LATVIA'S
NATIONAL INVENTORY REPORT

Submission under UNFCCC and the Kyoto Protocol

Common Reporting Formats (CRF)
1990 – 2011

2013

PREFACE

Latvia's National Inventory Report (NIR) under the United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and Decision No 280/2004/EC contains following parts:

1. Latvia's National Inventory Report prepared using the reporting guidelines of UNFCCC 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 1990-2011 including KP-LULUCF data tables. The CRF tables are compiled with the UNFCCC CRF Reporter software (version 3.6.2.).
3. SEF (Standard Electronic Format (Excel tables)) for reporting of Kyoto units (AAU, ERU, CER, t-CER. l-CER, RMU) in the registry as for 31.12.2012 and transfers of the units during the year 2012.

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The Latvia's inventory report as well as the CRF tables can be downloaded from address: http://www.varam.gov.lv.

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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)
Gg	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

AWMS - Animal waste management systems
CRF – Common Reporting Format
CSB – Central Statistical Bureau of Latvia
EMEP/CORINAIR 2007 – Atmospheric emission inventory guidebook, Co-operative Programme for Monitoring and Evaluation od the Long Range Transmission of Air Pollutants in Europe, The Core inventory of air emissions in Europe
EMEP/EEA - air pollutant emission inventory guidebook 2009
ETR – Emission trading registry
GHG – Greenhouse Gases
GDP – Grand domestic product
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)
IPCC 2006 – 2006 IPCC Guidelines for National Greenhouse Gas Inventories
IPE – Institute of Physical Energetic
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
MEPRD - Ministry of Environmental Protection and Regional Development
MoT - Ministry of Transport
NCV – Net calorific value
NIR – National inventory report
OECD - Organisation for Economic Co-operation and Development
REB – Regional Environment Boards
RTSD – Road Traffic Safety Department
SAM – State Agency of Medicines
SFRS – State Fire fighting & Rescue Service
SFS – State Forest Service
UN – United Nations
UNFCCC – United Nations Framework Convention on Climate Change
ERT – Expert review team
EU – European Union
ETS – Emisions trading scheme
IPPC - Integrated Pollution Prevention Control

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. In accordance with the Kyoto Protocol Latvia, individually or in a joint action with other country, should reach the level when aggregate anthropogenic CO_2, CH_4, N_2O, HFC, PFC and SF_6 emissions by the years 2008-2012 are 8% below emission level in 1990.

ES.1.2 Background information on greenhouse gas inventories

As a party to the UNFCCC and the Kyoto Protocol Latvia is required to produce and regularly update national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by Montreal Protocol from following sectors: Energy, Industrial Processes, Solvent and Other Product Use, Agriculture, Land Use, Land Use Change and Forestry and Waste.

Latvia is a member of European Union since May, 2004 and Latvia's climate change policy is based on European Union climate policy therefore according to Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementation of Kyoto Protocol article 3 (1) Member States shall report information regarding their anthropogenic GHG emissions.

Single national entity with overall responsibility for the Latvia's GHG inventory is the Ministry of Environmental Protection and Regional Development. The preparation of GHG inventory is collaborative work of different involved institutions.

This report contains of updated information on anthropogenic emissions by sources and removals by sinks for the direct CO_2, CH_4, N_2O, HFCs and SF_6 and indirect CO, NO_x, SO_2, NMVOC greenhouse gases. Greenhouse gas inventory covers the years 1990-2011.

The GHG inventory is prepared according to the UNFCCC reporting guidelines on annual inventories (UNFCCC 2006). For the preparation of the 2013 submission CRF Reporter v.3.6.2 software has been used. Greenhouse gas inventory is compiled according to the methodologies recommended by the IPCC.

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

This report also includes supplementary information in accordance with Article 7, paragraph 1, of the Kyoto Protocol. The required information is specified in the Annex of Decision 15/CMP.1 and includes information on changes in the national system and national registry, information related to Article 3, paragraphs 3 and 4, and Article 3, paragraph 14. The summary of information on the accounting of Kyoto units is provided in Chapter 12.

ES.2 SUMMARY OF NATIONAL EMISSION AND REMOVAL RELATED TRENDS

ES.2.1 GHG inventory

In 2011, Latvia's greenhouse gas emissions totalled 11494.19 Gg CO_2 eq. excluding LULUCF.

Latvia's total GHG emissions without LULUCF in 2011 showed a decrease of 56.3% comparing to the base year.

Between 1990 and 2000 GHG emissions decreased significantly as reason of crisis in Latvian national economy in the beginning and end of 1990-ties.

Latvia's emission limitation target for the Kyoto Protocol's first commitment period (2008-2012) is to limit greenhouse gas emissions to the 8% from the emissions in the base year. Latvia's base year is 1990, except for F-gas emissions for which the year 1995 was selected. The assigned amount for the first commitment period is 119182130 tonnes CO_2 equivalents, which is approximately 23836426 tonnes CO_2 eq. annually on average.

Table ES.1 Aggregated GHG emissions by gases and sectors (1990 - 2011), Gg CO_2 eq

GREENHOUSE GAS EMISSIONS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	CO_2 eq (Gg)											
CO_2 emissions including net CO_2 from LULUCF	-3432.60	-5725.36	-9302.22	-10247.59	-12836.17	-12775.30	-13154.67	-11823.06	-11195.61	-11940.56	-12471.76	-11647.56
CO_2 emissions excluding net CO_2 from LULUCF	19041.87	17486.32	14007.64	11743.53	10231.94	9036.44	9130.59	8603.33	8220.37	7627.03	6992.61	7412.10
CH_4 emissions including CH_4 from LULUCF	3496.91	3415.24	2952.74	2217.11	2043.94	2037.40	1987.35	1957.02	1870.46	1759.51	1722.60	1783.87
CH_4 emissions excluding CH_4 from LULUCF	3477.54	3392.75	2914.84	2191.70	2014.71	2001.21	1950.93	1910.64	1818.90	1701.45	1663.76	1750.96
N_2O emissions including N_2O from LULUCF	3953.05	3692.15	2901.14	2107.22	1865.91	1692.50	1677.39	1683.20	1626.58	1542.91	1561.97	1678.15
N_2O emissions excluding N_2O from LULUCF	3804.00	3541.58	2745.55	1953.73	1710.92	1535.40	1519.69	1524.13	1466.52	1381.29	1399.83	1518.40
HFCs	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	IE,NA, NE,NO	0.64	0.84	1.93	2.86	3.28	5.12	7.59
PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
SF_6	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.25	0.29	0.51	0.71	0.98	1.28	1.98
Total (including LULUCF)	**4017.36**	**1382.03**	**-3448.35**	**-5923.25**	**-8926.31**	**-9044.51**	**-9488.82**	**-8180.40**	**-7695.00**	**-8633.88**	**-9180.79**	**-8175.98**
Total (excluding LULUCF)	**26323.42**	**24420.65**	**19668.04**	**15888.95**	**13957.58**	**12573.95**	**12602.33**	**12040.54**	**11509.37**	**10714.02**	**10062.60**	**10691.03**

