
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	130	86	43	129	216	NO	NO	NO	NO	NO	NO
Diesel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	340	127	127	212	NO	NO	NO	NO	NO	NO
RFO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	8120	11815	853	1218	893	122	NO	NO	NO	NO	NO
Other liquid fuels	167	122	122	81	84	42	126	167	126	42	42	42	NO	84	42	42	42	42	42	42	NO	NO	NO	NO	NO
Losses																									
LPG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	46	46	46	46	46	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Diesel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	127	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gasoline	44	44	44	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	114	114	114	57	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	26	NO	NO	NO	NO	1	NO
Peat	70	20	10	30	NO	NO	NO	NO	10	10	60	NO	NO	241	10	NO	NO	NO	40	10	60	NO	NO	20	NO
Natural gas	136	1625	1481	1434	1004	977	999	1032	1032	999	673	472	572	740	536	167	268	335	336	639	269	505	505	275	588
Secondary Production																									
Other liquid fuels	NO	NO	NO	NO	NO	NO	1088	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other fossil fuels	42	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	419	292	88	292	205	234	263	88	66	29	29	29	29

A.3.2. Energy Detailed discussion of methodology and data for estimating CO2 emissions from fossil fuel combustion

Guidance manual for CO_2 emission estimations

(Developed in accordance with UNFCCC and IPCC recommendations and physical characteristics of fuels used in Latvia)

V.Bergmanis

Riga 2004

Annotation

The report is done in accordance with conditions of contract No. 15 of 17 May 2004. Guidance manual of CO_2 emissions from stationary fuel combustion installations estimations is developed in accordance to requirements from IPCC Guidelines. It means that according to developed guidance, CO_2 emissions from every object could be determined using physical characteristics of combusted fuel and amount of consumed fuel. In case such physical characteristics are not available, average estimated data for types of fuels used in Latvia could be used (Table 1).

Following additional information are given:

capacity of combustion installations,

particle content of fuel,

concept of heat of combustion and use of it in estimations

discretion in composition of thermal balance of combustion installation that provide better understanding of combustion installations operations and processes that generate CO_2 emissions.

The report is developed to help enterprises that operate with combustion installations, Regional Environmental Boards (REB) and environment experts calculate CO_2 emission from stationary fuel combustion.

Introduction

Guidance for practical determination of CO_2 emission factors in the case of:

combusted type of fuel and physical qualities of it;

combusted amount of fuel,

is developed for enterprises to fulfil the requirements of national legislation (Cabinet of Ministers Regulations "About taxes of natural resources" and Cabinet of Ministers Regulation No. 555).

Stationary combustion installations are divided in:

boiler units – generation of electricity and heat for public utilities;

technological equipment combustion installations that are divided in:

installations where flue gases directly do not collide with produced products (mainly food industry – bread baking, malt drying;

Installations where flue gases directly collide with produced products (construction materials and metal production).

In point 1 and 2.1 mentioned installations emission thresholds of noxious products are determined and guidance of CO_2 emission estimations could be used. In other cases technological specific of production should be taken into account.

Mathematical expression of CO_2 emission determination given in first chapter is used in specified calculation using data from fuel certificates and combusted amount of fuels. In cases when data from fuel certificates are not available (carbon content and net calorific value of fuel), CO_2 emission factors (Table 1) that are estimated using mathematical expression, IPCC Guidelines and average values of physical qualities of fuels used in Latvia are used.

In CO_2 emission determination it is assumed that all carbon stored in fuel transforms into CO_2 in combustion process. Practically part of carbon (depends on type of fuel, type of furnaces, maintenance conditions of boiler units) doesn't burn fully and forms CO that transforms into CO_2 in length of time (approximately 48 h).

Consequently enterprise operating combustion installation and permit chemically incomplete combustion (q_3) has to consume bigger amount of fuel to obtain necessary amount if heat and therefore bigger amount of CO_2 is generated.

Part of fuel did not participate in combustion processes. This part is composed by non-combusted fuel (carbon) that is discharged from combustion installation with ashes, slag and soot. Non-combusted part of fuel is accounted as mechanically incomplete combustion losses q_4 in thermal balance of combustion installation. These loses are rather big if solid fuels – coal, peat, are combusted (ashes, slag), smaller – if liquid fuels are combusted (soot) and minimal – if gaseous fuels are combusted. For gaseous fuels q_4 is technological losses (maintenance of installations and safe work requirements provision) that are gas-fittings leakage in units processes to avoid possible explosions. In leakage process other greenhouse effect gas – methane, is emitted to atmosphere.

Brief discretion in particle content of organic fuel, relevance between fuel working, dry and combusted volumes, gross and net calorific values and suggestions in what cases previously mentioned relevancies could be used in estimations are given in the report.

1. CO_2 emission estimations for combusted organic fuels (guidance manual)

In combustion of organic fuels process carbon (C) in fuel connects with air oxygen as a result carbon dioxide (CO_2) is made. In case of chemically incomplete combustion also carbon monoxide (CO) is made that in approximately 48 h time connects with air oxygen and transforms in CO_2.

To estimate CO_2 emissions, it is necessary to know:

- combusted type of fuel;
- amount of combusted fuel B_n;
- carbon content (C^d %) in working mass of fuel;
- net calorific values of working mass of fuel (Q_z^d, MJ/kg (m^3)).

Easier way to estimate CO_2 emissions is to calculate emission factor (E) and consumed amount of fuel (B_q) marked in heat amount units (MJ, GJ, TJ…. / time period). For E and B_q estimation necessary data is collected from fuel certificates (Quality note) or analyse data and accounting of combusted fuels.

For emission factor calculation following relevance is used:

$$EF_{CO_2} = \frac{C^d \times M_{CO_2} \times 1000}{Q_z^d \times M_C \times 100} = \frac{C^d}{Q_z^d} \times 36{,}6413$$

where:

EF_{CO2} – emission factor for CO_2 (kg CO_2/MJ)
Q_z^d – net calorific value of fuel (MJ/kg (m^3))
C^d – carbon content in fuel (%)
MCO_2 – molecule weight for CO_2 – 44, 0098 (g/mcl)
Mc – molecule weight for C – 12,011 (g/mcl)
1000 – switching from MJ to GJ
100 – percentage determination

Heat amount generated into furnaces with fuel is estimated:

$$B_q = B_n \times Q_z^d$$

where:

Bn – consumption of fuel in natural units in time period, tn (10^3 m^3)
CO_2 emissions in time period are estimated:

$$CO_2 = E_{CO_2} \times B_q$$

where:

CO_2 – estimated emissions, kg (t)
E_{CO2} – calculated emission factor, kg/GJ (t/TJ)
B_q - heat amount generated into furnaces with fuel, GJ (TJ)

Practically all amount of fuel input in furnaces doesn't take part in combustion process. Part of non-combusted fuels is discharged from furnace with ashes, soot and slag. These are so-called mechanically incomplete combustion losses. That's why oxidation factor p has to be taken into account in CO_2 emission estimations.

Oxidation factor:

$$p = \frac{100 - q_4}{100}$$

Practically CO_2 emissions:

$$E'_{CO_2} = E_{CO_2} p$$

If data from fuel certificates are not available, average data summarized in Table 1 could be used in CO_2 emission estimations. Data reported in table are estimated by using average data from fuel certificates of fuels used in Latvia and suggestions from IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.

Table 1 Carbon content in organic fuels working masses, net calorific values and CO_2 emission factor

Type of fuel	Carbon content C^d %	NCV (Q_z^d) MJ/kg	Emission factor without oxidation factor (E CO_2) kg/GJ	Oxidation factor (p)	Emission factor with oxidation factor (EF CO_2) kg/GJ
Wood, W^d = 55%	20.11	6.70*	109.98	0.98	**107.78**
Peat, W^d = 40%	29.07	10.05	105.98	0.98**	**103.87**
Residual fuel oil	85.72	40.60	77.36	0.99	**76.59**
Gasoline (used in offroads***)	93.13	44 (1990-2001) 43.97 (2003-2014)	88.75 87.36	0.99	**68.53** **68.58**
Diesel oil, liquid oven fuel	86.68	42.49	74.75	0.99	**74.00**
Natural gas	Changes annually; see Chapter 3.2.4.2			0.995	**Changes annually**
LPG	77.99	45.54	62.75	0.995	**62.44**
Shale oil	82.82	39.35	77.12	0.99	**76.35**
Other kerosene	85.17	43.20 (1990-2000) 43.21 (2004) 43.2 (2005-2014)	72.24 72.22	0.99	**71.52** **71.50**
Jet fuel	85.18	43.2 (1990-2002) 43.21 (2003-2014)	72.25 72.23	0.99	**71.53** **71.51**

* for wood – Q_z^d ir TJ/1000m^3

** natural gas – Q_z^d is MJ/m^3

**** off roads – vehicles not involved in traffic, for example, asphalt pavers, and other commercial and household technological equipment, for example, grass rollers

Emission factor values (E^nCO_2) that are determined for natural unit of consumed amount of fuel – t, (1000 m^3) could be used equally in CO_2 emission estimations. These values are reported in Table 2.

Table 2 CO_2 emission factors for natural units of organic fuel

Type of fuel	E^nCO_2, kg/t (1000 m^3)
Wood, W^d = 55%	722
Peat, W^d = 40%	1044
Residual fuel oil	3110
Diesel oil, liquid oven fuel	3144
Motor gasoline (for off-roads)	3016
Natural gas	1879
LPG	2844
Shale oil	2968
Other kerosene	3090
Jet fuel	3089

Following relevance for very approximate (control) CO_2 emission estimations could be used:

$$E_k \approx \frac{B_n \times C^d \times M_{CO_2}}{M_C \times 100} \approx B_n \times C^d \times 0{,}0366413$$

where:
B_n – consumed natural units amount of fuels, t (1000 m^3)
C^d – carbon content in working mass of fuel, %

Note: CO_2 emissions of renewable energy resources are not estimated. Emission factors given in Table 1.1 and Table 1.2 could be used as comparative values.

4. Explanation and suggestions

1. In IPCC methodology it is determined that in each country all available data have to be used in estimation of CO_2 emission factors for different fuel types and only when these data aren't available data from methodology could be used. It was taken into account when CO_2 emission factors for fuels used in Latvia were estimated.

2. Country's average CO_2 emission factors are estimated using actual data of fuel consumption and types [L1 chapter 1.2.1]. These data are obtained by Central Statistical Bureau of Latvia. Also in L1 it is stated that only part of fuel consumption used for acquisition of Energy has to be taken into account instead of the part that is used in technological processes. In the same chapter it is stated that amount of all combusted fuel types has to be estimated by using the same output measures. In the energy balance prepared by Central Statistical Bureau fuel consumption is estimated by using net calorific value of working volume of each particular type of fuel Q_z^d, but for natural gas – gross calorific value Q_a (it is recommendation of EUROSTAT). It has to be taken into account in estimation of total country's CO_2 emissions.

3. In total amount of CO_2 emissions leakage of gas (ventilation and technological losses) in the extraction fields of coal-gas aren't taken into account. It is referable to the exploitation

of natural gas utilization equipment. Oxidation coefficient for the gaseous fuels is used in the estimation of CO_2 emissions. Leakage of gas is accounted as fugitive CH_4 emissions.

5. In cases if net calorific values of fuels Q_z^d aren't available but only Q_a data it is possible to use average values in the estimation [L1]:

for liquid and solid fuels $Q_z^d \sim 0,95\ Q_a$

for gaseous fuels $Q_z^d \sim 0,9\ Q$

A.3.3. Energy: CO_2 reference approach and comparison with sectoral approach

Table 1 Reference Approach estimations (TABLE 1.A(b))

TABLE 1.A(b) SECTORAL BACKGROUND DATA FOR ENERGY

CO_2 from fuel combustion activities - reference approach (IPCC worksheet fuel combustion activities)

(Sheet 1 of 1)

FUEL TYPES			Unit	Production	Imports	Exports	International bunkers	Stock change	Apparent consumption	Conversion factor (TJ/Unit)[1]	NCV/ GCV (2)	Apparent consumption (TJ)	Carbon emission factor (t C/TJ)	Carbon content (kt)	Carbon stored[C excluded] (kt C)	Net carbon emissions ((kt) C)	Fraction of carbon oxidized	Actual CO_2 emissions ((kt) CO_2)
Liquid fossil	Primary fuels	Crude oil	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Orimulsion	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Natural gas liquids	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
	Secondary fuels	Gasoline	TJ		9491.00	912.00	NO	-791.00	9370.00	1.00	NCV	9370.00	18.91	177.15	NO	177.15	0.99	643.05
		Jet kerosene	TJ		4796.00	173.00	4580.00	NO	43.00	1.00	NCV	43.00	19.71	0.85	NO	0.85	0.99	3.08
		Other kerosene	TJ		43.00	43.00	NO	NO	0.00	1.00	NCV	0.00	NO	NO	NO	NO	NO	NO
		Shale oil	TJ		79.00	79.00		NO	0.00	1.00	NCV	0.00	NO	NO	NO	NO	NO	NO
		Gas/diesel oil	TJ		58254.00	25027.00	2932.00	-4122.00	34417.00	1.00	NCV	34417.00	20.40	702.11	NO	702.11	0.99	2548.66
		Residual fuel oil	TJ		6821.00	487.00	6780.00	-487.00	41.00	1.00	NCV	41.00	21.11	0.87	NO	0.87	0.99	3.14
		Liquefied petroleum gases (LPG)	TJ		8971.00	4645.00		91.00	4235.00	1.00	NCV	4235.00	17.13	72.53	NO	72.53	1.00	264.60
		Ethane	TJ		NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Naphtha	TJ		NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Bitumen	TJ		3014.00	NO		84.00	2930.00	1.00	NCV	2930.00	22.00	64.46	69.98	-5.52	0.99	-20.04
		Lubricants	TJ		1426.00	836.00	NO	-42.00	632.00	1.00	NCV	632.00	20.00	12.64	1.00	11.64	1.00	42.70
		Petroleum coke	TJ		NO	NO		NO	NO	1.00	NCV	NO	NO	NO	NO	NO	NO	NO
		Refinery feedstocks	TJ		NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Other oil	TJ		3259.00	2805.00		42.00	412.00	1.00	NCV	412.00	20.00	8.24	NO	8.24	1.00	30.21
Other liquid fossil												NO		NO	NO	NO		NO
Liquid fossil totals												52080.00		1038.84	70.98	967.86		3515.40