GREENHOUSE GAS EMISSIONS	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from 1990 to latest reported year
	CO_2 eq (Gg)										(%)
CO_2 emissions including net CO_2 from LULUCF	-10287.59	-10676.50	-10148.69	-10398.74	-11746.78	-10160.09	-11675.23	-12628.41	-8084.79	-9261.49	169.81
CO_2 emissions excluding net CO_2 from LULUCF	7409.32	7633.83	7799.15	7789.85	8273.31	8629.23	8175.66	7433.66	8529.00	8088.05	-57.52
CH_4 emissions including CH_4 from LULUCF	1778.19	1690.85	1678.89	1699.32	1677.83	1717.53	1685.77	1714.48	1717.62	1589.97	-54.53
CH_4 emissions excluding CH_4 from LULUCF	1738.22	1653.14	1644.71	1664.49	1639.56	1686.19	1657.58	1680.15	1677.19	1580.42	-54.55
N_2O emissions including N_2O from LULUCF	1646.61	1726.01	1703.29	1768.98	1773.63	1824.85	1808.37	1843.29	1905.49	1891.08	-52.16
N_2O emissions excluding N_2O from LULUCF	1484.96	1564.53	1542.04	1607.48	1609.75	1662.76	1646.26	1680.37	1742.91	1730.28	-54.51
HFCs	9.87	15.72	18.10	28.39	62.64	98.66	72.96	74.48	72.32	82.97	100.00

GREENHOUSE GAS EMISSIONS	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from 1990 to latest reported year
	CO_2 eq (Gg)										(%)
PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
SF_6	3.38	4.41	5.37	7.53	7.12	8.60	10.08	13.53	13.13	12.45	100.00
Total (including LULUCF)	**-6,849.53**	**-7,239.50**	**-6,743.03**	**-6,894.51**	**-8,225.56**	**-6,510.45**	**-8,098.06**	**-8,982.62**	**-4,376.24**	**-5,685.01**	**-241.51**
Total (excluding LULUCF)	**10,645.75**	**10,871.64**	**11,009.36**	**11,097.74**	**11,592.39**	**12,085.43**	**11,562.54**	**10,882.19**	**12,034.54**	**11,494.19**	**-56.33**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	CO_2 eq (Gg)																						(%)
1. Energy	19136.30	17664.32	14400.15	12297.42	10713.17	9514.63	9593.72	9031.25	8615.22	7961.29	7341.10	7761.67	7755.94	7953.73	7980.08	8079.26	8491.69	8816.78	8353.54	7691.09	8487.08	7857.03	-58.94
2. Industrial Processes	598.87	536.07	256.64	83.67	146.72	160.21	176.27	183.12	184.86	222.76	179.40	207.29	223.70	247.28	389.84	286.20	348.05	404.10	371.84	339.63	605.33	727.69	21.51
3. Solvent and Other Product Use	50.70	46.49	44.20	41.35	40.51	41.49	43.65	44.48	43.88	45.03	44.81	50.89	36.49	29.40	35.88	35.69	55.21	63.25	43.62	26.55	45.25	41.31	-18.52
4. Agriculture	6002.03	5628.81	4423.38	2936.83	2531.32	2331.76	2261.71	2249.97	2131.15	1943.96	1950.80	2095.95	2059.46	2112.57	2076.12	2168.30	2162.91	2254.39	2218.70	2250.75	2321.69	2315.52	-61.42
5. Land Use, Land-Use Change and Forestry(5)	-22306.06	-23038.62	-23116.38	-21812.20	-22883.89	-21618.46	-22091.15	-20220.94	-19204.37	-19347.90	-19243.39	-18867.01	-17495.28	-18111.14	-17752.40	-17992.25	-19817.94	-18595.88	-19660.60	-19864.82	-16410.78	-17179.20	-22.98
6. Waste	535.52	544.96	543.66	529.69	525.85	525.85	526.98	531.71	534.25	540.98	546.50	575.23	570.15	528.66	527.44	528.28	534.52	546.91	574.83	574.18	575.19	552.62	3.19
7. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total (including LULUCF)	**4017.36**	**1382.03**	**-3448.35**	**-5923.25**	**-8926.31**	**-9044.51**	**-9488.82**	**-8180.40**	**-7695.00**	**-8633.88**	**-9180.79**	**-8175.98**	**-6849.53**	**-7239.50**	**-6743.03**	**-6894.51**	**-8225.56**	**-6510.45**	**-8098.06**	**-8982.62**	**-4376.24**	**-5685.01**	**-241.51**

ES.2.2 KP-LULUCF activities

For the LULUCF activities under Article 3 paragraphs 3 and 4, of Kyoto Protocol Latvia has chosen period accounting. Therefore the accounting quantity will be reported in the annual report commitment submitted for the last year of the commitment period (in 2014) and calculated over the entire commitment period. Article 3.3 covers direct, human induced aforestation (A), reforestation (R) and deforestation activities, and accounting of these activities is mandatory. Under Article 3.4 Latvia has elected the activity Forest Management (FM) for the first commitment period. Latvia's cap value for the commitment period is 6233 Gg CO_2 equivalents.

ES.3 OVERVIEW OF SOURCE AND SINK CATEGORY EMISSION ESTIMATES AND TRENDS

ES.3.1 GHG inventory

The main sources of greenhouse gas emissions have been officially divided into the following sectors: Energy (CRF 1), Industrial processes (CRF 2), Solvent and other product use (CRF 3), Agriculture (CRF 4), Land use, Land use change and Forestry (LULUCF – CRF 5) and Waste (CRF 6). GHG emissions by sectors are shown in the Figure ES.1.

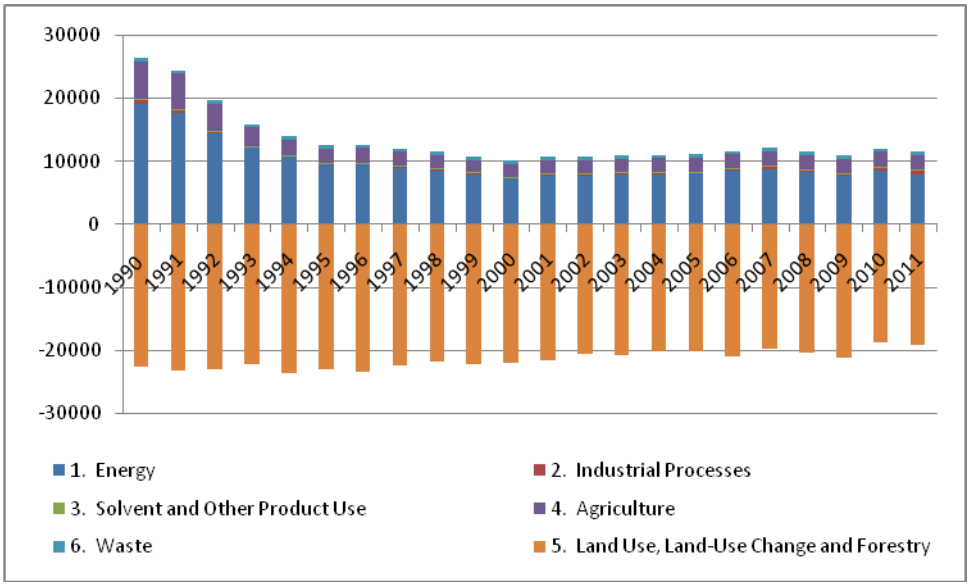


Figure ES.1. Latvian greenhouse gas emission trends by sector, Gg CO_2 eq.

The **Energy sector** is the most significant source of GHG emissions with 68.4% share of the total emissions in the 2011. GHG emissions fluctuate in the latest years mainly according to the economic trend, the energy supply structure and climate conditions. Total emissions in Energy sector in 2011 decreased by 7% because of reduced emissions mainly in stationary combustion sector – the most significant decrease in emissions are in 1.A.2 sector, especially in 1.A.2.a Iron and Steel sector where consumption of fuels decreased by 74%, 1.A.2.c Chemicals sector (-20.44%) and 1.A.2.d Pulp, Paper and Print sector (-19.08%), therefore GHG emissions in the whole 1.A.2 sector have decreased by 17.32%. There is also a great decrease of emissions in 1.A.4 sector by 5.8% – in 1.A.4.b Residential sector there is a decrease of fuels consumpted by 13.5% and in 1.A.4.a Commercial/Institutional sector by 9.66%. A large part of energy sector emissions comes from transport sector (40%), and the emissions decreased by 3.6% comparing with year 2010. One of the critical factors influencing GHG emissions in transport sector is the amount of consumed fuel. The main reason for this trend was the decreasing of fuel consumption in road transport by 2.3 % mainly affected by sharp increase in gasoline and diesel oil price.

Agriculture is the second most significant source of GHG emissions, with approximately 20 % of Latvia's total emissions. Emissions from agriculture include CH_4 and N_2O emissions. GHG emissions decreased in 2011 by 0.3% if to compare with 2010, because of small decrease of horses, swine and poultry and expansion of anaerobic digester use. The annual emissions have reduced approximately by 60% since 1990 due to decreases in the number of livestock, nitrogen fertilisation and etc.Given in CO_2 equivalents, the N_2O emission contributed with 67% of total GHG emission from the agricultural sector, but CH_4 contributed with the remaining 33% in 2011.

Emissions from the **Waste sector** consist of CH_4 and N_2O emissions and have been increased since 1990. In 2011, emissions were approximately 3.2% higher than in 1990, but compare to 2010 emissions decreased by 4% due to higher share of population, which are connected to public waste water collecting system. In 2011, emissions from the Waste sector were 552.6 Gg CO2 equivalents; it contributes 4.8 % of total GHG emissions (excluding LULUCF).

The **Industrial Processes** category contributes approximately 6.3% of the total GHG emissions. The emissions from industrial processes (referred to as non-energy related ones), include CO_2, CH_4, N_2O and F-gases. The largest decrease in emissions occurred between years 1991 and 1993, when industry was going through a crisis.

In the latest years emissions increased significantly due to overall increasing of activity for industrial production processes. In 2011, emissions increased by 19.64%, compare to 2010 due to increase of activity data in sectors 2.A.1 Cement production (increase of activity data +31.17%), 2.A.5 Asphalt roofing (increase of activity data +58.08%) and 2.A.6 Road paving with asphalt (increase of activity data +58.08%), 2.A.7 (Other) (increase of activity data +31.06%), 2.F. Consumption of Halocarbons and SF6 (about 11.5% increase of actual emissions).

Solvent and Other Product Use made only about 0.4% of Latvia's total GHG emissions. Emissions in the Solvent and Other Product Use sector are linked with the economic situation of the country. The annual emissions have reduced approximately by 18.5% since 1990. In 2011, emissions decreased by 10,47% comparing with 2010. In 2011 emissions from 3.D.5/3.D.1 Printing sector and 3.A Paint Application decreased by 87.5% and 33.4%, accordingly.

Land use, Land use change and forestry (LULUCF) is a net sink in Latvia. In 2011, CO_2 removals were -17179.2 Gg CO_2 eq compared to -2306.06Gg CO_2 eq in the base year that is approximately 23 % smaller than in 1990, because of increase of harvesting rate in forest. In 2012, it was twice higher than in 1990. Most of the removals in the LULUCF sector come from forest growth.

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 following table:

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net emissions/removals					Accounting Parameters	Accounting Quantity
	2008	2009	2010	2011	Total		
A. Article 3.3 activities							
A.1. Afforestation and Reforestation							-3,929.79
A.1.1. Units of land not harvested since the beginning of the commitment period	-908.49	-1,007.09	-1,007.09	-1,007.12	-3,929.79		-3,929.79
A.1.2. Units of land harvested since the							NA,NO

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net emissions/removals					Accounting Parameters	Accounting Quantity
	2008	2009	2010	2011	Total		
beginning of the commitment period							
Harvested lands	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO		NA,NO
A.2. Deforestation	1,079.89	1,067.95	1,044.78	1,042.65	4,235.27		4,235.27
B. Article 3.4 activities							
B.1. Forest Management	-19,093.16	-17,774.32	-14,603.09	-14,851.39	-66,321.95		-6,233.33
3.3 offset						305.48	
FM cap						6,233.33	-6,233.33
B.2. Cropland Management (if elected)	NA	NA	NA	NA	NA	NA	NA
B.3. Grazing Land Management (if elected)	NA	NA	NA	NA	NA	NA	NA
B.4. Revegetation (if elected)	NA	NA	NA	NA	NA	NA	NA

ES.4 OVERVIEW OF EMISSION ESTIMATES AND TRENDS OF INDIRECT GHG AND SO_2

Emission estimates of indirect GHG and SO_2 are presented in Table ES.2.

Table ES.2 Emissions of indirect GHG and SO_2, Gg

	NOx	CO	NMVOC	SO2
1990	64.56	455.09	101.48	104.71
1991	59.11	399.73	75.62	85.90
1992	50.04	386.83	70.86	72.87
1993	45.10	384.95	70.98	67.42
1994	42.37	372.01	69.91	67.26
1995	39.12	347.35	67.23	49.05
1996	39.45	354.62	69.80	55.19
1997	38.67	325.77	66.57	42.90
1998	37.76	305.53	64.24	38.50
1999	36.17	290.88	63.83	30.26
2000	35.85	289.21	64.59	15.77
2001	38.99	298.61	68.80	12.45
2002	38.59	287.75	64.66	11.01
2003	38.94	288.34	64.47	8.83
2004	38.64	283.70	109.51	6.78
2005	37.12	282.45	73.14	6.60
2006	37.22	281.50	74.30	5.85
2007	38.15	265.62	82.68	5.67
2008	33.90	249.08	73.45	4.77
2009	32.07	269.35	60.87	4.18
2010	34.01	258.94	66.08	3.25
2011	31.66	225.31	69.91	3.17

In the period from 1990 to 2002 indirect emissions have decreased, but starting from 2003 NO_x, NMVOC and CO started to grow as a reason of increasing firewood consumption in Residential sector as well as fuel consumption in Transport sector. SO_2 emissions have decreased significantly as reason of fuel switch and approved legislation.