FUEL TYPES			Unit	Production	Imports	Exports	International bunkers	Stock change	Apparent consumption	Conversion factor (TJ/Unit)[1]	NCV/ GCV (2)	Apparent consumption (TJ)	Carbon emission factor (t C/TJ)	Carbon content (kt)	Carbon stored[C excluded] (kt C)	Net carbon emissions ((kt) C)	Fraction of carbon oxidized	Actual CO_2 emissions ((kt) CO_2)
Solid fossil	Primary fuels	Anthracite(3)	TJ	NO	NO	NO		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
		Coking coal	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Other bituminous coal	TJ	NO	2061.00	145.00	NO	-557.00	2473.00	1.00	NCV	2473.00	25.80	63.80	NO	63.80	1.00	233.95
		Sub-bituminous coal	TJ	NO	NO	NO	NO	NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Lignite	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Oil shale and tar sand	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
	Secondary fuels	BKB(4) and patent fuel	TJ		NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Coke oven/gas coke	TJ		NO	NO		NO	NO	1.00	NCV	NO	NO	NO	NO	NO	NO	NO
		Coal tar	TJ		NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
Other solid fossil												NO		NO	NO	NO		NO
Solid fossil totals												2473.00		63.80	NO	63.80		233.95
Gaseous fossil		Natural gas (dry)	TJ	NO	32733.00	NO		-12653.00	45386.00	1.00	NCV	45386.00	14.88	675.47	NO	675.47	1.00	2464.34
Other gaseous fossil												NO		NO	NO	NO		NO
Gaseous fossil totals												45386.00		675.47	NO	675.47		2464.34
Waste (non-biomass fraction)			TJ	NO	IE	IE	NO	IE	NO,IE	IE	NCV	NO,IE	IE	NO,IE	IE	NO,IE	IE	NO,IE
Other fossil fuels												1294.04		16.02	NO	16.02		58.75
		Industrial waste	TJ	NO	342.70	NO		-7.54	350.24	1.00	NCV	350.24	16.53	5.79	NO	5.79	1.00	21.23
		Municipal waste	TJ	NO	929.15	11.15		3.19	914.81	1.00	NCV	914.81	10.55	9.65	NO	9.65	1.00	35.39
		Waste oils	TJ	29.00	NO	NO		NO	29.00	1.00	NCV	29.00	20.00	0.58	NO	0.58	1.00	2.13
Peat(5,6)			TJ	50.00	NO	NO	NO	15.00	35.00	1.00	NCV	35.00	28.59	1.00	NO	1.00	0.98	3.60
Total												101268.04		1795.14	70.98	1724.16		6276.03
Biomass total												60963.71		1748.31	NO	1748.31		6287.68
		Solid biomass	TJ	85666.00	2514.00	30678.00		1782.00	55720.00	1.00	NCV	55720.00	30.01	1672.31	NO	1672.31	0.98	6009.78
		Liquid biomass	TJ	2788.10	637.89	2465.24		-35.68	996.43	1.00	NCV	996.43	19.30	19.23	NO	19.23	1.00	70.51
		Gas biomass	TJ	2974.83	NO	NO		NO	2974.83	1.00	NCV	2974.83	13.95	41.51	NO	41.51	1.00	151.44
		Other non-fossil fuels (biogenic waste)	TJ	NO	1286.86	13.86		0.55	1272.45	1.00	NCV	1272.45	11.99	15.26	NO	15.26	1.00	55.95

Table 2 Comparison of CO_2 emissions from fuel combustion (1.A(c))

TABLE 1.A(c) COMPARISON OF CO_2 EMISSIONS FROM FUEL COMBUSTION
Comparison of CO_2 emissions from fuel combustion
(Sheet 1 of 1)

Inventory 2014
Submission 2016 v3
LATVIA

FUEL TYPES	REFERENCE APPROACH			SECTORAL APPROACH(1)		DIFFERENCE(2)	
	Apparent energy consumption(3) (PJ)	Apparent energy consumption (excluding non-energy use, reductants and feedstocks) (4) (PJ)	CO_2 emissions (kt)	Energy consumption (PJ)	CO_2 emissions(5) (kt)	Energy consumption (%)	CO_2 emissions(6) (%)
Liquid fuels (excluding international bunkers)	52.08	48.14	3515.40	51.30	3721.72	-6.16	-5.54
Solid fuels (excluding international bunkers)	2.47	2.47	233.95	2.47	233.95	-0.01	0.00
Gaseous fuels	45.39	45.39	2464.34	44.80	2430.72	1.31	1.38
Other fossil fuels	1.29	1.29	58.75	1.28	109.70	1.20	-46.44
Peat	0.04	0.04	3.60	0.03	3.59	0.42	0.20
Total(5)	101.27	97.33	6276.03	99.88	6499.67	-2.56	-3.44

A.3.4. Fugitive emissions

METHODOLOGY FOR CALCULATION OF TECHNOLOGICAL LOSSES OF NATURAL GAS IN INČUKALNS UNDERGROUND GAS STORAGE FACILITY (IUGSF)

In order to calculate losses of natural gas, it is necessary to determine the territory where it is stored. Inčukalns Underground Gas Storage Facility (IUGSF) consists of underground geological formations where natural gas is stored, underground and surface technological equipment with whose assistance gas from the Transport (Main) pipeline is injected into the "gas-bearing" underground layer and received from it. IUGSF border with the Transport (Main) pipeline system is the IUGSF access node to the Transport (Main) pipeline system.

In many cases calculation of technological losses of natural gas are grounded with the gas loss standards. These standards are determined based on the normative technical documentation that is related to the technical equipment at the respective time.

Technological losses of natural gas are calculated in standard conditions: gas temperature 200C, pressure 760 mm Hg. Quantities used in the calculations are obtained based on the current technological equipment and as a result of practical measurements.

In general, the amount of technological losses of natural gas depends on the technical condition of gas system.

1. Calculation of natural gas losses with gas release into the atmosphere without burning it:

1.1. Purging technological pipelines, connective pipelines with gas in order to clear them from hydrate formations, oil, mud and water.

In order to clear technological pipelines, connective pipelines from hydrate formations, oil, mud and water, it is necessary to purge them with gas. This operation is done at the gas collection points (GCP) by conveying gas into the Transport (Main) gas pipeline system.

Nonetheless, sometimes in practice it is necessary to release gas into the atmosphere because of technical and technological reasons. In these cases losses of natural gas are calculated using the following formula:

$$Q_{gas} = 0.0307 \frac{(p_a + p_g) F \tau}{\rho \sqrt{273.15 + t_g}}$$ (m^3) where

P_a– atmospheric pressure, MPa;
P_g– gas pressure in technological pipelines, connective pipeline, MPa;
F– area of gas release opening, mm^2;
τ– gas leak time, s;
ρ– gas density in standard conditions, km/m^3(0.685 km/m^3);
t_g– gas temperature, 0C.

1.2. Releasing condensate collectors, contactors, separators, filter-separators and filters form condensate.

Amount of natural gas losses that occurs when removing condensate from condensate collectors, contactors, separators, filter separators and filters is determined by the amount of condensate in which gas has dissolved and additional amount of gas removed from the equipment.

Total amount of gas losses that occurs when releasing condensate collectors, contactors, separators, filter separators and filters from condensate are calculated using the following formula:

$$Q_{gas} = 1692 \frac{p_a + p_g}{273.15 + t_g} V_k + 0.133F \frac{p_a + p_g}{Z(273.15 + t_g)} \tau \text{ m}^3 \text{ where}$$

Q_{gas}– losses of natural gas occurred when releasing condensate collectors, contactors, separators, filter-separators and filters form condensate, m^3 ;
P_a – atmospheric pressure, MPa (0.1 MPa);
P_g– gas pressure in condensate collector, contactor, separator, filter-separator, filter, MPa;
F – area of gas release opening, $mm^{2;}$
t_g– gas temperature, ^0C;
V_k– amount of removed condensate, m^3 ;
τ– condensate release time, s;
Z – gas compressibility factor (in condensate collector, contactor, separator, filter-separator, filter).

1.3. Starting gas motor compressor.

Amount of natural gas losses that occurs when starting motor compressor is determined by the consumed amount of natural gas. For starter motor that spins engine crankshaft with gas. To spin auxiliary turbines that spin basic turbines with gas in order to ensure air supply in cylinders. For operation of oil pump with gas in order to ensure oiling of compressor during the time of its launch.

1.3.1. Amount of natural gas consumed for starter motor that spins crankshaft:

$$Q_{gas_{st.}} = 0.0307 \frac{(p_a + p_g) F \tau}{\rho \sqrt{273.15 + t_g}} \text{ (m}^3\text{)}.$$

P_a– atmospheric pressure, MPa;
P_g– pressure of natural gas to spin starter motor P_g= 1.8 MPa
F– area of gas release opening, mm^2;
τ– gas leak time, s;
ρ– gas density in standard conditions, km/m^3(0.685 km/m^3);
t_g– gas temperature, 0C.

1.3.2. Amount of natural gas consumed to start auxiliary turbines that are spun with gas by the basic turbines in order to ensure air supply in cylinders is calculated with the following formula (1).

Calculations are similar to the paragraph 1.3.1. Differences are the following:

Natural gas pressure, Pg = 0.15 MPa ; Cross-section area thought which gas flows out.

1.3.3. Amount of natural gas consumed to operate oil pumps is calculated with the following formula (1).

Calculations are similar to the paragraph 1.3. Gas pressure, Pg= 0.3 MPa ;

Total amount of natural gas consumed to start motor compressor $Q_{tostartcompr.}$ is calculated by summarizing natural gas consumption paragraphs 1.3:

$$Q_{tostartcompr.} = Q_{gastostart} + Q_{gasinaddturb.} + Q_{gasoilp.} \text{ (m}^3\text{)}.$$

1.4. Releasing gas motor compressor and gas air cooling equipment from gas.

Losses of natural gas occur at the end of injection period when gas motor compressors and air cooling equipment is released from gas (end of October, beginning of November) when operation of previously mentioned equipment is stopped and released from gas.

Amount of natural gas losses that occurs in the process when motor compressors and gas air cooling equipment is released from gas is calculated with the following formula:

$$Q_{rel.} = V \frac{P_{equip} T_{st.}}{P_{st} T_{equip} Z} \ (m^3) \text{ where}$$

Q_{rel}– natural gas losses that occur when fully releasing gas pipelines and equipment from gas, m^3;
V – internal geometric volume of pipelines and equipment, m^3;
T_{st}– temperature of natural gas in standard conditions, K;
T_{equip}– temperature of natural gas in pipelines and equipment, K ;
P_{equip} – absolute pressure of natural gas in gas pipelines and equipment, MPa ;
P_{st} – absolute pressure of natural gas in standard conditions. MPa (≈0.1MPa) ;
Z – compressibility factor of natural gas at pressure P_{equip} and temperature T_{equip}.

1.5. Releasing condensate collectors, contactors, separator, filter-separators and filters from gas.

In order to perform maintenance and examination of the mentioned equipment, equipment must be released from gas. When calculating amounts of natural gas, previously mentioned equipment can be divided into two groups - equipment that is related to the compressor facility, equipment that is related to gas collections points.

1.5.1. Calculation of natural gas losses for gas purification equipment that is related to the compressor facility.

Those are the following - dust receivers (3 pieces), filter-separators (3 pieces).

Amount of natural gas losses that occurs when releasing equipment from gas is calculated using the following formula:

$$Q_{rel.} = V \frac{P_{equip} \cdot T_{st.}}{P_{st} T_{equip} \cdot Z} (\mathrm{m}^3).$$

Q_{rel}– natural gas losses that occur when fully releasing gas pipelines and equipment from gas, m^3;
V – internal geometric volume of pipelines and equipment, m^3;
T_{st}– temperature of natural gas in standard conditions, K;
T_{equip}– temperature of natural gas in pipelines and equipment, K ; $T=10^0C$
P_{equip} – absolute pressure of natural gas in gas pipelines and equipment, MPa ; P_{equip}=4.0 MPa
P_{st} – absolute pressure of natural gas in standard conditions. MPa (≈0.1MPa) ;
Z – compressibility factor of natural gas at pressure P_{equip} and temperature T_{equip}. Z=0.92

1.5.2. Calculation of natural gas losses for gas purification equipment that is related to gas collection points (GCP).

GCP-1 -Condensate collectors (12 pieces), contactors (12 pieces).

GCP-2 - First degree separators (9 pieces), first degree gas separators (10 pieces), second degree gas separators (5 pieces).

GCP-3 -First degree separators (14 pieces), first degree separators (16 pieces), second degree gas separators (8 pieces).

Decrease of gas pressure in gas purification equipment that is related to gas collection points is done by burning gas through "candle". It is practically equal with internal geometric volume of equipment and is calculated with the following formula:

$$Q_{rel.} = V_{equip.}(m^3).$$

By observing volume of circuits and frequency of maintenance, permissible loss of natural gas for the previously mentioned equipment.

1.6. Partial decrease of gas pressure in pipelines and equipment.

Partial decrease of gas pressure in gas pipelines and equipment is done according to the requirements of safety rules related to gas pressure in gas pipelines and equipment – if repair works are carried out nearby, decreasing gas pressure in them. Amount of natural gas losses that occurs when partly decreasing gas pressure in gas pipelines and equipment is calculated using the following formula:

$$Q_{red.} = \frac{VT_{st.}}{P_{st.}T_g}\left(\frac{P_{abs.}}{Z_{abs.}} - \frac{P_{atl.}}{Z_{atl.}}\right)(m^3)$$ where:

Q_{red}– natural gas losses that occur when partly decreasing gas pressure in pipelines and equipment, m^3;
V – internal geometric volume of gas pipeline (equipment) in which gas pressure is decreased, m^3;
T_{st}– temperature of natural gas in standard conditions, K;
P_{st}– pressure of natural gas in standard conditions, MPa ;
T_g– temperature of natural gas in pipeline (equipment), K ;
P_{abs}– pressure of natural gas in pipeline (equipment) before it is decreased, MPa ;
Z_{abs}– compressibility factor of natural gas at gas pressure P_{abs} and temperature T_g
P_{atl}– pressure of natural gas in pipeline (equipment) after it is decreased, MPa ;
Z_{atl}– compressibility factor of natural gas at gas pressure P_{atl} and temperature T_g.

1.7. Releasing air from gas separators, filter-separators, dust receivers, contact lines, connective pipelines (gas purification equipment, system).

When filling gas pipelines and equipment with gas, certain amount of gas – air mixture is released. Gas pipelines and equipment is filled with gas under low gas pressure. When carrying out these operations, losses of natural gas are calculated using the following formula:

$$Q_{mixture} = 2V(m^3)$$ where:

$Q_{mixture}$– losses of natural gas that occur when releasing separators, dust receivers, contractor lines, connective pipeline from air, m^3;
V – internal geometric volumes of separators, filter-separators, dust receivers, contractor lines, connective pipelines, m^3;

1.8. Examinations of safety drain valves.

In order to examine operation of safety drain valves, they are examined. Amount of natural gas losses that occurs when carrying out examinations of safety drain valves is calculated using the following formula:

$$Q_{s.v.} = \frac{BF_{s.v.}\tau P_m n}{TZ} + C_k$$ where:

$Q_{s.v.}$ – losses of natural gas that occur when carrying out examination of safety drain valves, m^3;
B – factor 9.16 ;
$F_{s.v.}$ – cross-section area of safety drain valve mounting, cm^2 ;
τ– time of safety leak valve actuation, s ;
P_m– pressure of natural gas, kgf/cm^2;
n – number of safety drain valve actuations (examinations);
T – temperature of natural gas, K ;
Z – compressibility factor of natural gas ;
C_k– factor (pressure of natural gas at the safety drain valve actuation exceeding: setting pressure of actuation, C_k =1.65; at the safety drain valve manual actuation, C_k =3.2).

1.9. Closing and opening of valving.

Part of the valving has a pneumatic actuator that is operated with gas. After the opening or closing (maneuver) of valving, natural gas from the pneumatic actuator is released into the atmosphere. Amount of natural gas losses occurred by opening or closing of the valving is calculated using the following formula:

$Q_n = Gn$ where:

Q_n- losses of natural gas occurred when opening or closing the valving (shift, day, month, quarter, year), m^3 ;
G – consumption of natural gas that occurred when carrying out one maneuver of valving (opening or closing), m^3;
n – number of valving maneuvers (opening or closing).

1.10 Geophysical research (neutron-gamma logging).

When carrying out geophysical research (borehole neutron-gamma logging), radioactive element with a wire is let into a borehole with a special auxiliary device that is installed on the fountain fitting of the borehole. Gradually radioactive element is moved upwards and geophysical research of borehole is carried out. Amount of natural gas losses that occur when carrying out research (neutron-gamma logging of borehole) is calculated with the following formula:

$$Q_{gas} = 106\frac{(p_a + p_g)F\tau}{\rho\sqrt{273.15 + t_g}}$$ m^3at $(p_a + p_g)/\ p_a \geq 1.84$ where:

Q_{gas}- losses of natural gas that occur when carrying out research (neutron-gamma logging of borehole), m^3;
P_a- atmospheric pressure, MPa ;
P_g- gas pressure, MPa ;
τ- time of gas leak , h;
ρ- density of gas, kgf/m^3 (0.685 kgf/m^3) ;
t_g- gas temperature, ^{0}C;

In order to calculate gas loss, area of opening through which gas is flowing out must be known. It is calculated using the following formula:

$$F = \frac{\pi D^2}{4} - \frac{\pi d^2}{4}$$ (mm^2) where:

D – diameter of gasket, mm;
d – diameter of wire, mm.