PART I: ANNUAL INVENTORY SUBMISSION

CHAPTER 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 64 559 km^2 and there are 2 074 605 (2011) inhabitants. Baltic coastline is approximately 498 km. Since the beginning of the previous century the forest area of Latvia has almost doubled and currently occupies more than 51% of the total territory of the country (according to Fifth National Communication (NC5)). 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 minerals 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 hydroecosystems 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-economical systems in Latvia[1].

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. In accordance with the Kyoto Protocol Latvia, individually or in a joint action with other country, should reach the level when aggregate anthropogenic CO_2, CH_4, N_2O, HFC, PFC and SF_6 emissions by the years 2008-2012 are 8% below emission level in 1990. On 29 October 2002, The Cabinet of Ministers of the Republic of Latvia approved the Strategy of Joint Implementation for 2002-2012 as defined in the Kyoto Protocol to the UN Framework Convention on Climate Change and passed Regulations of the Cabinet of Ministers No. 653 "On the Strategy of Joint Implementation (2002-2012) as defined in the Kyoto Protocol to the UN Framework Convention on Climate Change".

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

Latvia is a member of EU since May 2004 and Latvia's climate change policy is based on Europe Union climate policy.

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, Climate Policy and Technology Department coordinate policy related to climate change and renewable energy in Latvia are the designated single national entity.

As a party of the UNFCCC, Kyoto Protocol and European Union Latvia is required to produce and regularly update report on GHG emissions and removals. This report is the annual submission of the Latvia to the UNFCCC, Kyoto Protocol and European Comission. It presents the GHG inventory, the process and the methods used for the compilation of the inventory for 1990 to 2011. The structure of this NIR follows the "Annotated outline of the national Inventory Report including elements under Kyoto Protocol" prepared by UNFCCC.

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

A summary of information on the accounting of Kyoto units is provided in Chapter 12.

1.2 DESCRIPTION OF THE INSTITUTIONAL ARRANGEMENT FOR INVENTORY PREPARATION, INCLUDING THE LEGAL AND PROCEDURAL ARRANGEMENTS FOR INVENTORY PLANNING, PREPARATION AND MANAGEMENT

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

Latvian national GHG inventory system is designed and operated according to the guidelines for national system under article 5, paragraph 1, of the Kyoto Protocol (Decision 20/CP7) to ensure the transparency, consistency, comparability, completeness and accuracy of 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) is shown in Figure 1.1.

Ministry of the Environmental Protection and Regional Development of the Republic of Latvia (MEPRD) Climate Policy and Technology Department coordinate policy related to climate change and renewable energy in Latvia as well as are designated single national entity with overall responsibility for the Latvian GHG inventory.

The MEPRD 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;
- Timely submission of GHG inventory to the UNFCCC and European Commission;
- Formal agreements with inventory experts and for 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);
- Keeping of archive of official submissions to UNFCCC and European Commission (starting from 2012 submission).

Since 1st of August 2009 Latvian Environment, Geology and Meteorology Centre (LEGMC) is a governmental limited liability company and is responsible for collecting of activity data (activity data are mainly collected from other institutions and LEGMC uses them to calculate emissions), preparation of the emission estimates for the Energy, Industrial Processes, Solvent and Other Product use and Waste sectors, preparation of QC procedures for relevant categories and documentation and archiving of used materials for emission calculation. For submission 2013, LEGMC compile the final NIR using information from all involved institutions.

Since submission 2009, removals and emission calculations for the LULUCF sector were done by Latvian State Forest Research Institute "Silava" in collaboration with MoA. "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.

Since submission 2009, Institute of Physical Energetic (IPE) calculates emissions for Transport sector according to agreement with MEPRD. 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.

Since submission 2012, emissions 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 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 Central Statistical Bureau of Latvia (CSB). Mainly MEPRD, LEGMC, IPE, Latvia University of Agriculture contacted with five CSB experts.

In 2013, Steering committee of GHG inventory preparation was established for advisory purposes.

Before final GHG inventory are submitted to European Commission and UNFCCC secretariat it is forwarded to the involved ministries for review and approving. Based on received coments inventory are corrected appropriate.

Several meetings (related Energy, LULUCF, Agriculture, Industrial Processes, Waste) 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 was discussion 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 involved in preparing activity data and calculating emissions are summarized in the Table 1.1.