2. Calculation of burned amount of natural gas.

Amount of natural gas that can be burned through "candle" is made from gas amounts at gas collection points (GCP), condensate collectors, contactors and separators that after equipment maintenance is released through candle, reducing gas pressure to atmospheric pressure.

In order to not complicate calculations the remaining amount of gas in equipment, after gas is burned through "candle", is considered equal with internal geometric volume and burned gas amount is calculated using the following formula:

$$Q_{burn} = \frac{VT_{st}}{P_{st}T_g}\frac{P_{abs}}{Z_{abs}} - V(m^3)$$ where:

Q_{burn}- amount of gas that is burned when reducing amount of gas in GCP equipment, m^3;
V – internal geometric volume of equipment in which gas pressure is decreased, m^3;
T_{st}– temperature of natural gas in standard conditions, K (293.15 K);

P_{st}– pressure of natural gas in standard conditions, MPa;
T_g– temperature of natural gas in pipeline (equipment), K;
P_{abs}– pressure of natural gas in equipment before it is decreased, MPa;
Z_{abs}– compressibility factor of natural gas at gas pressure P_{abs} and temperature T_g

By taking into account the volume of gas collection point circuits, gas pressure and temperature in them, as well as frequency of maintenance, permissible amount of burned gas per year, decreasing gas pressure in GCP equipment, is calculated with the following conditions:

GCP-1 -Condensate collectors (12 pieces), contactors (12 pieces).

GCP-2 - First degree separators (9 pieces), first degree gas separators (10 pieces), second degree gas separators (5 pieces).

GCP-3 -First degree separators (14 pieces), first degree separators (16 pieces), second degree gas separators (8 pieces).

Factual amount of burned gas is calculated at factual gas pressures and temperatures in equipment. Methodology of the given calculation is used to calculate amounts of burned gas – if necessary, releasing technological pipelines from gas.

3. Calculation of technological losses of natural gas from gas leaks.

Losses of natural gas from leaks occur of gas leaks at gas pipeline unit shut-off devices, fountain fitting, as well as leakages in compressors and intercolumns. When calculating losses of natural gas from gas leaks at gas pipeline unit shut-off devices, fountain fitting and leakages in compressors, data from the common researches of the U.S. Gas Research Institute and Environmental Protection Agency were used.

3.1. Amount of natural gas losses from leaks in gas pipeline line part shut-off devices is calculated using the following formula:

$$Q_n = Q_{con} \cdot N_{con} + Q_{gal} \cdot N_{gal} \left(\frac{m^3}{a}\right)$$ where:

Q_n- losses of natural gas from leaks in gas pipeline unit shut-off devices, m^3/a;
Q_{con}- average amount of gas leak in the gas pipeline unit shut-off device, 24.55 m^3/a;
N_{con}- amount of gas pipeline unit shut-off devices (except of candle valves), pcs. ;
Q_{con} - average amount of gas leak in gas pipeline unit "candle" valve, 317.2 m^3/a;
N_{gal}- amount of gas pipeline unit "candle" valves, pcs.

3.2. Natural gas losses from gas leaks thought compressor leakages are calculated using the following formula:

$$Q_{c.g} = Q_{compressorgaskets} N \left(\frac{m^3}{a}\right)$$ where:

$Q_{c.g}$– average losses of natural gas from compressor gas leaks, m^3/a;
$Q_{compressorgaskets}$– average losses of natural gas (with compressor operating non-stop) because of leaks through compressor gaskets per year, 8496 m^3/a;
N – amount of operating motor compressors, pcs.

3.3. Amount of natural gas losses from gas leaks in fountain fitting is calculated using the following formula:

$$Q_{f.a} = Q_{clos} \cdot N_{clos} + Q_{candlevalves} \cdot N_{candlevalves} \left(\frac{m^3}{a}\right)$$ where:

$Q_{f.a}$– average losses of natural gas from leaks in fountain fitting, m^3/a;

Q_{clos} – average amount of gas leaks in shut-off device of fountain fitting (except of "candle" valves), 26 m^3/a;
N_{clos}– number of shut-off devices of fountain fitting (except of "candle" valves), pcs.;
$Q_{candlevalues}$– average amount of gas leaks in "candle" valves of fountain fitting, 6.71 m^3/a;
$N_{candlevalues}$ – amount of "candle" valves of fountain fitting, pcs.

These losses of natural gas occur from leaks in shut-off devices of fountain fitting.

3.4. The amount of gas losses of intercolumns Qst. is calculated in accordance with indications of gas meter.

Amount of natural gas leaks that occur in intercolumns are measured with gas meters. That is why given amount is calculated using indications of gas meters. Amount of natural gas leaks in intercolumns in the IUGSF is measured and recorded by the Geological Department of IUGSF.

4. Calculation of losses of natural gas without gas leaks into the atmosphere.

It consists of the amount of natural gas that is necessary to fulfil internal geometric volume of gas pipelines and equipment, as well as to reach operating pressure. Natural gas losses are calculated using the following formula:

$$Q_{gas} = \frac{VP_{abs}T_{st}}{P_{st}T_gZ}$$ (m^3) where:

Q_{gas}– losses of natural gas that occur when filling pipelines and equipment with gas after construction works will be finished and they will be put into operation, m^3 ;
V – geometric volume of gas pipeline, equipment , m^3 ;
P_{abs}– absolute pressure of natural gas in the gas pipeline, equipment after injection of gas, kgf/cm^2;
T_{st}– absolute temperature in standard conditions, K (293.15 K);
P_{st}– gas pressure in standard conditions, kgf/cm^2; (1.0332 kgf/cm^2;);
T_g– gas temperature, K;
Z – compressibility factor of gas at temperature T_g and pressure $P_{abs.}$

5. Calculation of emergency outflows (losses).

Emergency outflows are unplanned losses of natural gas that can occur from significant damages of gas pipelines and equipment. If area of the damage is smaller than the area of pipeline cross-section and gas pressure does not decrease, then natural gas losses, Qgas are calculated using the following formula:

$$Q_{gas} = 106\frac{(p_a + p_g)F\tau}{\rho\sqrt{273.15 + t_g}}$$ m^3 at $(p_a + p_g)/p_a \geq 1.84$ where:

P_a- atmospheric pressure, MPa ;
P_g- gas pressure, MPa;
F – area of damaged pipeline, mm^2;
τ- gas leak time, h;
ρ- density of gas,kg/m^3;
t_g- gas temperature, ^0C.

If area of damaged pipeline is comparable with cross-section area of pipeline, then gas pressure in pipeline decreases and becomes a multiple parameter function.

In this case amount of released gas is calculated using another methodology.

METHODOLOGY FOR CALCULATION OF TECHNOLOGICAL LOSSES OF NATURAL GAS IN THE TRANSPORT (MAIN) GAS PIPELINE SYSTEM

In order to calculate losses of natural gas, it is necessary to determine the territory where it is stored. Transport (Main) gas pipeline system has borders with: neighbouring countries has state border, Inčukalns Underground Gas Storage Facility (IUGSF) has access node to the Transport (Main) gas pipeline system, distribution system has gas regulation station (GRS) fence above the GRS exit pipes.

Calculation of losses of natural gas in many cases is grounded with gas loss standards. At the moment, modernisation, change of valves in the line and other works of gas regulator stations (GRS) are carried out. In order to use energy most efficiently, amount of gas to be released into the atmosphere and related costs before repair works, gas pressure of pipelines, conveying gas to users, is reduced to a minimum. In general, amount of natural gas losses depends on technical condition of gas system that, according to its improvement and development process, changes continuously.

1. Calculation of natural gas losses that occur when releasing gas into the atmosphere without burning it:

1.1. Calculation of natural gas losses necessary to purge gas pipeline with gas – after it is put into operation after construction works, as well as repair works, installations or other works are done and gas pipeline was released from gas.

Amount of natural gas losses are calculated using the following formula:

$$Q_{gas} = 5786 V_{sist} \frac{P_{purg}}{273.15 + t_g}$$ (m^3) where:

Q_{gas}– losses of natural gas that occur when purging gas pipeline with gas – after it is put into operation after construction works, as well as repair works, installations or other works are done and gas pipeline was released from gas, m^3;
V_{sist}– internal geometric volume of gas pipeline , m^3;
P_{purg}– pressure of gas purged through the pipes, MPa;
t_g– gas temperature during the release, ^{0}C (average amount after measurements – 7 ^{0}C).

1.2. Calculation of natural gas losses that occur when releasing gas pipeline from gas before repair works or other works when it has to be completely free from gas.

It consists of the remaining amount of gas in the geometric volume of gas pipeline at the atmospheric pressure. Amount of natural gas is calculated using the following formula:

$$Q_{gas} = 2893 \frac{V_{sist} p_a}{(273.15 + t_g) 0.998}$$ (m^3) where:

Q_{gas}– losses of natural gas that occur when releasing gas pipeline from gas, m^3;
V_{sist}– internal geometric volume of gas pipeline, m^3;
P_a– atmospheric pressure, MPa (0.1MPa) ;
t_g– gas temperature, (average amount after measurements – 7 ^{0}C).

1.3 Calculation of natural gas losses that occur when decreasing gas pressure at gas regulation stations (GRS) in order to release equipment and communications from gas completely.

It consists of gas from gas pipelines and equipment released into the atmosphere after pressure of gas in them has been decreased (when conveying gas to consumers) to the pressure at the GTS exit. Amount of natural gas losses is calculated with the following formula:

$$Q_{gas} = 2893 \frac{V_{sist} (p_a + p_g)}{(273.15 + t_g) K_z}$$ (m^3) where:

Q_{gas}- losses of natural gas that occur when gas pressure at gas regulation stations (GRS) is decreased, m^3;
V_{sist}- internal geometric volume of gas pipelines and equipment, m^3;
P_a- atmospheric pressure, MPa (0.1 MPa);
P_g- gas pressure in gas pipelines and equipment (equal with gas pressure at the exit of gas regulation stations), MPa ;

t_g- gas temperature, ^{0}C (average amount after measurements – 7 ^{0}C).
K_z- relative gas compressibility factor at gas pressure P_g.

1.4. Calculation of natural gas losses that occur when carrying out maintenance of gas regulation stations (GRS).

1.4.1. Calculation of natural gas losses that occur when filters, filter-separators are released from condensate.

Amount of natural gas losses that occur when releasing filters (for the new GRS) and filter-separators (for old pattern GRS) from condensate is calculated with the following formula:

$Q_{gas} = (G_f x V_k + 3.2) \times N \times n \ (m^3)$ where:

Q_{gas}- losses of natural gas that occur when filters and filter-separators are separated from condensate, m^3 ;
G_f- gas factor – 49.9 (the amount of gas melted in condensate and gas released together with condensate is taken into account);
V_k- amount of condensate released from filter, filter-separator, m^3 ;
N – number of purges;
n – number of devices.

1.4.2. Calculation of natural gas losses occurred during the examination of gas regulators.

According to the methodology of gas regulators, examination of gas regulators is done by releasing gas into the atmosphere through "'candle". Losses of natural gas that occur during the examination of regulators are calculated with the following formula:

$$Q_{gas} = V_{piev} \frac{2893}{273.15 + t_g} \{\frac{p_a + p_g}{K_z} - \frac{p_a}{0.998}\} (\frac{m^3}{\text{maneuver}})$$ where:

Q_{gas}- losses of gas occurred when opening or closing (maneuver) pneumatic valve, m^3/maneuver;
P_a- atmospheric pressure, MPa ;
P_g- gas pressure, MPa ;
t_g- gas temperature, ^{0}C ;
V_{piev}- volume of pneumatic valve actuator chamber, m^3;
K_z- relative gas compressibility factor at gas pressure P_g.

1.4.4. Calculation of the amount of gas losses for gas odorization when gas pressure in the odorization equipment is decreased to the atmospheric pressure.

The amount of gas losses for gas odorization when gas pressure in the odorization equipment is decreased to the atmospheric pressure is calculated using the following formula:

$$Q_{gas} = V_{equip} \frac{2893}{273.15 + t_g} \{\frac{p_a + p_g}{K_z} - \frac{p_a}{0.998}\}$$ m^3 where:

Q_{gas}- gas losses for odorization, m^3 ;
V_{equip}- volume of odorization equipment, m^3 ;
t_g- gas temperature, ^{0}C;
P_a- atmospheric pressure, MPa;
P_g- gas pressure, MPa;
K_z- relative gas compressibility factor at gas pressure P_g.

1.5. Losses of natural gas in the automotive gas filling compressor station AGUKS.

Losses of natural gas in the automotive gas filling compressor station AGUKS are calculated using, standards of gas losses determined after calculations.

2. Calculation of the amount of burned natural gas.

2.1. Amount of burned gas during repair works, decreasing gas pressure in the Transport (Main) gas pipelines to the atmospheric pressure.

The amount of burned gas is calculated using the following formula:

$$Q_{gas} = 2893\ V_{syst}\ \frac{1}{273.15+t_g}\left(\frac{p_a+p_g}{K_z}-\frac{p_a}{0.998}\right)$$ (m^3) where:

Q_{gas} - amount of burned gas, m^3;
V_{syst} - internal geometric volume of gas pipeline, m^3;
t_g – gas temperature, ^0C;
P_a – atmospheric pressure, MPa;
P_g – gas pressure, MPa;
K – relative gas compressibility factor at gas pressure P_g.

2.2. Amount of burned gas during repair works, partly decreasing gas pressure in the Transport (Main) gas pipelines.

The amount of burned gas is calculated using the following formula:

$$Q_{gas} = 2893\ V_{syst}\ \frac{1}{273.15+t_g}\left(\frac{p_a+p_g}{K_z}-\frac{p_a+p_{atl.}}{K_{z\,atl.}}\right)$$ m^3 where:

Q_{gas}– amount of burned gas, m^3;
V_{syst} – internal geometric volume that is released from gas, m^3;
P_a – atmospheric pressure, MPa;
$P_{atl.}$ – gas pressure in pipeline to which it was decreased, MPa;
P_g – gas pressure in gas pipeline before it was decreased, MPa;
K_z – relative gas compressibility factor at gas pressure P_g ;
$K_{z\,atl.}$ – relative gas compressibility factor at gas pressure $P_{atl.}$;
t_g – gas temperature, ^0C.

3. Calculation of technological losses of natural gas through gas system leakages.

Losses of natural gas occur from gas leaks through gas system line unit shut-off device leakages. Their amount is calculated using common researches of the U.S. Gas Research Institute and Environmental Protection Agency on average gas losses through gas pipeline leakages in shut-off devices of Transport (Main) gas pipeline. Losses of natural gas because from leaks through the gas pipeline leakages are calculated using the following formula:

$$Q_{gas} = Q_{sav.}N_{sav.} + Q_{gal.}N_{gal.}\left(\frac{m^3}{a}\right)$$ where:

Q_{gas}– total amount of gas losses from gas leaks through leakages in Transport (Main) gas pipeline unit valves, m^3/a;
Q_{sav}– average amount of gas leaks through leakages in Transport (Main) gas pipeline unit valve, 24.55 m^3/a;
N_{sav}- amount of Transport (Main) gas pipeline unit valves (except of "candle" valves), pcs.;
Q_{gal}- average amount of gas leaks through leakages in Transport (Main) gas pipeline unit "candle" valve, 317.2 m^3/a;
N_{gal}- amount of Transport (Main) gas pipeline unit "candle" valves, pcs.;

4. Calculation of technological losses of natural gas without gas releases into the atmosphere.

It consists of the amount of natural gas necessary to fulfil pipeline with gas after the line is put into operation after repair works. Construction organisation is responsible for putting gas pipeline into operation after completion of repair works, gas necessary for implementation of this operation is sold to the organisation. Natural gas consumption is calculated using the following formula:

$$Q_{gas} = 2893\frac{V_{syst}(p_a+p_g)}{(273.15+t_g)K_z}(m^3)$$ where:

Q_{gas}– natural gas consumption necessary to fulfil gas pipeline with gas when putting it into operation after completion of construction works,m^3;
V_{syst} – internal geometric volume of gas pipeline, m^3;
P_a – atmospheric pressure, MPa (0.1 MPa);
P_g – gas pressure in gas pipeline after it was filled with gas, MPa;
t_g – gas temperature,^0C (average amount after measurements – 7 ^0C);
K_z – relative gas compressibility factor at gas pressure P_g.

At gas pressure $(p_a+p_g)/p_a \geq 1.84$

$$Q_{gas} = 106 \frac{(p_a + p_g) F \tau}{\rho \sqrt{273.15 + t_g}}$$ where:

P_a– atmospheric pressure, MPa;
P_g– gas pressure, MPa;
F – area of pipeline damage, mm^2;
τ– time of gas leak, h;
ρ– density of gas ,kg/m^3;
t_g– gas temperature, ^0C.

At gas pressure $(p_a + p_g) / p_a < 1.84$

$$Q_{gas}=461 \frac{(p_a + p_g)^{0.24} p_a^{0.76} F \tau}{\rho \sqrt{273.15 + t}} \sqrt{1 - (\frac{p_a}{p_g + p_a})^{0.24}}$$ m^3

6. Calculation of total technological losses of natural gas in the Transport (Main) gas pipeline system.

Total losses of natural gas with gas release into the atmosphere in the Transport (Main) gas pipeline system Qtot. are calculated by summarising the following calculation points of natural gas losses.

METHODOLOGY FOR CALCULATION OF TECHNOLOGICAL LOSSES OF NATURAL GAS IN THE INTERNAL USER GAS SUPPLY SYSTEM

It is necessary to determine the territory where gas pipelines and equipment is located. In compliance with gas supply and usage instructions, location for gas users is determined in the place behind shut-off device in the gas pipeline actuator or other location specified in the border deed attached to gas supply agreement.

1. Natural gas losses through gas system leakages in residential buildings with gas stoves are calculated using the following formulas:

Q_{gas} = q N n (m^3) where:

Q_{gas} – gas losses because of leaks though internal gas system, m^3 ;
N – number of days, d_n ;
n – amount of apartments, pcs. ;
q – amount of leaks because of leaks though internal gas system in residential buildings with stoves

2. Additional losses of natural gas in gas fired boilers and (or) water preparation devices are calculated using the following formulas:

Q_{gas} = 0.7q N n (m^3) where

Q_{gas} – additional losses of natural gas because of leaks in gas fired boilers and (or) hot water preparation devices, m^3 ;
0.7 – factor that takes into account condition of equipment;
N – number of days, d_n ;
n – amount of devices, pcs.;
q – amount of leaks in gas fired boilers and (or) hot water preparation devices

METHODOLOGY FOR CALCULATION OF TECHNOLOGICAL LOSSES OF NATURAL GAS IN THE DISTRIBUTION SYSTEM

It is necessary to determine the territory between gas transport system and distribution system for gas supplier and gas pipeline, as well as territory of equipment, gas supplier (distribution system) and user. Calculation of losses of natural gas in many cases is grounded with gas loss standards.

1. Calculation of technological losses of natural gas that occur when releasing gas into the atmosphere without burning it.

1.1. Calculation of natural gas consumption that is necessary to purge gas pipeline with gas when putting it into operation after construction works, as well as repair works, installation or other works when gas pipeline was released from gas are done.

When finishing gas pipeline purge, gas in the geometric volume of gas pipeline is not released into the atmosphere. Amount of natural gas released in the air consists of gas – air mixture. The amount of natural gas is calculated with the following formula:

$$Q_{gas} = 0.20 \frac{Q_{syst}(p_a + p_g)T_{20}}{p_a(273.15 + t_g)}$$ (m^3) where:

Q_{gas}– consumption of natural gas necessary to purge gas pipeline with gas, m^3;
Q_{sist}– geometric volume of gas pipeline, m^3;
P_a– atmospheric pressure kgf/m^2;
P_g– gas pressure in gas pipeline, 150 kgf/m^2 (in distribution networks gas pipelines are purged with gas whose pressure in gas pipeline during its purge time is close to 150 kgf/m^2or 150 mm H_2O):
T_{20}– absolute temperature in standard conditions, K ;
t_g- gas temperature, ^{0}C (average gas temperature of the year = 10 ^{0}C);
0.20 – factor that ensures quality of purging {1-25}.

1.2. Calculation of gas consumption that occurs when releasing gas pipeline from gas before repair works or other works when gas pipeline must be released from gas.

Consumption of natural gas is calculated using the following formula:

$$Q_{gas} = Q_{syst}$$ (m^3)

Q_{gas}- consumption of gas that occurs when releasing gas pipeline from gas before repair works or other works when gas pipeline must be released from gas, m^3 ;
Q_{syst}- geometric volume of gas pipeline, m^3 ;

1.3. Calculation of gas consumption that occurs when decreasing gas pressure at gas regulator points (GRP).

Consumption of natural gas is calculated using the following formula:

$$Q_{gas} = \frac{Q_{syst}(p_a + p_g)T_{20}}{p_a(273.15 + t_g)}$$ (m^3) where:

Q_{gas}- consumption of natural gas when decreasing gas pressure at gas regulator point, m^3;
Q_{syst} – geometrical volume of gas pipeline and equipment, m^3;
P_a- atmospheric pressure, kgf/m^2;
P_f- gas pressure in gas pipeline and equipment after its decrease through gas users to pressure at GRP exit, kgf/m^2;
T_{20}- absolute temperature in standard conditions, K;
t_g- gas temperature, ^{0}C.

1.4. Calculation of gas that occurs when carrying out repair works of condensate collectors, water seals, gas inlet with special auxiliary device.

Consumption of gas is calculated using the following formula:

$$Q_{gas} = qn$$ (m^3) where:

q – natural gas consumption standard, m^3/unit;
n – amount of condensate collectors, water seals, gas inlets.

2. Calculation of the amount of burned gas.

Amount of burned gas – when the gas is burned through "candle" – occurs when pressure in gas line is decreased to the atmospheric pressure. It is calculated using the following formula:

$$Q_{gas} = \frac{Q_{syst}(p_a + p_g)T_{20}}{p_a(273.15 + t_g)} - \frac{Q_{syst}T_{20}}{273.15 + t_g}$$ (m^3) where:

Q_{gas}- amount of burned gas, m^3;
$Q_{syst.}$ – geometrical volume of gas pipeline, m^3;
P_a- atmospheric pressure, kgf/m^2;
P_g- gas pressure in gas pipeline, kgf/m^2;
T_{20}- absolute temperature in standard conditions, K;
t_g- gas temperature, ^0C.

3. Calculation of technological losses of natural gas leaks through gas system.

3.1. Gas leaks through gas system from low-pressure yard and internal quarter gas pipelines, low-pressure distribution gas pipelines, average and high-pressure gas pipelines are calculated using the following formula:

$$Q_{gas} = 0.5qF(\frac{m^3}{m^2 d_n})$$ where:

Q_{gas}- gas losses from leaks in gas system, m^3;
q – amount of leaks , m^3/m^2d_n;
F - area of internal surface of gas pipeline , m^2;
0.5 – factor that – using experimental data – observes;

3.2. Gas leaks from devices at unreconstructed gas regulator points (GRP) and cabinet-type gas regulator points (CGRP) are calculated using the following formula:

$$Q_{gas} = qN(\frac{m^3}{d_n})$$ where:

N – amount of GRP, CGRP, pcs.;
q – amount of leaks 0.288 m^3/d_n.

3.3. Gas leaks of equipment at gas regulator points (GRP), cabinet-type gas regulator points (CGRP), as well as new cabinet-type gas regulator points are calculated using the following formulas:

$$Q_{gas} = 0.5qN(\frac{m^3}{d_n})$$ where:

Q_{gas}– leaks from gas pipelines and equipment at reconstructed gas regulator points (GRP), cabinet-type gas regulator points (CGRP), as well as at the new cabinet-type gas regulator points, m^3/d_n;
q – amount of leaks 0.288 m^3/d_n;
N – amount of GRP, CGRP, pcs.;
0.5 – factor that observes gas leak decrease as a result of reconstruction and renovation.

4. Calculation of losses of natural gas without gas releases into the atmosphere.

It consists of natural gas consumption necessary to fulfill gas pipeline with gas after construction works are completed and it is being put into operation.

Consumption of natural gas is calculated using the following formula {1-25}:

$$Q_{gas} = \frac{Q_{syst}(p_a + p_g)T_{20}}{p_a(273.15 + t_g)}$$ (m^3) where: (15)

Q_{gas}- natural gas consumption to fulfill gas pipeline with gas after construction works are completed and it is being put into operation, m^3;
$Q_{syst.}$ – internal geometrical volume of gas pipeline, m^3;

P_a- atmospheric pressure, kgf/m²;
P_g- gas pressure in gas pipeline, kgf/m²;
T_{20}- absolute temperature in standard conditions, K;
t_g- gas temperature, ^{0}C.

5. Calculation of emergency outflows.

Emergency outflows are unplanned losses of natural gas that occur from significant damages of gas pipelines and equipment. These unplanned losses of natural gas can be released into the atmosphere by burning, as well as not burning the gas. If area of damage is smaller than cross-section area of pipeline, then natural gas losses, are calculated using the following formulas:

$$Q_{gas} = 106\frac{(p_a + p_g)F\tau}{\rho\sqrt{273.15 + t_g}} \quad \text{m}^3 \text{ at } (p_a + p_g)/p_a \geq 1.84$$

where:

P_a– atmospheric pressure, MPa ;
P_g– gas pressure, MPa;
F – area of damaged pipeline, mm²;
τ– gas leak time, h;
ρ– density of gas,kg/cm³;
t_g– gas temperature, ^{0}C.

$$Q_{gas} = 461\frac{(p_a + p_g)^{0.24} p_a^{0.76} F\tau}{\rho\sqrt{273.15 + t}}\sqrt{1 - \frac{p_a}{(p_g + p_a)^{0.24}}} \quad (m^3) \text{ at } (p_a + p_g)/p_a < 1.84$$

If area of damaged pipeline is comparable with cross-section area of pipeline, then gas pressure in pipeline decreases and becomes a multiple parameter function.

A.3.5 Transport

Distribution of road transport fleet by subsectors and layers, year 2014

Subsector	Technology	population	mileage
Passenger Cars			
Gasoline <1,4 l	ECE 15/03	400	2700
Gasoline <1,4 l	ECE 15/04	934	3600
Gasoline <1,4 l	PC Euro 1 - 91/441/EEC	5023	5500
Gasoline <1,4 l	PC Euro 2 - 94/12/EEC	7189	9000
Gasoline <1,4 l	PC Euro 3 - 98/69/EC Stage2000	6934	12000
Gasoline <1,4 l	PC Euro 4 - 98/69/EC Stage2005	10715	14000
Gasoline <1,4 l	PC Euro 5 - EC 715/2007	6031	19000
Gasoline <1,4 l	PC Euro 6 - EC 715/2007	164	19000
Gasoline 1,4 - 2,0 l	ECE 15/03	4552	2430
Gasoline 1,4 - 2,0 l	ECE 15/04	10621	3600
Gasoline 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	50263	7150
Gasoline 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	41820	12000
Gasoline 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	23128	15068
Gasoline 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	27028	17000
Gasoline 1,4 - 2,0 l	PC Euro 5 - EC 715/2007	9656	20000
Gasoline 1,4 - 2,0 l	PC Euro 6 - EC 715/2007	279	22000
Gasoline >2,0 l	ECE 15/03	690	2700
Gasoline >2,0 l	ECE 15/04	1610	4228
Gasoline >2,0 l	PC Euro 1 - 91/441/EEC	7074	9902
Gasoline >2,0 l	PC Euro 2 - 94/12/EEC	9149	14000
Gasoline >2,0 l	PC Euro 3 - 98/69/EC Stage2000	8975	15000
Gasoline >2,0 l	PC Euro 4 - 98/69/EC Stage2005	7886	19000
Gasoline >2,0 l	PC Euro 5 - EC 715/2007	2178	21000
Gasoline >2,0 l	PC Euro 6 - EC 715/2007	160	21500
Diesel <2,0 l	Conventional	5262	10000
Diesel <2,0 l	PC Euro 1 - 91/441/EEC	19961	11000
Diesel <2,0 l	PC Euro 2 - 94/12/EEC	35457	12000
Diesel <2,0 l	PC Euro 3 - 98/69/EC Stage2000	53902	14000
Diesel <2,0 l	PC Euro 4 - 98/69/EC Stage2005	33920	16545
Diesel <2,0 l	PC Euro 5 - EC 715/2007	13002	21586
Diesel <2,0 l	PC Euro 6 - EC 715/2007	614	22000
Diesel >2,0 l	Conventional	3035	11872
Diesel >2,0 l	PC Euro 1 - 91/441/EEC	14486	13000
Diesel >2,0 l	PC Euro 2 - 94/12/EEC	21856	14000
Diesel >2,0 l	PC Euro 3 - 98/69/EC Stage2000	46364	15000
Diesel >2,0 l	PC Euro 4 - 98/69/EC Stage2005	22095	18000
Diesel >2,0 l	PC Euro 5 - EC 715/2007	5684	23000
Diesel >2,0 l	PC Euro 6 - EC 715/2007	507	22000
LPG	Conventional	3110	15000
LPG	PC Euro 1 - 91/441/EEC	10994	19000

Subsector	Technology	population	mileage
LPG	PC Euro 2 - 94/12/EEC	13692	20000
LPG	PC Euro 3 - 98/69/EC Stage2000	10127	21000
LPG	PC Euro 4 - 98/69/EC Stage2005	6221	22040
LPG	PC Euro 5 - EC 715/2007	1484	23690
LPG	PC Euro 6 - EC 715/2007	6	24620
Light Duty Vehicles			
LPG	Conventional	255	30369
LPG	LD Euro 1 - 93/59/EEC	171	30369
LPG	LD Euro 2 - 96/69/EEC	154	31000
LPG	LD Euro 3 - 98/69/EC Stage2000	117	33000
LPG	LD Euro 4 - 98/69/EC Stage2005	233	43074
LPG	LD Euro 5 - 2008 Standards	139	47984
Gasoline <3,5t	Conventional	266	17000
Gasoline <3,5t	LD Euro 1 - 93/59/EEC	201	18000
Gasoline <3,5t	LD Euro 2 - 96/69/EEC	404	19000
Gasoline <3,5t	LD Euro 3 - 98/69/EC Stage2000	303	21500
Gasoline <3,5t	LD Euro 4 - 98/69/EC Stage2005	593	28000
Gasoline <3,5t	LD Euro 5 - 2008 Standards	308	31000
Gasoline <3,5t	LD Euro 6	5	31000
Diesel <3,5 t	Conventional	2636	25000
Diesel <3,5 t	LD Euro 1 - 93/59/EEC	3245	25000
Diesel <3,5 t	LD Euro 2 - 96/69/EEC	7540	26000
Diesel <3,5 t	LD Euro 3 - 98/69/EC Stage2000	8297	27800
Diesel <3,5 t	LD Euro 4 - 98/69/EC Stage2005	11203	32460
Diesel <3,5 t	LD Euro 5 - 2008 Standards	7203	39000
Diesel <3,5 t	LD Euro 6	21	39000
Heavy Duty Trucks			
LPG	Conventional	340	24000
LPG	HD Euro I - 91/542/EEC Stage I	120	24400
LPG	HD Euro II - 91/542/EEC Stage II	62	26000
Gasoline >3,5 t	Conventional	769	18000
Gasoline >3,5 t	HD Euro I - 91/542/EEC Stage I	293	18500
Gasoline >3,5 t	HD Euro II - 91/542/EEC Stage II	72	18644
Gasoline >3,5 t	HD Euro III - 2000 Standards	13	25057
Rigid <=7,5 t	Conventional	873	20400
Rigid <=7,5 t	HD Euro I - 91/542/EEC Stage I	526	20411
Rigid <=7,5 t	HD Euro II - 91/542/EEC Stage II	630	20411
Rigid <=7,5 t	HD Euro III - 2000 Standards	566	27431
Rigid <=7,5 t	HD Euro IV - 2005 Standards	443	40071
Rigid <=7,5 t	HD Euro V - 2008 Standards	182	42079
Rigid <=7,5 t	HD Euro VI	11	42079
Rigid 7,5 - 12 t	Conventional	439	20600
Rigid 7,5 - 12 t	HD Euro I - 91/542/EEC Stage I	273	20603
Rigid 7,5 - 12 t	HD Euro II - 91/542/EEC Stage II	310	20603