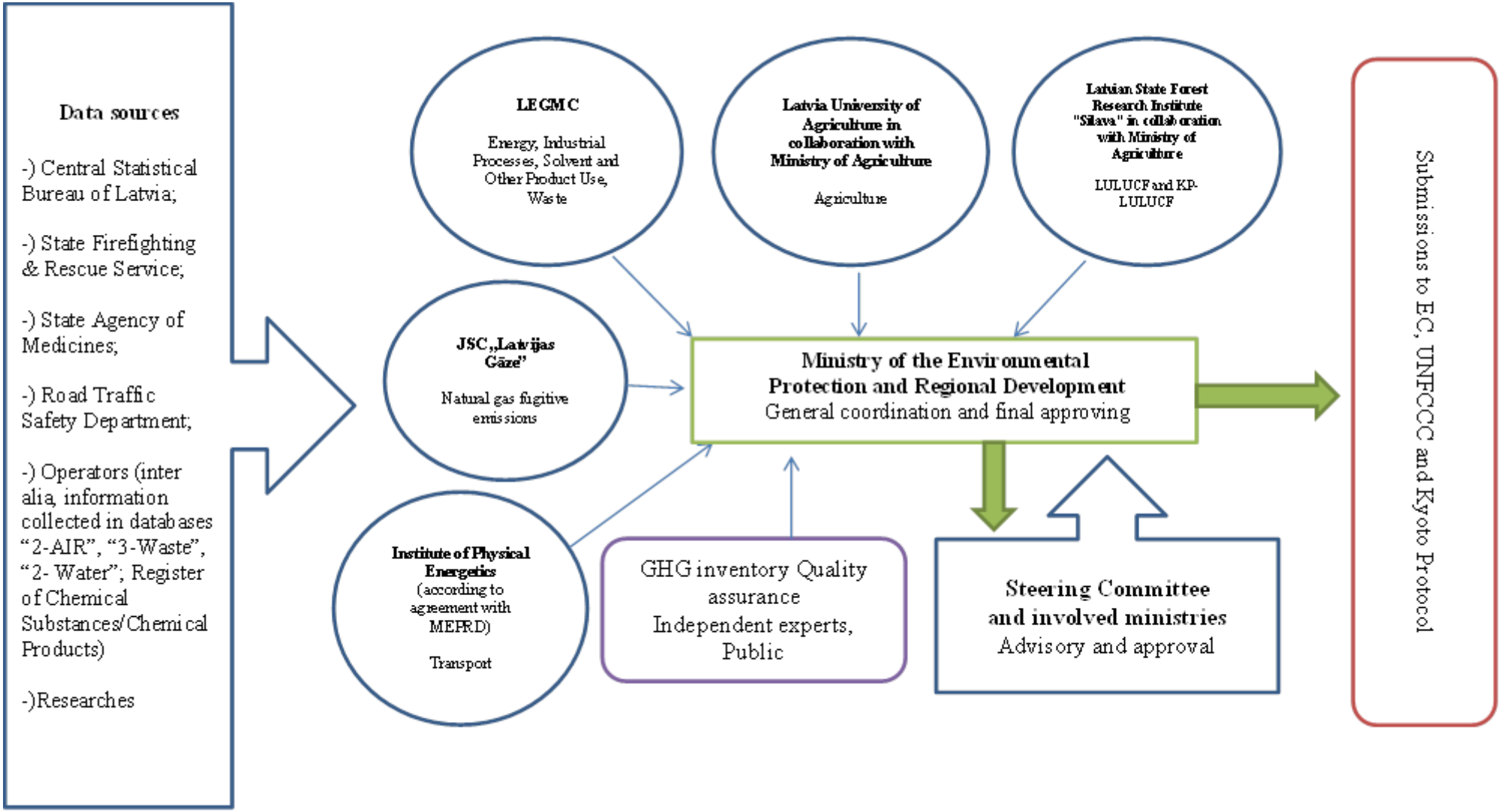


Figure 1.1 The structure of National Inventory System

Table 1.1 Institutions responsible for activity data and calculating emissions

CRF sectors	Data	Responsible institutions
Table 1.A(a) - Fuel Combustion Activities (Sectoral Approach)	Activity data	CSB, Road Traffic Safety Department (RTSD)
	Calculations	LEGMC, Institute of Physical Energetics (IPE)
Table 1.A(b) – CO_2 from Fuel Combustion Activities – Reference Approach	Activity data	CSB
	Calculations	LEGMC
Table 1.A(d) – Feedstock's and Non-Energy Use of Fuels	Activity data	CSB
	Calculations	LEGMC
Table 1.B.2. – Fugitive Emissions from Oil and Natural Gas	Activity data	CSB
	Calculations	LEGMC, JSC "LatvijasGāze"
Table 1.C – International Bunkers and Multilateral Operations	Activity data	CSB
	Calculations	LEGMC
Table 2(I).A-G – Industrial Processes	Activity data	CSB, EU Emission Trading Scheme operator
	Calculations	LEGMC, EU Emission Trading Scheme operators
Table 2(II) F – Industrial Processes - HFCs, PFCs AND SF_6	Activity data	Central Statistical Bureau; Latvenergo AS; State Agency of Medicines; Enterprises operating with F-gases (reported to Chemicals Register of LEGMC)
	Calculations	LEGMC
Table 3 – Solvent and Other Product Use	Activity data	CSB; State Agency of Medicines; Research of experts; LEGMC "2-AIR" and "Chemical" databases
	Calculations	LEGMC
Table 4.A – Agriculture, Enteric Fermentation	Activity data	CSB
	Calculations	Latvia University of Agriculture
Table 4.B(a) - Agriculture, CH_4 Emissions from Manure Management	Activity data	CSB
	Calculations	Latvia University of Agriculture
Table 4.B(b) - Agriculture, N_2O Emissions from Manure Management	Activity data	CSB
	Calculations	Latvia University of Agriculture
Table 4.D - Agriculture, Agricultural Soils	Activity data	CSB
	Calculations	Latvia University of Agriculture
Table 5. A. Forest Land Table 5. B. Cropland Table 5. C. Grassland Table 5. D. Wetlands Table 5. E. Settlements Table 5. F. Other Land	Activity data	CSB; Starting from 2007 National Forest resource monitoring program (FRM)
	Calculations	Latvian State Forest Research Institute "Silava" collaborated withMinistry of Agriculture
Table 5. B. Cropland – 5.B.1 Cropland remaining Cropland	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 5. C. Grassland – 5.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"

CRF sectors	Data	Responsible institutions
Table 5.(IV) CO_2 emissions from agricultural lime application	Activity data	CSB
	Calculations	Latvian State Forest Research Institute "Silava"
Table 5. (V) Biomass Burning	Activity data	CSB; State Firefighting& Rescue Service
	Calculations	Latvian State Forest Research Institute "Silava"
KP LULUCF	Activity data	Latvian State Forest Research Institute "Silava"
	Calculations	Latvian State Forest Research Institute "Silava"
Table 6 A - Waste, Solid Waste Disposal on Land	Activity data	LEGMC, Methane recovery installations
	Calculations	LEGMC
Table 6 B - Waste, Wastewater Handling	Activity data	CSB, LEGMC
	Calculations	LEGMC
Table 6 C - Waste, Waste Incineration	Activity data	LEGMC
	Calculations	
Table 6 D – Waste Other (composting)	Activity data	LEGMC

1.3 INVENTORY PREPARATION

Latvia prepares a National Inventory Report (NIR) and Common Reporting Format (CRF) tables annually according to requirements of the UNFCCC, the Kyoto Protocol and the EU greenhouse gas monitoring mechanism. The 2013 submission contains estimates for the 1990-2011.

The organization of the preparation and reporting of Latvia's greenhouse gas inventory and the responsibilities of its different parties are detailed in the section 1.2.1 and Table 1.2

All involved institutions to the GHG inventory system produce emission estimates according to Regulation of Cabinet of Ministers No.217 inter alias the UNFCCC reporting guidelines.

Ministry of Environmental Protection and Regional Development in coloboration with other involved institutions prepares final NIR and submits GHG inventory, including CRF tables to the UNFCCC Secretariat and to the European Commission.

The annual GHG inventory is prepared according to reporting schedule.

Concerning EU monitoring mechanism to the Commission:

- the annual inventory is submitted by 15th January;
- updated submission by 15th March.

Concerning UNFCCC:

- the annual inventory is submitted by 15th April.