Subsector	Technology	population	mileage
Rigid 7,5 - 12 t	HD Euro III - 2000 Standards	342	28929
Rigid 7,5 - 12 t	HD Euro IV - 2005 Standards	247	38291
Rigid 7,5 - 12 t	HD Euro V - 2008 Standards	88	36565
Rigid 7,5 - 12 t	HD Euro VI	5	36565
Rigid 12 - 14 t	Conventional	135	20700
Rigid 12 - 14 t	HD Euro I - 91/542/EEC Stage I	87	20702
Rigid 12 - 14 t	HD Euro II - 91/542/EEC Stage II	72	20702
Rigid 12 - 14 t	HD Euro III - 2000 Standards	31	23111
Rigid 12 - 14 t	HD Euro IV - 2005 Standards	41	29129
Rigid 12 - 14 t	HD Euro V - 2008 Standards	16	31534
Rigid 12 - 14 t	HD Euro VI	2	31534
Rigid 14 - 20 t	Conventional	795	29000
Rigid 14 - 20 t	HD Euro I - 91/542/EEC Stage I	588	29000
Rigid 14 - 20 t	HD Euro II - 91/542/EEC Stage II	1337	29000
Rigid 14 - 20 t	HD Euro III - 2000 Standards	1887	36000
Rigid 14 - 20 t	HD Euro IV - 2005 Standards	1380	52000
Rigid 14 - 20 t	HD Euro V - 2008 Standards	3364	57000
Rigid 14 - 20 t	HD Euro VI	239	57000
Rigid 20 - 26 t	Conventional	266	38000
Rigid 20 - 26 t	HD Euro I - 91/542/EEC Stage I	295	38000
Rigid 20 - 26 t	HD Euro II - 91/542/EEC Stage II	303	38000
Rigid 20 - 26 t	HD Euro III - 2000 Standards	419	53000
Rigid 20 - 26 t	HD Euro IV - 2005 Standards	380	74000
Rigid 20 - 26 t	HD Euro V - 2008 Standards	629	78000
Rigid 20 - 26 t	HD Euro VI	67	78000
Rigid 26 - 28 t	Conventional	31	38000
Rigid 26 - 28 t	HD Euro I - 91/542/EEC Stage I	45	38000
Rigid 26 - 28 t	HD Euro II - 91/542/EEC Stage II	45	38000
Rigid 26 - 28 t	HD Euro III - 2000 Standards	79	53000
Rigid 26 - 28 t	HD Euro IV - 2005 Standards	56	74000
Rigid 26 - 28 t	HD Euro V - 2008 Standards	95	78000
Rigid 26 - 28 t	HD Euro VI	20	78000
Rigid 28 - 32 t	Conventional	18	38400
Rigid 28 - 32 t	HD Euro I - 91/542/EEC Stage I	33	38400
Rigid 28 - 32 t	HD Euro II - 91/542/EEC Stage II	50	38400
Rigid 28 - 32 t	HD Euro III - 2000 Standards	67	53000
Rigid 28 - 32 t	HD Euro IV - 2005 Standards	63	74000
Rigid 28 - 32 t	HD Euro V - 2008 Standards	94	78000
Rigid 28 - 32 t	HD Euro VI	12	78000
Rigid >32 t	Conventional	22	38400
Rigid >32 t	HD Euro I - 91/542/EEC Stage I	22	38400
Rigid >32 t	HD Euro II - 91/542/EEC Stage II	43	38400
Rigid >32 t	HD Euro III - 2000 Standards	37	53000
Rigid >32 t	HD Euro IV - 2005 Standards	98	74000

Subsector	Technology	population	mileage
Rigid >32 t	HD Euro V - 2008 Standards	37	78000
Rigid >32 t	HD Euro VI	2	78000
Articulated 14 - 20 t	Conventional	340	29200
Articulated 14 - 20 t	HD Euro I - 91/542/EEC Stage I	252	29500
Articulated 14 - 20 t	HD Euro II - 91/542/EEC Stage II	573	29550
Articulated 14 - 20 t	HD Euro III - 2000 Standards	808	38000
Articulated 14 - 20 t	HD Euro IV - 2005 Standards	591	52000
Articulated 14 - 20 t	HD Euro V - 2008 Standards	1441	57000
Articulated 14 - 20 t	HD Euro VI	103	57000
Articulated 20 - 28 t	Conventional	335	38000
Articulated 20 - 28 t	HD Euro I - 91/542/EEC Stage I	383	38000
Articulated 20 - 28 t	HD Euro II - 91/542/EEC Stage II	392	38000
Articulated 20 - 28 t	HD Euro III - 2000 Standards	562	52000
Articulated 20 - 28 t	HD Euro IV - 2005 Standards	492	74000
Articulated 20 - 28 t	HD Euro V - 2008 Standards	816	78000
Articulated 20 - 28 t	HD Euro VI	97	78000
Articulated 28 - 34 t	Conventional	46	38000
Articulated 28 - 34 t	HD Euro I - 91/542/EEC Stage I	62	38000
Articulated 28 - 34 t	HD Euro II - 91/542/EEC Stage II	105	38000
Articulated 28 - 34 t	HD Euro III - 2000 Standards	117	52000
Articulated 28 - 34 t	HD Euro IV - 2005 Standards	182	74000
Articulated 28 - 34 t	HD Euro V - 2008 Standards	149	78000
Articulated 28 - 34 t	HD Euro VI	15	78000
Buses			
Urban Buses	Conventional	7	29840
Urban Buses	HD Euro I - 91/542/EEC Stage I	2	29840
Urban Buses	HD Euro II - 91/542/EEC Stage II	11	29840
Urban Buses Midi <=15 t	Conventional	245	32567
Urban Buses Midi <=15 t	HD Euro I - 91/542/EEC Stage I	199	32567
Urban Buses Midi <=15 t	HD Euro II - 91/542/EEC Stage II	260	32567
Urban Buses Midi <=15 t	HD Euro III - 2000 Standards	308	43891
Urban Buses Midi <=15 t	HD Euro IV - 2005 Standards	354	56098
Urban Buses Midi <=15 t	HD Euro V - 2008 Standards	627	52520
Urban Buses Midi <=15 t	HD Euro VI	47	52520
Coaches Standard <=18 t	Conventional	229	47805
Coaches Standard <=18 t	HD Euro I - 91/542/EEC Stage I	199	47805
Coaches Standard <=18 t	HD Euro II - 91/542/EEC Stage II	180	47805
Coaches Standard <=18 t	HD Euro III - 2000 Standards	168	59027
Coaches Standard <=18 t	HD Euro IV - 2005 Standards	115	62020
Coaches Standard <=18 t	HD Euro V - 2008 Standards	129	69080
Coaches Standard <=18 t	HD Euro VI	1	69080
Coaches Articulated >18 t	Conventional	55	47805
Coaches Articulated >18 t	HD Euro I - 91/542/EEC Stage I	126	47805
Coaches Articulated >18 t	HD Euro II - 91/542/EEC Stage II	183	47805

Subsector	Technology	population	mileage
Coaches Articulated >18 t	HD Euro III - 2000 Standards	251	59027
Coaches Articulated >18 t	HD Euro IV - 2005 Standards	76	62020
Coaches Articulated >18 t	HD Euro V - 2008 Standards	19	69080
Coaches Articulated >18 t	HD Euro VI	48	69080
Mopeds			
<50 cm³	Conventional	132	1000
<50 cm³	Mop - Euro I	1456	1150
<50 cm³	Mop - Euro II	11648	1150
Motorcycles			
2-stroke >50 cm³	Conventional	1252	1100
2-stroke >50 cm³	Mot - Euro I	1879	1600
2-stroke >50 cm³	Mot - Euro II	835	1600
2-stroke >50 cm³	Mot - Euro III	1253	1600
4-stroke <250 cm³	Mot - Euro III	702	400
4-stroke 250 - 750 cm³	Conventional	1168	1400
4-stroke 250 - 750 cm³	Mot - Euro I	1752	2000
4-stroke 250 - 750 cm³	Mot - Euro II	1168	2000
4-stroke 250 - 750 cm³	Mot - Euro III	1752	2400
4-stroke >750 cm³	Conventional	730	1800
4-stroke >750 cm³	Mot - Euro I	1094	2000
4-stroke >750 cm³	Mot - Euro II	730	2000
4-stroke >750 cm³	Mot - Euro III	1094	2400

A.3.6 Industrial Processes and Product Use Sector

Methodological description for emission estimation from bricks and tiles production

There is only one tiles production plant in Latvia and CO_2 emissions from use of clay in tile production process in 1995-2014 are reported in 2.A.4 sector. The tiles production plant is participant of EU ETS therefore the data from plant's annual GHG reports is available for inventory.

Table 1 CO_2 emissions from tile production (kt)

	CO_2 emissions (kt)
1990	NO
1995	0.163
2000	0.208
2005	0.135
2006	0.140
2007	0.179
2008	0.042
2009	0.229
2010	0.200
2011	0.279
2012	0.483
2013	0.535
2014	0.524

Default methodology was used to estimate emissions when activity data is multiplied with emission factor but the CO_2 emission factor – 0.08794 (t CO_2/t dry clay), used to estimate emissions from clay use in tiles production are taken from Monitoring Reporting Guidelines (MRG[262]).

Amount of used clay in tiles production is taken from only tiles production plant in Latvia (Table 2).

Table 2 Activity data for tiles production (kt)

	Use of clay in tiles production (kt)
1990	NO
1995	2.034
2000	2.594
2005	1.685
2006	1.748
2007	2.242

[262] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:LV:PDF, *page 80*

	Use of clay in tiles production (kt)
2008	0.525
2009	2.861
2010	2.497
2011	3.484
2012	6.033
2013	6.684
2014	6.556

Estimation of CO_2 emission factor in bricks production plants is rather complicated and based on physical and chemical characteristics of raw materials and type of activity data for estimations of emissions.

CO_2 emission estimation for 1990-1992

For years 1990-1992 no plant specific data is available from bricks production plants therefore CO_2 emission estimation for these 3 years is done based on final produced bricks amount if average weight of one brick is known.

According to statistical information average weight of one brick is 3.9kg and according to plant data average produced bricks / used clay ratio is 1.25.

If final amount of produced bricks is known, it is possible to determine approximate clay consumption (Table 3). In CO_2 emission estimation emission factor 0.047 tCO_2/t used clay is used.

Table 3 Data and assumptions used for CO_2 emission estimation for 1990-1992

	1990	1991	1992
produced bricks (thousand pieces)	471800	546423	259918
average weight of one brick (kg)	3.9	3.9	3.9
produced bricks (tonnes)	1840020	2131049.7	1013680.2
average produced bricks / used clay ratio	1.25	1.25	1.25
used clay (kt)	**1472.016**	**1704.84**	**810.9442**
CO_2 emission factor of used clay tCO_2/t used clay	0.047	0.047	0.047
CO_2 emissions (kt)	69.1848	80.1275	38.1144

CO_2 emissions are estimated differently in Latvia's five bricks production plants as well as estimation methodology differs because it was possible to use higher tier of emission estimation in latest years due to availability of necessary activity data and laboratory measurements of used raw materials.

1st bricks production plant

During the revision of 1st bricks production plant's application to GHG permit, annual GHG reports for 2005-2009 it was stated that the plant has changed used CO_2 emission estimation methodology 3 times:

1. CO_2 emission for time period 1993-2004 was estimated by using used clay as an activity data and CO_2 emission factor for used clay – 0.047 t CO_2/t used clay. The particular emission factor is determined for total used clay data when clay characterizations are not known. CO_2 emissions are determined by ignition loses of clay: in 1000° C – 4.7% of instant CO_2 is emitted).
2. For 2005-2007 the plant is using calculation method B – alkali earth oxides, from the MRG when calculation is based on the content of the CaO, MgO and other (earth) alkali.
3. For years 2008-2012 plant is using the calculation method "A" – carbon input, from the MRG when calculation is based on the carbon input on each of the relevant raw materials. Tier 1 emission factors from the MRG corresponding particular method are used when conservative value of 0.2 tonnes $CaCO_3$ (0.08794 tonnes of CO_2) per tonne of dry clay is applied for the calculation of the emission factor instead of results of analyses.

First bricks production plant's used methodology for CO_2 emission estimation in whole time series is inconsistent as methodology is changed several times and for 2008 estimation methodology is again switched from Tier2 to Tier1 and default average CO_2 emission factor is used.

Methods

The CO_2 emissions in whole time period was calculated by using calculation method B – alkali earth oxides, from the MRG when calculation is based on the content of the CaO, MgO and other (earth) alkali[263].

According to bricks production plant's reported information the following equation to estimate CO_2 emissions was used:

$$CO_2 = \sum \left(\left(AD_{raw} \times AD_{CaO,MgO} \right) \times EF \times CF \right)$$

where:
CO_2 – total CO_2 emissions from bricks production (kt)
AD_{raw} – activity data of used raw materials – clay (kt)
$AD_{CaO,MgO}$ – CaO and MgO content in used raw materials (%)
EF – CO_2 emission factor of CaO and MgO (kt/kt)
CF – conversion factor

Emission factors

CO_2 emission factors for CaO and MgO – 0.785 and 1.092 for tonne CO_2 per tonne of oxide respectively, were taken from MRG[264] (Table 4).

Activity data

[263] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF *(page 80)*
[264] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF *(page 81)*

As MgO and CaO content data was not available for years 1993-2004 therefore the data reported in bricks production plant's GHG report for 2005 was used: MgO content – 4.9%, CaO content – 11.6%.

As for years 2008-2009 different emission estimation methodology is used and MgO and CaO data is not available content data of 2006-2007 was used also to estimate emissions for 2008-2012: MgO content – 2.9%, CaO content – 10.26%.

Table 4 Data and assumptions used for CO_2 emission estimation from 1st bricks production plant

	Use of clay (kt)	MgO content (%)	CaO content (%)	MgO amount (kt)	CaO amount (kt	MgO CO_2 EF (tCO_2/t oxide)	CaO CO_2 EF (tCO_2/t oxide)	CO_2 emissions (kt)	Average CO_2 EF (tCO_2/t oxides)
1990	NO	NO	NO	NO	NO	NO	NO	NO	NO
1995	2.700	4.90%	11.60%	0.132	0.313	1.092	0.785	0.390	0.876
2000	4.800	4.90%	11.60%	0.235	0.557	1.092	0.785	0.694	0.876
2005	5.257	4.90%	11.60%	0.258	0.610	1.092	0.785	0.760	0.876
2006	6.245	2.90%	10.26%	0.181	0.641	1.092	0.785	0.701	0.853
2007	7.745	2.90%	10.26%	0.225	0.795	1.092	0.785	0.869	0.853
2008	3.880	2.90%	10.26%	0.113	0.398	1.092	0.785	0.435	0.853
2009	2.268	2.90%	10.26%	0.066	0.233	1.092	0.785	0.254	0.853
2010	1.922	2.90%	10.26%	0.056	0.197	1.092	0.785	0.216	0.853
2011	1.698	2.90%	10.26%	0.049	0.174	1.092	0.785	0.191	0.853
2012	1.670	2.90%	10.26%	0.048	0.171	1.092	0.785	0.187	0.853

In 2013 1st bricks production plant is not operating anymore.