Table 1.2 Inventory preparation plan

Element	Activity	Responsible performers	Procedures	Due date
To reconsider the changes needed for the next year's submission, taking into account comments and recommendations made by the review team (ERT)	All institutions		All institutions involved in inventory preparation process to reconsider the changes needed for the next year's submission, 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		All institutions involved in inventory preparation and approval process to participate in annual workshop where all things relating next year's submission is discussed, including necessary improvements, changes and problems.	till 30th June
Additional meetings	All institutions involved in GHG emissions and removals preparation		Additional meetings was organized for solving different problems regarding reviews, quality control activities etc.	during inventory preparation cycle
Agreement on the changes and adjustments to be made for next year's reporting	All institutions		All institutions involved in inventory preparation and approval process to come to an agreement on the changes and adjustments to be made for next year are reporting.	till 1st August
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. LEGMC uses these data in GHG inventory.	till 30th March
		Operators	LEGMC collects information for emission calculation for CRF2, CRF 3, CRF 6 in following databases: • "2-AIR" database; • "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 15th June till 1st October
		Statistical bureau of Latvia (CSB)	CSB send to LEGMC activity data regarding Energy, Agriculture, and Industrial Processes sectors according to interdepartmental contract. Many of received and used activity data is available in statistical databases: http://www.csb.gov.lv/csp/content/?lng=en&cat=355	till 1st October
		State Firefighting & Rescue Service (SFRS)	SFRS send to LEGMC activity data - area of last years grass burning (ha).	till 1st October
		Ministry of Health collaborating with State Agency of Medicines (SAM)	SAM sends to LEGMC activity data.	till 1st October
Emissions and descriptions	Submission to MoA and MEPRD	Latvia University of Agriculture collaborated with Ministry of Agriculture	Latvia University of Agriculture send to MEPRD report about emissions from Agriculture, including information about used assumptions, activity data which was received from CSB.	till 1st December

Element	Activity	Responsible performers	Procedures	Due date
Emissions and descriptions	Submission to MEPRD	IPE according to agreement with Ministry of Environmental Protection and Regional Development	IPE send to MEPRD report about emissions from Transport, including information about activity data, which was received from CSB.	till 1st December
		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
CO_2 removals and emissions, descriptions	Submission to MoA and MEPRD	Latvian State Forest Research Institute (LSFRI) "Silava" collaborated with Ministry of Agriculture	LSFRI "Silava" send to MoA and MEPRD NIR relevant chapters, CRF about CO_2 removals and emissions from LULUCF	till 1st December
CRF tables (XML)	Compilation of the CRF tables and QC by the LEGMC experts	LEGMC	LEGMC experts compile CRF tables, QC and send to national inventory compiler	till 10th December
CRF data Draft NIR according to Decision 280/2004/EC	CRF, NIR	MEPRD	After corrections MEPRD send to EC CRF tables and draft short NIR through the Permanent Representation. MEPRD uploaded CRF tables, XML and draft NIR in the EIONET CDR and electronically sent to EC notification about uploaded data.	15th January
Quality control checks	QA/QC procedures, reports according to QC plan	MEPRD Other institutions involved in the preparation process	According to QC plan internal review was carried out.	January - February
NIR 1st draft		sectoral experts	Sectoral experts send NIR 1st draft to MEPRD (national inventory compiler)	End of January
NIR 1st draft		MEPRD	MEPRD send to involved institutions NIR 1st draft for comments and approving.	till 30 January
NIR 1st draft		Involved institutions	Involved institutions send to MEPRD comments about NIR 1st draft and approval.	23 February
Quality control checks	QC	All institutions involved in inventory preparation process	Verification of national data in EC inventory and updates as necessary and response to EC. This process includes collaboration with involved institutions for preparing of response to EC.	1st March to 15th March
Quality control checks	QA	Expert Public	NIR was uploaded in the MEPRD home page for review.	February/March
CRF data NIR according to Decision 280/2004/EC	CRF, NIR	MEPRD LEGMC	MEPRD sends to EC final CRF tables and final NIR according to Decision 280/2004/EC requirements through the Permanent Representation. MEPRD uploaded CRF tables, XML and draft NIR in the EIONET CDR and electronically sent to EC notification about uploaded data.	15th March
NIR and emission data in CRF	Inventory submission	MEPRD	MEPRD uploaded approved GHG inventory to UNFCCC portal.	15th April

1.4 BRIEF GENERAL DESCRIPTION OF METHODOLOGIES AND DATA SOURCES

1.4.1 GHG inventory

Latvia's GHG emissions inventory is based on the Revised 1996 Guidelines for National Greenhouse Gas Inventories (1997), Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000) and Good Practice Guidance for Land Use, Land-Use Change and Forestry (2003) as well as EMEP/CORINAIR Emission Inventory Guidebook – 3rd editions (2002) and EMEP/EEA 2009 according to the UNFCCC recommendations for inventories.

The main sources for emission factors are:

- 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.);
- Revised 1996 IPCC;
- IPCC GPG 2000;
- IPCC GPG LULUCF 2003;
- IPCC 2006;
- EMEP/CORINAIR Guidebook 2007 and EMEP/EEA 2009.

The CRF Reporter version 3.6.2 is used for data compiling. To calculate GHG emissions, supplemental locally developed database in Excel format was used for all sectors except for Road Transport and partly for Agriculture sector, where COPERT IV and IPCC Software were 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 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 1990–2011.

Emissions from Solvent and Other Product Use were estimated according to EMEP/CORINAIR 2007 Guidebook, expert research and judgment about activity data and emission factors.

Emissions from Agriculture sector were estimated according to IPCC methodologies additional using local researches related some parameters.

New IPCC GPG LULUCF 2003 was used to estimate emissions from LULUCF sector.

IPCC GPG 2000 and IPCC 2006 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; 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
Industry	National production and sales statistics; Direct information from enterprises operating with pollutants; Central Statistical Bureau; Chemicals Register; Assumption of experts.	LEGMC; plant operators
Solvent	Central Statistical Bureau; State Agency of Medicines; Research of experts; LEGMC "2-AIR" database	LEGMC
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

1.4.2 KP-LULUCF inventory

See Section 1.4.1.

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 detailed reporting tables required by the official UNFCCC reporting guidelines are provided in the Annex 1 of this report. The identification of key categories is described in the IPCC Good Practice Guidance (IPCC GPG 2000), Chapter 7 and in the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC GPG LULUCF 2003), chapter 5.4.

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: Tier 1 and Tier 2. In the Tier 1 method, the emission sources are sorted according to their contribution to emission level or trend. In the Tier 2 method, the relative uncertainties of the source categories are also taken into account. The key sources are the emission categories, which represent together 90% of the inventory uncertainty.

Tier 2 method is used to identify key sources for time period 1990-2011. The identification is divided in two parts, key sources excluding LULUCF and key sources including LULUCF source categories. The starting point for the choice of source categories without LULUCF is the list presented in the Good Practice Guidance as Table 7.A1 and with LULUCF is presented in Good Practice Guidance for LULUCF as Table 5.4.1. The base year for CO_2, CH_4, and N_2O greenhouse gas emissions was 1990.

For submission 2013, key categories for 2011 (Table 1.4) were identified as described in the IPCC GPG 2000 using Tier 2 level and trend assessment taking into account qualitative criteria. Category uncertainty estimates developed under Tier 1 uncertainty analysis are incorporated in Tier 2 approach for detemination of key sources.