2nd bricks production plant

CO_2 emissions for 2nd bricks production plant is recalculated only for year 2008 in comparison with plant's annual GHG report. For 1999-2008 the plant is using the same emission estimation methodology but for year 2008 average default emission factor from MRG is used. As this emission factor is Tier1 emission factor but for previous years Tier2 emission factors are used it was decided to recalculate emissions for 2008.

The plant was closed at the end of 2008 and wasn't operated in 2009 due to company's reorganization when production plant using old obsolete installations were closed and all production was transferred to other modern production facilities.

Methods

Calculation method A – carbon input, from the MRG[265] is used in plant's emission estimation for its application for GHG permit as well for reporting of annual CO_2 emission:

[265] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF (page 79)

$$CO_2 = \left(AD_{raw} \times AD_{CaCO_3} \times EF_{CaCO_3}\right) + \left(AD_{raw} \times AD_{MgCO_3} \times EF_{MgCO_3}\right)$$

where:
CO_2 – CO_2 emissions from 2nd bricks production plant (kt)
AD_{raw} – activity data of used clay (kt)
AD_{CaCO3} – $CaCO_3$ content in used clay (%)
EF_{CaCO3} – $CaCO_3$ emission factor (kt/kt)
AD_{MgCO3} – $MgCO_3$ content in used clay (%)
EF_{MgCO3} – $MgCO_3$ emission factor (kt/kt)

Emission factors

Default CO_2 emission factors from the MRG for the $CaCO_3$ and $MgCO_3$ are used. CO_2 emission factor for $CaCO_3$ is 0.44 tCO_2/t $CaCO_3$ and CO_2 emission factor for $MgCO_3$ is 0.522 tCO_2/t $MgCO_3$.

Activity data

The content of $CaCO_3$ and $MgCO_3$ are determined in plant laboratories or stated in mineral deposits passport.

Activity data carbonate is $CaCO_3$, $MgCO_3$ or other alkali earth or alkali carbonates amount that is used during the reporting period input (clay). Carbonate mass is estimated using clay consumption amount and results of clay content measurement with maximal allowable process uncertainty of ± 2.5% (Table 5).

Table 5 Data and assumptions used for CO_2 emission estimation from 2nd bricks production plant

	1990	1995	2000	2005	2006	2007	2008
Use of clay (kt)	NO	NO	16.37	22.983	28.559	37.203	13.975
$MgCO_3$ content (%)	NO	NO	5.00%	10.98%	9.56%	9.52%	9.50%
$CaCO_3$ content (%)	NO	NO	9.00%	13.06%	13.15%	13.10%	13.10%
$MgCO_3$ amount (kt)	NO	NO	0.819	2.523	2.729	3.542	1.328
$CaCO_3$ amount (kt)	NO	NO	1.473	3.002	3.756	4.874	1.831
$MgCO_3$ CO_2 EF (tCO_2/t oxide)	NO	NO	0.522	0.522	0.522	0.522	0.522
$CaCO_3$ CO_2 EF (tCO_2/t oxide)	NO	NO	0.440	0.440	0.440	0.440	0.440
CO_2 emissions (kt)	NO	NO	1.076	2.638	3.077	3.993	1.500
Average CO_2 EF (tCO_2/t oxides)	NO	NO	0.469	0.477	0.475	0.475	0.474

As it was mentioned the plant wasn't operated in 2009 and it is approved that most likely the plant will not be reopened again.

3rd bricks production plant

CO_2 emission that 3rd plant is estimated for 1998-2004 in its application for GHG permit during the implementation of ETS in Latvia by using the methodology that is not in line with 2006 IPCC Guidelines. Still in the application the plant had reported the MgO and CaO content data in used dry clay therefore the emissions were recalculated using the available activity data.

The CO_2 emissions from particular bricks production plant was recalculated for 2008 and 2009 as the methodology use was stated as consistent only in 1998-2007 although the methodology was changed in 2005. The methodology was changed from one approach – alkali earth oxides, to other approach – carbon input because the carbon input laboratory

measurement data is available since 2005. As both methodologies are appropriate and both are assumed as Tier2 therefore the methodology change was considered as acceptable.

Still for years 2008-2009 lower tier emission factor from MRG[266] – a conservative value of 0.2 tonnes $CaCO_3$ (corresponding to 0.08794 tonnes of CO_2) per tonne of dry clay, was used to estimate CO_2 emissions. The plant indicates that the lower tier use is acceptable within EU ETS as the plant is low emission producer.

Methods

For 1998-2004 the plant is using calculation method B – alkali earth oxides, from the MRG when calculation is based on the content of the CaO, MgO and other (earth) alkali.

According to bricks production plant's reported information the following equation to estimate CO_2 emissions was used:

$$CO_2 = \sum\left(\left(AD_{raw} \times AD_{CaO,MgO}\right) \times EF \times CF\right)$$

where:
CO_2 – total CO_2 emissions from bricks production (kt)
AD_{raw} – activity data of used raw materials – clay (kt)
$AD_{CaO,MgO}$ – CaO and MgO content in used raw materials (%)
EF – CO_2 emission factor of CaO and MgO (kt/kt)
CF – conversion factor

The plant for time period 2005-2007 is using the calculation method A – carbon input, from the MRG when calculation is based on the carbon input on each of the relevant raw materials. As it was mentioned above the plant in using different methodology again for 2008-2009 therefore the data was recalculated using the emission estimation method as for 2005-2007. Following equation from MRG is used to estimate emissions for 2005-2012:

$$CO_2 = \left(AD_{raw} \times AD_{CaCO_3} \times EF_{CaCO_3}\right) + \left(AD_{raw} \times AD_{MgCO_3} \times EF_{MgCO_3}\right)$$

where:
CO_2 – CO_2 emissions from 3rd bricks production plant (kt)
AD_{raw} – activity data of used clay (kt)
AD_{CaCO3} – $CaCO_3$ content in used clay (%)
EF_{CaCO3} – $CaCO_3$ emission factor (kt/kt)
AD_{MgCO3} – $MgCO_3$ content in used clay (%)
EF_{MgCO3} – $MgCO_3$ emission factor (kt/kt)

Emission factors

CO_2 emission factors for CaO and MgO – 0.785 and 1.092 for tonne CO_2 per tonne of oxide respectively, were taken from MRG[267] (Table 4.2.17).

CO_2 emission factors for $CaCO_3$ and $MgCO_3$ – 0.44 and 0.522 for tonne CO_2 per tonne of carbonates respectively, were taken from MRG[268] to recalculate the emissions (Table 6, Table 7).

Activity data

[266] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF *(page 80)*
[267] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF *(page 81)*
[268] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF *(page 79)*

For 1998-2004 emission estimation MgO and CaO content is used. According to mineral passport of State Geology Service's quarry "Progress" alkali earth oxides – MgO and CaO, contents are 8.03% and 3.02% respectively.

For years 2005-2007 emission estimation the contents of $CaCO_3$ and $MgCO_3$ are determined in plant laboratories or stated in mineral deposits passport and are 12.79% and 10.75% respectively. As for year 2008-2009 the carbonates input percentage amount is not known the data of 2005-2007 was used (Table 6, Table 7).

According to production plant's application for GHG permit and annual GHG reports activity data of used raw materials is estimated using following equation:

$$AD_{raw} = AD_{clay} \times (1 - M)$$

where:
AD_{raw} – activity data of used raw materials – dray clay (kt)
AD_{clay} – amount of used clay (kt)
M – moisture content of clay in bricks pressing process (%)

For year 2005-2014 the activity data was estimated by using following equation from bricks production plant's GHG report:

$$AD_{raw} = \sum (AD_{bulk} \times M_{av})$$

where:
AD_{raw} – activity data of used raw materials – clay (kt)
AD_{bulk} – amount of dried bulk materials (pieces)
M_{av} – average mass with 0% moisture content (kt)

The activity data was estimated by plant randomly taking 10 examples of production from drying tunnels dried after that till 0% moisture content and weighted. After that average mass of production is estimated. Therefore for year 2005-2014 the used clay is reported already with 0% moisture content.

The used raw materials – used clay, were estimated by taking into account the moisture content of the clay.

Table 6 Data and assumptions used for CO_2 emission estimation from 3rd bricks production plant

	1990	**1995**	**2000**
use of clay (kt)	NO	NO	10.25
moisture content (%)	NO	NO	17.00%
used raw materials - dry clay (kt)	NO	NO	8.51
MgO content (%)	NO	NO	8.03%
CaO content (%)	NO	NO	3.02%
MgO amount (kt)	NO	NO	0.683
CaO amount (kt)	NO	NO	0.257
MgO CO_2 EF (tCO_2/t oxide)	NO	NO	1.092
CaO CO_2 EF (tCO_2/t oxide)	NO	NO	0.785
CO_2 emissions (kt)	**NO**	**NO**	**0.95**
Average CO_2 EF (tCO_2/t oxides)	NO	NO	1.008

Table 7 Data and assumptions used for CO_2 emission estimation from 3rd bricks production plant (continuation)

	use of clay (kt)	$MgCO_3$ content (%)	$CaCO_3$ content (%)	$MgCO_3$ amount (kt)	$CaCO_3$ amount (kt)	$MgCO_3$ CO_2 EF (tCO_2/t oxide)	$CaCO_3$ CO_2 EF (tCO_2/t oxide)	**CO_2 emissions (kt)**	Average CO_2 EF (tCO_2/t oxides)
2005	29.891	10.75%	12.79%	3.213	3.823	0.522	0.440	**3.359**	0.477
2006	22.316	10.75%	12.79%	2.399	2.854	0.522	0.440	**2.508**	0.477
2007	23.854	10.75%	12.79%	2.564	3.051	0.522	0.440	**2.681**	0.477
2008	77.687	10.75%	12.79%	8.351	9.936	0.522	0.440	**8.730**	0.477
2009	19.814	10.75%	12.79%	2.13	2.534	0.522	0.440	**2.230**	0.477
2010	32.513	10.75%	12.79%	3.495	4.158	0.522	0.440	**3.650**	0.477
2011	38.914	10.75%	12.79%	4.183	4.977	0.522	0.440	**4.370**	0.477
2012	40.698	10.75%	12.79%	4.375	5.205	0.522	0.440	**4.570**	0.477
2013	49.705	NA	NA	NA	NA	NA	NA	**4.772**	0.096
2014	63.733	NA	NA	NA	NA	NA	NA	**6.145**	0.096

According to data from plant GHG annual report average CO_2 EF=0.096 tCO_2/t oxides already include $CaCO_3$ and $MgCO_2$ emission factors.

4th bricks production plant

The CO_2 emission estimation from 4th bricks production plant is rather complicated due to allowed approach in Latvia that Latvia's ETS operator can use different methodology for every year to estimate their CO_2 emissions.

After the review of 4th bricks production plant's application for GHG permit during ETS implementation in Latvia and the plant's annual GHG reports in 2005-2008 the plant's used methodology for CO_2 emission estimation in time series is inconsistent as methodology is changed four times during whole time series:

1. CO_2 emission for time period 2000-2004 was estimated by using used clay (with moisture content 23%) as an activity data and CO_2 emission factor for used clay – 0.0658 t CO_2/t used clay. Then CO_2 emission factor for dry clay is estimated by reducing it by 23% that gives emission factor – 0.050666 tCO_2/t used clay.
2. The plant for year 2005 is using the calculation method "A" – carbon input, from the MRG when calculation is based on the carbon input on each of the relevant raw materials. The content of $CaCO_3$ and $MgCO_3$ are determined in plant laboratories or stated in mineral deposits passport. Default CO_2 emission factors from the MRG for the $CaCO_3$ and $MgCO_3$ are used.
3. For years 2006 and 2007 the plant is using calculation method B – alkali earth oxides, from the MRG when calculation is based on the content of the CaO, MgO and other (earth) alkali.

4. For year 2008 plant is using the same calculation method A as for year 2005– carbon input, from the MRG when calculation is based on the carbon input on each of the relevant raw materials. Still Tier 1 emission factors from the MRG corresponding particular method are used when conservative value of 0.2 tonnes $CaCO_3$ (0.08794 tonnes of CO_2) per tonne of dry clay is applied for the calculation of the emission factor instead of results of analyses.

To make emission estimation more consistent the CO_2 emissions from 4th bricks production plant was recalculated:

1. for years 2000-2004 were recalculate by using the $CaCO_3$ and $MgCO_3$ content data reported by plant in its application for GHG permit when ETS was implemented in Latvia – $CaCO_3$ – 11.48%, and $MgCO_3$ – 1.8%, and using emission factors from MRG.
2. For year 2006-2007 the $CaCO_3$ and $MgCO_3$ content data were estimated from MgO and CaO content data corresponding molar mass of MgO, CaO and CO_2.
3. For year 2008 the same $CaCO_3$ and $MgCO_3$ content data as for 2007 was used in emission estimation as other information was not available (Table 8).

Methods

As bricks production plant is constantly changing used methodology to estimate their annual CO_2 emissions within ETS requirements, the emissions were recalculated using the most appropriate approach for the best result. As the $CaCO_3$ and $MgCO_3$ content data was available for 2000-2004 and then for 2005 but MgO and CaO content data was available for 2006-2007 it was decided to estimate CO_2 emissions using Calculation A method – carbon input from MRG [269].

The following equation was used to estimate CO_2 emissions from 4th bricks production plant:

$$CO_2 = \left(AD_{clay} \times AD_{CaCO_3} \times EF_{CaCO_3}\right) + \left(AD_{clay} \times AD_{MgCO_3} \times EF_{MgCO_3}\right)$$

where:

CO_2 – CO_2 emissions from 4th bricks production plant (kt)
AD_{clay} – activity data of used clay (kt)
$ADCaCO_3$ – $CaCO_3$ content in used clay (%)
$EFCaCO_3$ – $CaCO_3$ emission factor (kt/kt)
$ADMgCO_3$ – $MgCO_3$ content in used clay (%)
$EFMgCO_3$ – $MgCO_3$ emission factor (kt/kt)

Emission factors

CO_2 emission factors for $CaCO_3$ and $MgCO_3$ – 0.44 and 0.522 for tonne CO_2 per tonne of carbonates respectively, were taken from Monitoring Reporting Guidelines[270] to recalculate the emissions.

Activity data

The plant reported that amount of carbonates ($CaCO_3$ and $MgCO_3$) in used clay is estimated according to chemical content of clay that was determined in Institute of Silicate Materials. For years 2005 the $CaCO_3$ and $MgCO_3$ content is taken from production plant's annual GHG

[269] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF *(pages 78,79)*
[270] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF *(page 79)*

report. For years 2006-2007 $CaCO_3$ and $MgCO_3$ data was estimated by taking into account used clay content data and its estimation parameters available from bricks production plant. For year 2008 that particular data was no available therefore the percentage amount of carbonates of year 2007 was used (Table 8).

According to production plant's application for GHG permit and annual GHG reports activity data of used raw materials is estimated using following equation:

$$AD_{raw} = \sum \left(AD_{bulk} \times M_{av} - M_{bulk} \times moisture/100 \right) - M_{chippings} - M_{tenisite}$$

where:
AD_{raw} – activity data of used raw materials – clay (kt)
AD_{bulk} – amount of dried bulk materials (pieces)
M_{av} – average mass (kt)
M_{bulk} – mass of dried bulk materials loaded in furnace
moisture/100 – average moisture content of clay (%)
$M_{chippings}$ – mass of dried scobs (kt)
$M_{tenisite}$ – mass of tenisite (granulated burnt defectives of ceramics) (kt)

Mass of chippings wasn't taken into account as it is biomass and is assumed as CO_2 neutral. Mass of tenisite – granulated burnt defectives of previously made ceramics that is folded into mass of clay to improve lasting of final production, is not taken into account as it is secondary process and during repeated burning the CO_2 emissions are not emitted.