Results of key category analysis have been used to prioritize inventory improvements. For example:

-) 4.D.1 Direct Soil emission is key category and directly the biggest amount of emissions comes from sub-category Cultivation of Histosols, therefore in the improvement plan is included that specific research to identify exact Histosol areas in the country is necessary;

-) CO_2 emissions from 1.A.3.c Railways are key category. As emissions are estimated by Tier 1 method to move on use of higher Tier is included in the improvement plan. In the 2013, the process for improving estimation of emissions are started.

Table 1.4 Key categories for 2011

IPCC GHG Source and Sink Categories	Direct	Key category	Criteria for identification
1.A.3.b Road Transportation - Diesel Oil	CO_2	Yes	L,T, Q
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	Yes	L,T, Q
4.D.1 Direct Soil Emissions	N_2O	Yes	L,T, Q
1.A.3.b Road Transportation - Gasoline	CO_2	Yes	L,Q
4.A. Enteric Fermentation	CH_4	Yes	L,T, Q
2.A.1 Cement Production	CO_2	Yes	L,T, Q
4.D.3.Indirect Emissions	N_2O	Yes	L,T, Q
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO2	Yes	L,T, Q
6.A.2 Unmanaged Waste Disposal Sites	CH_4	Yes	L,T, Q
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	Yes	L,T, Q
1.A.4.b Residential - Gaseous Fuels	CO_2	Yes	L,T, Q
1.A.3.c Railways - Liquid Fuels	CO2	Yes	L,Q
1.A.2.f Other - Gaseous Fuels	CO_2	Yes	L,T, Q
1.A.2.f Other - Solid Fuels	CO2	Yes	L,T, Q
1.A.4.b Residential - Biomass	CH4	Yes	L,T, Q
1.A.4.b Residential - Liquid Fuels	CO2	Yes	L,T, Q
1.A.2.f Other - Liquid Fuels	CO2	Yes	L,T, Q
4.B.Manure Management	N2O	Yes	L,T, Q
6.A.1 Managed Waste Disposal on Land	CH4	Yes	L,T, Q
1.A.4.a Commercial/Institutional - Solid Fuels	CO2	Yes	L,T, Q
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	Yes	L,Q
1.A.4.b Residential - Solid Fuels	CO2	Yes	L,T, Q
1.A.4.a Commercial/Institutional - Liquid Fuels	CO2	Yes	L,T, Q
1.B.2.b Natural Gas	CH4	Yes	L,Q
4.B Manure Management	CH4	Yes	L,T, Q
4.D.2 Pasture, Range and Paddock Manure	N2O	Yes	L,T, Q
2.F(a).1 Refrigeration and Air Conditioning Equipment	HFCs	Yes	L,T, Q
1.A.3.b Road Transportation - LPG	CO2	Yes	L,Q
1.A.2.f Other – Other Fuels	CO2	Yes	L,T, Q
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	Yes	L,Q

IPCC GHG Source and Sink Categories	Direct	Key category	Criteria for identification
2.A.6 Road paving with Asphalt	CO_2	Yes	L,T, Q
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO2	Yes	L, Q
6.B.2 Domestic and Commercial Waste Water	CH_4	Yes	L,T, Q
6.B.2 Domestic and Commercial Waste Water	N2O	Yes	L,T, Q
5.A.1 Forest Land remaining Forest Land	CO_2	Yes	L, T, Q
5.G Other	CO_2	Yes	L, T, Q
5.A.2 Land converted to Forest Land	CO_2	Yes	L, T, Q
5.E.2 Land converted to Settlements	CO2	Yes	L,T, Q
5.B.1 Cropland remaining Cropland	CO2	Yes	L,T, Q
5.A.1 Forest Land remaining Forest Land	N2O	Yes	L,T, Q
5.B.2 Land converted to Cropland	CO_2	Yes	L,T, Q
5.C.1 Grassland remaining Grassland	CO_2	Yes	T, Q

1.5.2 KP-LULUCF inventory

Key category analysis for KP-LULUCF was performed according to section 5.4 of the IPCC good practice guidance for LULUCF 2003. The results are reported in Section 11.6.1 and CRF table NIR.3.

1.6 INFORMATION ON THE QA/QC PLAN INCLUDING VERIFICATION AND TREATMENT OF CONFIDENTALITY ISSUES

The implementation of Quality Assurance and Quality Control (QA/QC) procedures in the development of national GHG inventory is required by IPCC GPG 2000.

According to CoM Regulation No. 217 (17.02.2009) all institutions involved in inventory process are responsible for implementing QC procedures.

Mainly Tier 1 General Inventory Level QC procedures outlined in Table 8.1 of IPCC GPG 2000 are used.

The legislation act determines:

-) the quality objectives for GHG inventory;

-) 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.

-) tasks and responsibilities of involved institutions;

-) check-list and procedure description for independent experts for quality assurance of GHG inventory.

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

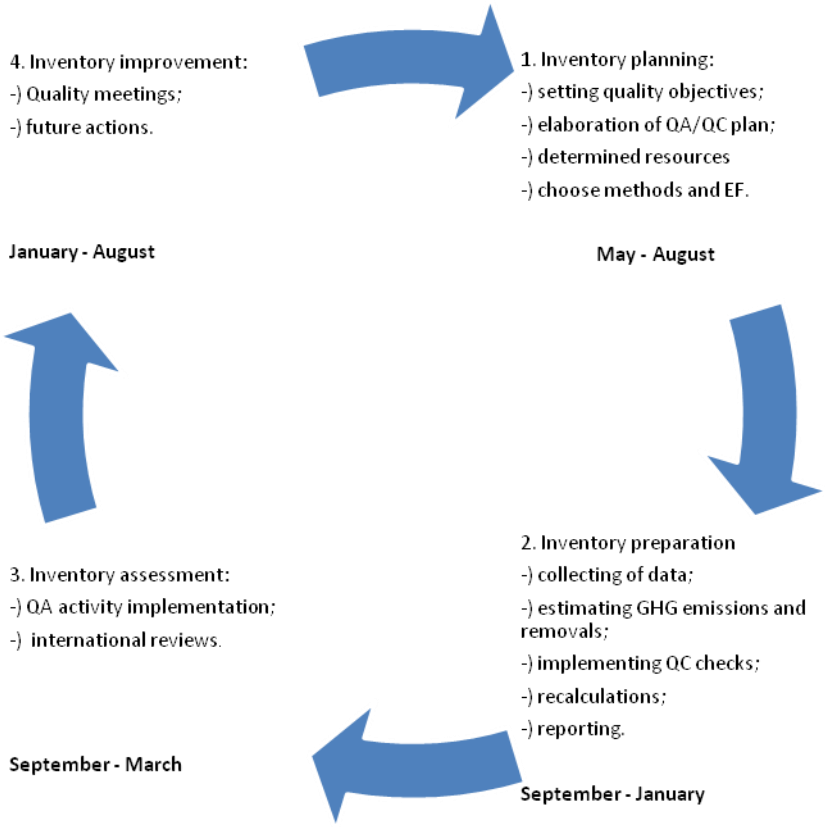
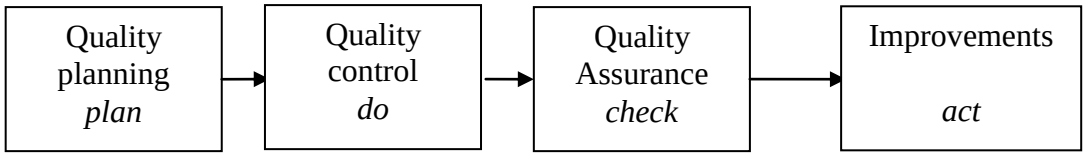