Table 8 Data and assumptions used for CO_2 emission estimation from 4th bricks production plant

	1990	1995	2000	2005	2006	2007	2008
use of clay (kt)	NO	NO	9.000	25.246	29.826	34.166	27.329
$MgCO_3$ content (%)	NO	NO	1.80%	6.47%	6.47%	6.67%	6.67%
$CaCO_3$ content (%)	NO	NO	11.48%	14.62%	14.62%	13.71%	13.71%
$MgCO_3$ amount (kt)	NO	NO	0.162	1.634	1.929	2.28	1.824
$CaCO_3$ amount (kt)	NO	NO	1.033	3.691	4.361	4.684	3.747
$MgCO_3$ CO_2 EF (tCO_2/t oxide)	NO	NO	0.522	0.522	0.522	0.522	0.522
$CaCO_3$ CO_2 EF (tCO_2/t oxide)	NO	NO	0.440	0.440	0.440	0.440	0.440
CO_2 emissions (kt)	NO	NO	0.539	2.477	2.926	3.251	2.601
Average CO_2 EF (tCO_2/t oxides)	NO	NO	0.451	0.465	0.465	0.467	0.467

In year 2009 the bricks production plant is not operating due to economic crisis that affected construction sector in Latvia where demand of the production sharply decreased. Still the non-operation of particular plant is assumed only temporary and it is prospective that plant will be operating again.

5th bricks production plant

In the bricks production plant's application for GHG permit during the implementation of ETS in Latvia in 2005 the CO_2 emission for time period 1993-2004 was estimated by using used clay as an activity data and CO_2 emission factor for used clay – 0.047 tCO_2/t used clay. After the review of the GHG report it was stated that plant is using the total used clay data as activity data instead of using particular CaO and MgO data even the MgO and CaO content is determined in Riga Technical University Institute of Silicate Materials for the clay used in particular plant. The plant's used an unknown source CO_2 EF for time series 1993-2004 therefore plant's reported data were recalculated according to available information and using the methodology from plant's latest reported annual GHG reports.

Methods

The particular bricks production plant is using Calculation method B – alkali earth oxides, from MRG[271]. According to MRG calcination of CO_2 is calculated based on the amounts of ceramics produced and the CaO, MgO and other (earth) alkali oxide contents of the ceramics.

Following equation from bricks production plant's annual GHG reports within EU ETS was used to estimate CO_2 emissions.

$$CO_2 = \sum \left(\left(AD_{raw} \times AD_{CaO,MgO} / 100 \right) \times EF \times CF \right)$$

where:
CO_2 – total CO_2 emissions from bricks production (kt)
AD_{raw} – activity data of used raw materials – clay (kt)
$AD_{CaO,MgO}$% / 100 – CaO and/or MgO content in used raw materials (%)
EF – CO_2 emission factor of CaO and/or MgO (kt/kt)
CF – conversion factor

For some years in bricks production also $CaCO_3$ was used as additive to clay for yellow bricks production. Following equation from plant's annual GHG reported was used to estimate CO_2 emissions from $CaCO_3$ use:

$$CO_2 = \sum \left(\left(AD_{raw} \times AD_{additive} / 100 \right) \times 1.785 \times EF \times CF \right)$$

where:
CO_2 – total CO_2 emissions from additive use (kt)
AD_{raw} – activity data of used raw materials – clay (kt)
$AD_{additive}$% / 100 – CaO content in used raw materials (%)
1.785 – factor to estimate CaO from used $CaCO_3$ data
EF – CO_2 emission factor of CaO (kt/kt)
CF – conversion factor

In latest years 2008-2013 the CO_2 emissions were estimated for different bulks of used clay therefore CaO and MgO content data for these bulks differs. Therefore the CO_2 emissions were estimated separately. In 2014 there is used EF=0.014 (tCO_2/t oxides) that already include CO_2 EFs from MgO and CaO (Table 9).

Table 9 Data and assumptions used for CO_2 emission estimation from 5th bricks production plant

	Use of clay (kt)	MgO content (%)	CaO content (%)	MgO amount (kt)	CaO amount (kt)	MgO CO_2 EF (tCO_2/t oxide)	CaO CO_2 EF (tCO_2/t oxide)	$CaCO_3$ (additive) (kt)	**CO_2 emissions (kt)**	Average CO_2 EF (tCO_2/t oxides)
1990	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1995	107.38	1.43%	10.39%	1.536	11.152	1.092	0.785	0.000	**10.431**	0.822
2000	112.50	1.43%	10.39%	1.609	11.683	1.092	0.785	0.000	**10.928**	0.822
2005	88.29	0.39%	1.75%	0.344	1.545	1.092	0.785	0.000	**1.589**	0.841
2006	94.44	0.39%	1.75%	0.368	1.653	1.092	0.785	0.342	**1.849**	0.841

[271] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF *(page 80)*

	Use of clay (kt)	MgO content (%)	CaO content (%)	MgO amount (kt)	CaO amount (kt)	MgO CO_2 EF (tCO_2/t oxide)	CaO CO_2 EF (tCO_2/t oxide)	$CaCO_3$ (additive) (kt)	**CO_2 emissions (kt)**	Average CO_2 EF (tCO_2/t oxides)
2007	80.90	0.36%	1.47%	0.291	1.189	1.092	0.785	1.218	**1.787**	0.845
2008	26.32	1.23%	0.32%	0.324	0.084	1.092	0.785	0.000	**1.594**	1.029
	28.33	1.35%	0.41%	0.382	0.116	1.092	0.785			1.020
	28.82	1.26%	0.38%	0.363	0.110	1.092	0.785			1.021
	13.21	1.09%	0.25%	0.144	0.033	1.092	0.785			1.035
2009	1.05	1.09%	0.25%	0.011	0.003	1.092	0.785	0.000	**0.647**	1.035
	21.02	1.07%	0.27%	0.225	0.057	1.092	0.785			1.030
	22.05	1.16%	0.27%	0.256	0.060	1.092	0.785			1.034
	1.19	1.12%	0.23%	0.013	0.003	1.092	0.785			1.040
2010	0.82	1.12%	0.23%	0.009	0.002	1.092	0.785	1.019	**1.396**	1.040
	21.05	1.23%	0.26%	0.259	0.055	1.092	0.785			1.038
	21.15	1.13%	0.24%	0.239	0.051	1.092	0.785			1.038
	20.80	1.16%	0.28%	0.241	0.058	1.092	0.785			1.032
2011	17.72	1.12%	0.23%	0.198	0.041	1.092	0.785	2.875	**2.638**	1.040
	26.51	1.23%	0.26%	0.326	0.069	1.092	0.785			1.038
	25.05	1.13%	0.24%	0.283	0.060	1.092	0.785			1.038
	24.07	1.16%	0.28%	0.279	0.067	1.092	0.785			1.032
2012	21.17	1.12%	0.23%	0.237	0.049	1.092	0.785	2.465	**2.287**	1.040
	20.83	1.23%	0.26%	0.256	0.054	1.092	0.785			1.038
	18.59	1.13%	0.24%	0.210	0.045	1.092	0.785			1.038
	21.41	1.16%	0.28%	0.248	0.060	1.092	0.785			1.032
2013	20.75	1.02%	0.25%	0.212	0.052	1.092	0.785	5.863	**3.744**	1.032
	20.28	1.22%	0.39%	0.247	0.079	1.092	0.785			1.018
	18.48	1.20%	0.30%	0.222	0.055	1.092	0.785			1.031
	20.60	1.20%	0.03%	0.247	0.006	1.092	0.785			1.085
2014	76.93	NA	NA	NA	NA	NA	NA	6.932	**4.163**	0.014

Emission factors

CO_2 emission factors for CaO and MgO – 0.785 and 1.092 for tonne CO_2 per tonne of oxide respectively, were taken from MRG[272]. In plant's application to GHG permit unknown source emission factor was used therefore the data for 1993-2004 was recalculated using emission factor from MRG.

Activity data

According to production plant's application for GHG permit and annual GHG reports activity data of used raw materials is estimated using following equation:

[272] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF *(page 81)*

$$AD_{raw} = \sum \left(AD_{bulk} \times M_{av} - M_{bulk} \times moisture/100 \right)$$

where:
AD_{raw} – activity data of used raw materials – clay (kt)
AD_{bulk} – amount of dried bulk materials (pieces)
M_{av} – average mass (kt)
M_{bulk} – mass of dried bulk materials
moisture/100 – content of moisture (%)

Content of CaO and MgO in used clay is determined in independent certified laboratory taking analysis of used clay. Used additives – $CaCO_3$ (limestone flour) is weighted in production plant before addition to clay.

For years 1993-2004 the CaO and MgO content was unknown as such laboratory measurements were not done before EU ETS implementation requirements. The CaO and MgO content data was determined only in the end of 2003. This particular amount was then used for all years in time period 1993-2004 as other data was not available.

A.3.7 Agriculture

Manure Management Systems distribution, 1990-2014

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Dairy cows																									
Pasture/Range/Paddock	0.12	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.07
Solid storage	0.83	0.83	0.82	0.82	0.81	0.81	0.80	0.79	0.78	0.77	0.76	0.72	0.72	0.71	0.70	0.70	0.69	0.67	0.64	0.62	0.60	0.58	0.56	0.54	0.53
Liquid/ Slurry	0.05	0.06	0.07	0.07	0.08	0.08	0.09	0.10	0.11	0.12	0.13	0.18	0.19	0.19	0.20	0.21	0.22	0.24	0.27	0.29	0.27	0.28	0.25	0.24	0.27
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.04	0.05	0.11	0.14	0.13
Sheep																									
Pasture/Range/Paddock	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Solid storage	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Goats																									
Pasture/Range/Paddock	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Solid storage	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Horses																									
Pasture/Range/Paddock	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Solid storage	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sows and boars																									
Pasture/Range/Paddock	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid storage	0.72	0.71	0.69	0.68	0.66	0.64	0.62	0.60	0.57	0.55	0.53	0.48	0.44	0.40	0.37	0.33	0.30	0.28	0.25	0.23	0.21	0.18	0.16	0.14	0.12
Liquid/ Slurry	0.28	0.29	0.31	0.32	0.34	0.36	0.38	0.41	0.43	0.45	0.47	0.52	0.56	0.60	0.63	0.67	0.70	0.72	0.75	0.77	0.71	0.71	0.61	0.56	0.52
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.08	0.11	0.24	0.30	0.36

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Piglets																									
Pasture/Range/Paddock	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid storage	0.72	0.71	0.70	0.68	0.67	0.65	0.63	0.60	0.58	0.56	0.53	0.49	0.45	0.41	0.37	0.34	0.31	0.28	0.26	0.23	0.21	0.19	0.16	0.14	0.12
Liquid/ Slurry	0.28	0.29	0.30	0.32	0.33	0.35	0.38	0.40	0.42	0.45	0.47	0.51	0.55	0.59	0.63	0.67	0.69	0.72	0.74	0.77	0.71	0.71	0.60	0.56	0.52
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.08	0.11	0.23	0.30	0.36
Fattening and young breeding pigs																									
Pasture/Range/Paddock	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid storage	0.71	0.70	0.68	0.67	0.65	0.63	0.61	0.58	0.56	0.54	0.52	0.47	0.43	0.39	0.35	0.32	0.29	0.27	0.24	0.22	0.20	0.17	0.15	0.13	0.11
Liquid/ Slurry	0.29	0.30	0.32	0.33	0.35	0.37	0.39	0.42	0.44	0.46	0.49	0.53	0.57	0.61	0.65	0.68	0.71	0.73	0.76	0.78	0.72	0.72	0.61	0.56	0.52
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.09	0.11	0.24	0.31	0.36
Laying hens																									
Pasture/Range/Paddock	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03
Solid storage	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.87	0.84	0.71	0.63	0.46
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.10	0.13	0.26	0.35	0.51
Broilers																									
Pasture/Range/Paddock	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid storage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Turkeys																									
Pasture/Range/Paddock	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Solid storage	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Ducks																									
Pasture/Range/Paddock	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Solid storage	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Geese																									
Pasture/Range/Paddock	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Solid storage	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Rabbits																									
Pasture/Range/Paddock	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid storage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Fur animals																									
Pasture/Range/Paddock	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid storage	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Deer																									
Pasture/Range/Paddock	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Solid storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Dairy cattle calves under 1 year																									
Pasture/Range/Paddock	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.09	0.08	0.08
Solid storage	0.88	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.91	0.91	0.88	0.88	0.84	0.81	0.82
Liquid/ Slurry	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.03	0.04	0.08	0.11	0.10

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Beef cattle calves under 1 year																									
Pasture/Range/Paddock	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Solid storage	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Liquid/ Slurry	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Dairy cow young cattle, aged 1-2 years																									
Pasture/Range/Paddock	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.09	0.08	0.08
Solid storage	0.88	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.91	0.91	0.88	0.88	0.84	0.81	0.82
Liquid/ Slurry	NO	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.03	0.04	0.08	0.11	0.10
Beef young cattle, aged 1-2 years																									
Pasture/Range/Paddock	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Solid storage	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Liquid/ Slurry	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Bulls over 2 year																									
Pasture/Range/Paddock	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Solid storage	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Heifers over 2 years																									
Pasture/Range/Paddock	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Solid storage	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Other cows over 2 year																									
Pasture/Range/Paddock	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Solid storage	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Liquid/ Slurry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Anaerobic digester	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Annex 4: National energy balance of Latvia in 2014 (TJ)

	Oil products - total	Shale oil	Liquefied petroleum gas	Motor and aviation petrol	Petrol type jet fuel	Kerosene type jet fuel	Kerosene	Diesel oil (oven fuel inclusive)	Residual (heavy) fuel oils	White spirit	Lubricants	Oil bitumen	Paraffin waxes	Other oil products	Used oils	Coal	Peat	Peat briquettes	Coke oven coke	Natural gas	Fuelwood	Used tires	Municipal waste for heating	Charcoal	Bioethanol	Biodiesel	Landfill gas	Sewage sludge gas	Other biogas	Straw
NCV		39.35	45.54	43.97	43.21	43.21	43.2	42.49	40.6	41.86	41.86	41.86	41.86	41.86	29.23	24.16	10.05	15.49	26.79	34.57		27.98	17.05	30	0.03	0.04	19.02	20.49	19.02	14.4
Production																	50				85567					2788	355	93	2688	99
Recycled products	29														29							168	171							
Imports	89374	79	8971	9491		4796	43	58254	41	42	1426	3014	335	2882		2061			0	32733	2454	196	2046	60	259	380				
Imported for bunkering	9712							2932	6780																					
Exports	35007	79	4645	912		173	43	25027	487		836			2805		145					30318			360	11	2454				
Bunkering	9712							2932	6780																					
Interproduct transfers																														
Stock changes	5225		-91	791				4122	487		42	-84		-42		557	-20	5		12653	-1782		153		9	27				
Statistical difference	31			-352				383																						
Gross energy consumption	59652		4235	9018		4623		37732	41	42	632	2930	335	35	29	2473	30	5	0	45386	55921	364	2370	-300	257	741	355	93	2688	99
Transformation	-51		-7					-34	-10							-244				-30263	-13694			390			-214	-93	-2473	-23
electricity plants																					-41									
public CHP	-10							-10								-167				-26460	-6575						-31	-93	-1842	
autoproducer CHP																				-506	-481						-183		-631	
public heat plants	-23		-1					-12	-10							-8				-2580	-4568									
autoproducer heat plants	-18		-6					-12								-69				-717	-1245									-23
production of peat briquettes																														
charcoal production																					-784			390						

	Oil products - total	Shale oil	Liquefied petroleum gas	Motor and aviation petrol	Petrol type jet fuel	Kerosene type jet fuel	Kerosene	Diesel oil (oven fuel inclusive)	Residual (heavy) fuel oils	White spirit	Lubricants	Oil bitumen	Paraffin waxes	Other oil products	Used oils	Coal	Peat	Peat briquettes	Coke oven coke	Natural gas	Fuelwood	Used tires	Municipal waste for heating	Charcoal	Bioethanol	Biodiesel	Landfill gas	Sewage sludge gas	Other biogas	Straw
Energy sector	286							286												830									
Losses																				588									
Final consumption	59315		4228	9018		4623		37412	31	42	632	2930	335	35	29	2229	30	5	0	13705	42227	364	2370	90	257	741	141		215	76
Transport	44951		2646	8621		4623		28468			593														257	666				
international air transport	4580					4580																							
domestic air transport	47			4		43																							
road transport	37206		2646	8617				25409			534														257	583				
rail transport	2948							2889			59															83				
inland shipping	170							170																					
pipeline transport																													
Industry and construction	5590		423	43				1722	31	42		2930	335	35	29	1336	20	4	0	5028	14792	364	2370			4			32	
manufacture of metals																				13									
manufacture of chemicals and chemical products	202		144	1				15		42							10	1		309	275					1			30	
manufacture of other fabricated metal products																				72									
manufacture of other non-metallic mineral products	275							275								1254				1352		364	2370			3			
manufacture of transport equipment	37		11					26											0	54	0								
machinery	29		15					14								24		2		235	123								
mining and quarrying	194			1				193									10	1		43	0								
manufacture of	411		160	4				152	31					35	29	24				1627	452							2	

	Oil products - total	Shale oil	Liquefied petroleum gas	Motor and aviation petrol	Petrol type jet fuel	Kerosene type jet fuel	Kerosene	Diesel oil (oven fuel inclusive)	Residual (heavy) fuel oils	White spirit	Lubricants	Oil bitumen	Paraffin waxes	Other oil products	Used oils	Coal	Peat	Peat briquettes	Coke oven coke	Natural gas	Fuelwood	Used tires	Municipal waste for heating	Charcoal	Bioethanol	Biodiesel	Landfill gas	Sewage sludge gas	Other biogas	Straw
food products, beverages and tobacco																													
manufacture of paper and paper products	6		4					2												97	3								
manufacture of wood and of products of wood and cork	524		25	13				360					126							535	13747								
construction	3642		52	23				637				2930				24				407	51								
manufacture of textiles	3							3								10				219	0								
manufacture of other products	267		12	1				45					209							65	141								
Other sectors	8774		1159	354				7222			39					893	10	1		8677	27435			90		71	141		183	76
other consumers - commercial and public sector	2111		155	44				1912								338	10	1		3803	3462					12	141			30
households	2283		957	264				1062								531				4252	23690			90						
crop and animal production, hunting and related service activities; forestry and logging	4078		45	44				3951			38					24		0		622	276					59			183	46
fishing	302		2	2				297			1										7									

Annex 5: Other

Additional information on CSB Integrated Statistical Data Management System (ISDMS)

ISDMS contents:

Following business application software modules are covering and supporting all phases of the statistical data processing:

Core metadata base module – the key part of the system ensures metadata collection and storage, defines all entire system processes starting from data collection and ending with output reports preparation. All System software modules are linked with the Core Metadata module.

Registers module – ensure system users with the full range of respondents data.

Data entry and validation module – generates date entry and validation applications, executes validation and data editing processes and storage clean data sets in the Micro Data Base.

Web based data collection module – ensures electronic data collection via Web.

Data aggregation module – ensures data aggregation on different conditions and storage of the aggregated data sets in the Macro Data Base.

Data analysis module – via micro data export to MS Excel and/or Access ensures data analysis processes, MS OLAP tools are available for data analysis as well.

Data dissemination module – ensures data storage for publication at CSB web.

User's administration module – administrates user roles and rights.

ISDMS advantages:

- Standardized data entry, processing and storage procedures => process oriented data processing.
- Centralized processing and storage of all types of statistical data, including metadata, by using data warehouse technologies and OLAP tools.
- The system is connected to Business Register => direct respondent basic data retrieval and updating.
- Special import and export procedure is created for data exchange with other systems.

A link with PC Axis is created for electronic data dissemination

Annex 6: Supplementary information under Article 6., 12., 17

In 2015 there are no Joint Implementation Project (Article 6) and no Clean Development Mechanism (Article 12) projects in Latvia.

There are no specific limitation rules for the operators and/or person accounts in Latvia's of holding of Kyoto protocol units with exception of AAUs that could be held only in the National Holding Account.

The list given below includes the legal entities that have active accounts in Latvia's ETR at the end of 2015 and doesn't include accounts that were closed after the compliance period 30/04/2015.

Legal entities authorized to participate in the mechanisms under Articles 6, 12 and 17 of the Kyoto Protocol

Legal entities authorized to participate in the mechanisms under Article 6, 12 and 17 of the Kyoto Protocol)	**Account ID**	**Role**
A/S "Olaines udens un siltums"	LV-HOLDING_ACCOUNT-5012073-0-4	Latvia's ETR operator (obligatory participation)
Pasvaldibas SIA "Ventspils siltums"	LV-HOLDING_ACCOUNT-5012074-0-96	Latvia's ETR operator (obligatory participation)
Pasvaldibas SIA "Ventspils siltums"	LV-HOLDING_ACCOUNT-5012075-0-91	Latvia's ETR operator (obligatory participation)
AS "Latvenergo" TEC-1	LV-HOLDING_ACCOUNT-5012078-0-76	Latvia's ETR operator (obligatory participation)
AS "Latvenergo" TEC-2	LV-HOLDING_ACCOUNT-5012079-0-71	Latvia's ETR operator (obligatory participation)
SIA "Fortum Jelgava"	LV-HOLDING_ACCOUNT-5012080-0-66	Latvia's ETR operator (obligatory participation)
SIA "Fortum Jelgava"	LV-HOLDING_ACCOUNT-5012081-0-61	Latvia's ETR operator (obligatory participation)
SIA "Livanu siltums"	LV-HOLDING_ACCOUNT-5012084-0-46	Latvia's ETR operator (obligatory participation)
SIA "Aizkraukles siltums"	LV-HOLDING_ACCOUNT-5012085-0-41	Latvia's ETR operator (obligatory participation)
A/S "Rigas siltums" katlu maja Gobas iela 33a	LV-HOLDING_ACCOUNT-5012086-0-36	Latvia's ETR operator (obligatory participation)
A/S "Rigas siltums" siltumcentrale Daugavgriva	LV-HOLDING_ACCOUNT-5012087-0-31	Latvia's ETR operator (obligatory participation)
A/S "Rigas siltums" siltumcentrale Vecmilgravis	LV-HOLDING_ACCOUNT-5012088-0-26	Latvia's ETR operator (obligatory participation)
A/S "Rigas siltums" siltumcentrale Ziepniekkalns	LV-HOLDING_ACCOUNT-5012089-0-21	Latvia's ETR operator (obligatory participation)
A/S "Rigas siltums" iecirknis Zasulauks	LV-HOLDING_ACCOUNT-5012090-0-16	Latvia's ETR operator (obligatory participation)
A/S "Rigas siltums" siltumcentrale Imanta	LV-HOLDING_ACCOUNT-5012091-0-11	Latvia's ETR operator (obligatory participation)
SIA "Dobeles energija"	LV-HOLDING_ACCOUNT-5012092-0-6	Latvia's ETR operator (obligatory participation)
Ogres novada PA "Ogres namsaimnieks"	LV-HOLDING_ACCOUNT-5012093-0-98	Latvia's ETR operator (obligatory participation)
SIA "Wesemann –Sigulda"	LV-HOLDING_ACCOUNT-5012094-0-93	Latvia's ETR operator (obligatory participation)
SIA "Jurmalas siltums" Dubulti	LV-HOLDING_ACCOUNT-5012096-0-83	Latvia's ETR operator (obligatory participation)
SIA "Jurmalas siltums" Kauguri	LV-HOLDING_ACCOUNT-5012097-0-78	Latvia's ETR operator (obligatory participation)
A/S "Cesvaines piens"	LV-HOLDING_ACCOUNT-5012100-0-63	Latvia's ETR operator (obligatory participation)
SIA "Rigas laku un krasu rupnica"	LV-HOLDING_ACCOUNT-5012101-0-58	Latvia's ETR operator (obligatory participation)

Legal entities authorized to participate in the mechanisms under Article 6, 12 and 17 of the Kyoto Protocol)	**Account ID**	**Role**
A/s "Putnu fabrika Kekava""	LV-HOLDING_ACCOUNT-5012102-0-53	Latvia's ETR operator (obligatory participation)
A/S "Rigas kugu buvetava"	LV-HOLDING_ACCOUNT-5012103-0-48	Latvia's ETR operator (obligatory participation)
A/S "BLB Baltijas Terminals"	LV-HOLDING_ACCOUNT-5012104-0-43	Latvia's ETR operator (obligatory participation)
SIA "Kraslavas 781ame"	LV-HOLDING_ACCOUNT-5012106-0-33	Latvia's ETR operator (obligatory participation)
SIA "Cesu siltumtikli"	LV-HOLDING_ACCOUNT-5012108-0-23	Latvia's ETR operator (obligatory participation)
PAS "Daugavpils siltumtikli" SC3	LV-HOLDING_ACCOUNT-5012110-0-13	Latvia's ETR operator (obligatory participation)
PAS "Daugavpils siltumtikli" SC1	LV-HOLDING_ACCOUNT-5012111-0-8	Latvia's ETR operator (obligatory participation)
PAS "Daugavpils siltumtikli" SC2	LV-HOLDING_ACCOUNT-5012112-0-3	Latvia's ETR operator (obligatory participation)
A/S "Ligija teks"	LV-HOLDING_ACCOUNT-5012113-0-95	Latvia's ETR operator (obligatory participation)
SIA "Jekabpils siltums"	LV-HOLDING_ACCOUNT-5012114-0-90	Latvia's ETR operator (obligatory participation)
A/S "Valmieras piens"	LV-HOLDING_ACCOUNT-5012117-0-75	Latvia's ETR operator (obligatory participation)
SIA "Lauma Fabrics"	LV-HOLDING_ACCOUNT-5012119-0-65	Latvia's ETR operator (obligatory participation)
SIA "Liepajas energija"	LV-HOLDING_ACCOUNT-5012120-0-60	Latvia's ETR operator (obligatory participation)
SIA "Liepajas energija"	LV-HOLDING_ACCOUNT-5012121-0-55	Latvia's ETR operator (obligatory participation)
A/S "Preilu siers"	LV-HOLDING_ACCOUNT-5012122-0-50	Latvia's ETR operator (obligatory participation)
SIA "Ogres Trikotaza"	LV-HOLDING_ACCOUNT-5012123-0-45	Latvia's ETR operator (obligatory participation)
SIA "Salaspils siltums"	LV-HOLDING_ACCOUNT-5012124-0-40	Latvia's ETR operator (obligatory participation)
A/S "Latvijas finieris" rupnica "Furniers"	LV-HOLDING_ACCOUNT-5012125-0-35	Latvia's ETR operator (obligatory participation)
A/S "Latvijas Finieris" rupnica "Lignums"	LV-HOLDING_ACCOUNT-5012126-0-30	Latvia's ETR operator (obligatory participation)
SIA "Sabiedriba Marupe"	LV-HOLDING_ACCOUNT-5012127-0-25	Latvia's ETR operator (obligatory participation)
A/S "Ventbunkers"	LV-HOLDING_ACCOUNT-5012129-0-15	Latvia's ETR operator (obligatory participation)
SIA "Papirfabrika Ligatne"	LV-HOLDING_ACCOUNT-5012130-0-10	Latvia's ETR operator (obligatory participation)
SIA "Saulkalne S"	LV-HOLDING_ACCOUNT-5012131-0-5	Latvia's ETR operator (obligatory participation)
SIA "Brocenu keramika"	LV-HOLDING_ACCOUNT-5012132-0-97	Latvia's ETR operator (obligatory participation)
A/S "Valmieras stikla skiedra"	LV-HOLDING_ACCOUNT-5012133-0-92	Latvia's ETR operator (obligatory participation)
LODE SIA, Liepas plant	LV-HOLDING_ACCOUNT-5012135-0-82	Latvia's ETR operator (obligatory participation)
A/S "KVV Liepajas metalurgs"	LV-HOLDING_ACCOUNT-5012137-0-72	Latvia's ETR operator (obligatory participation)
LODE SIA, Ane plant	LV-HOLDING_ACCOUNT-5012141-0-52	Latvia's ETR operator (obligatory participation)
SIA "Olaines kimiska rupnica "BIOLARS""	LV-HOLDING_ACCOUNT-5012154-0-84	Latvia's ETR operator (obligatory participation)
SIA "Bolderaja Ltd"	LV-HOLDING_ACCOUNT-5012166-0-24	Latvia's ETR operator (obligatory participation)
SIA "Juglas jauda"	LV-HOLDING_ACCOUNT-5012169-0-9	Latvia's ETR operator (obligatory participation)
A/S "Valmieras Energija" Rigas iela 25	LV-HOLDING_ACCOUNT-5012171-0-96	Latvia's ETR operator (obligatory participation)

Legal entities authorized to participate in the mechanisms under Article 6, 12 and 17 of the Kyoto Protocol)	**Account ID**	**Role**
A/S "Valmieras Energija" Dzelzcela iela 7	LV-HOLDING_ACCOUNT-5012172-0-91	Latvia's ETR operator (obligatory participation)
A/S "Latvijas Gaze"	LV-HOLDING_ACCOUNT-5012173-0-86	Latvia's ETR operator (obligatory participation)
SIA "Fortum Jelgava"	LV-HOLDING_ACCOUNT-5012175-0-76	Latvia's ETR operator (obligatory participation)
SIA "Rigens"	LV-HOLDING_ACCOUNT- 5012177-0-66	Latvia's ETR operator (obligatory participation)
SIA "Jaunpagasts Plus" Jaunpagasta spirta rupnica	LV-HOLDING_ACCOUNT-5012179-0-56	Latvia's ETR operator (obligatory participation)
A/S "Rezeknes Siltumtikli" Atbrivosanas aleja 155a	LV-HOLDING_ACCOUNT-5012180-0-51	Latvia's ETR operator (obligatory participation)
A/S "Rezeknes Siltumtikli" N.Rancana iela 5	LV-HOLDING_ACCOUNT-5012181-0-46	Latvia's ETR operator (obligatory participation)
A/S "Rezeknes Siltumtikli" Meza iela 1	LV-HOLDING_ACCOUNT-5012182-0-41	Latvia's ETR operator (obligatory participation)
SIA "Gamma - A"	LV-HOLDING_ACCOUNT-5012184-0-31	Latvia's ETR operator (obligatory participation)
SIA "CEMEX"	LV-HOLDING_ACCOUNT-5012185-0-26	Latvia's ETR operator (obligatory participation)
SIA "KNAUF"	LV-HOLDING_ACCOUNT-5020444-0-53	Latvia's ETR operator (obligatory participation)
A/S "Olainfarm"	LV-HOLDING_ACCOUNT-5023045-0-46	Latvia's ETR operator (obligatory participation)
SIA "KD LATGALE"	LV-HOLDING_ACCOUNT- 5021816-0-62	Legal person
Smartlynx Airlines	LV-HOLDING_ACCOUNT-5000042-0-19	Latvia's ETR aircraft operator (obligatory participation)
A/S AirBaltic Corporation""	LV-HOLDING_ACCOUNT-5000081-0-18	Latvia's ETR aircraft operator (obligatory participation)