Figure 1.2 Inventory process

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:



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

The quality objectives for the 2013 inventory were the following:

In order to ensure improvements:

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

In order to ensure transparency:

- transparent information is included in the National Inventory Report and CRF (including information regarding the used methodology, activity data and emissions in tables);
- key words and indicators is used according to the IPCC guidelines;
- recommendations of inventory reviews regarding transparency is taken into account as far as possible;
- documentation regarding quality control check is indicated;
- a summary regarding the changes since the last inventory in relation to transparency is provided in the National Inventory Report.

In order to ensure consistency:

- time series are consistent;
- recommendations received during inventory review regarding consistency is taken into account after evaluation as far as possible;
- information regarding consistency and recalculations is provided in the National Inventory Report;
- 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 National Inventory Report;
- 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 is calculated and information is provided in the National Inventory Report;
- a summary regarding changes in uncertainties and regarding improvements in comparison with the previous inventory is provided in the National Inventory Report.

In order to ensure timeliness:

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

1.6.1 QC procedures implemented

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

For submission 2013, 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 inventory compiler (NIC).

The special folder is created where experts can 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 are prepared and available to experts.

The recent improvements of QA/QC system include QC tables that the sectoral experts, national inventory compiler and third-pary reviewers have to fill in.

Instruction for experts how to prepare NIR to ensure comparability of NIR and CFR as well as how to fill in QC tables are 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 are performed by the experts during inventory calculation and compilation according to the QA/QC plan (Annex A 6.1).

The QC procedures comply with the IPCC good practice guidance. General inventory QC checks (IPCC GPG 2000, Table 8.1 and IPCC GPG LULUCF 2003, Table 5.5.1) include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies and documentation and archiving of inventory data and quality control actions.

For Submission 2013:

-) The sectoral experts sent XML files to national inventory compiler (NIC) who imports all data together in CRF Reporter. NIC performed cross-checking for all sectors to verify that no mistakes occurred during import process as well as CRF completeness and recalculations checks were carried out.

-) The sectoral experts prepared relevant chapters of NIR and sent to NIC. Sectoral experts before sending chapter of NIR to NIC 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. NIC together with expert from LEGMC prepared final NIR according to UNFCCC reporting guidelines.

-) Experts in LEGMC prepared quality control procedures according to the IPCC GPG 2000 Tier 1 method for Energy, Industrial Processes, Solvents and other product use and Waste sectors. All findings were documented by using check-lists and introduced in GHG inventory. All corrections are archived.

-) Additionally, expert in LEGMC not directly involved in the preparation process of GHG inventory checked NIR and CRF tables for Energy, Industrial Processes, Solvents and other product use and Waste sectors for ensuring transparency of information.

-) LSFRI "Silava" checked data according to QC procedures that was outlined in IPCC GPG LULUCF 2003, table 5.5.1. All information is conformed to MoA before sending to NIC. Corrections were sent to LSFRI "Silava" and NIC for including in the national inventory report.

-) Expert in Latvia University of Agriculture prepared quality control procedures according to the IPCC GPG 2000 Tier 1 method. All findings were documented by using check-lists and introduced in GHG inventory. All corrections are archived. Additionally, quality control

check was done by MEPRD, CSB and MoA. Findings were documented and introduced in the emission evaluation as well as in NIR.

-) Expert in FEI prepared quality control procedures according to the IPCC GPG 2000 Tier 1 method. All findings were documented by using check-lists and introduced in GHG inventory. All corrections are archived. Additionally, quality control check was done by MEPRD, CSB and MoT. Findings were documented and introduced in the emission evaluation as well as in NIR.

Main activity data provider for Latvia's GHG inventory – CSB of Latvia, is established Quality Guidelines[2] 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.

Quality control of member states submissions is conducted under European Community GHG Monitoring Mechanisms (completeness and consistency checks). Findings on errors and deficiencies are taking into account before Latvia submits final annual inventory to the UNFCCC.

1.6.2 Quality assurance procedures implemented

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 was sent to CSB, MoA, MoT on the beginning of February for checking and approving. Received corrections were implemented in the GHG report and CRF.

European Commission (EC) consistency report of inventory was received and the possible corrections were elaborate in the inventory.

UNFCCC reviews reports indicated the issues where inventory need of improvements. The possible improvements were elaborate in this inventory.

The improvement plan for GHG inventory is compiled based on the finding of the UNFCCC, EC, internal reviews and other recommendations.

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.

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

Untill now, QA activities for energy, waste and agriculture sectors were ensuared by personnel not directly involved in the inventory compilation.

In 2013, MEPRD is planned to ensure QA procedures for Industrial proceses, Solvent and other produt use, LULUCF, KP as well as for overall inventory by experts not directly involved in the inventory compilation. Within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy " it is planned to ensure detailed quality control procedures for quality assurance of Industrial process and LULUCF, KP sectors.

1.6.3 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.

Documentation system in CSB:

- 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;
- After the appropriate testing phase the so-called "public part" of ADS will be made accessible for external users on the CSB website (In the summer of 2012.year).

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 8.

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 MEPRD as well as additionally in the LEGMC too.

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.

1.6.4 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.

1.6.5 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.

1.6.5.1 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 exception of food and drink sector where wine and sugar production data is classified as confidential. 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.

1.6.5.2 Data of ETS

As all Latvia's industrial processes sector's companies are participating in ETS then data from these companies can be obtained from their annual GHG report within compliance obligations within 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 ETS can't be confidential and all companies' annual GHG reports are published in LEGMC webpage.

1.6.5.3 ETR documentation

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

1.7 GENERAL UNCERTAINTY EVALUATION

This section provides an overview of the approach to uncertainty analysis for Latvia's inventory. The mandatory reporting tables of analyses are provided in Annex 7.

The uncertainty estimate of the inventory 2013 has been done according to the Tier 1 method presented by the IPCC GPG 2000. The Tier 1 method is based on emission estimates and uncertainty coefficients for activity data and emission factors.

In many cases uncertainty coefficients have been assigned based on default uncertainty estimates according to IPCC GPG 2000 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 annualy.

The uncertainty analysis was done for the all sectors: Energy, Industrial Processes, Solvent and Other Product Use, Agriculture and Waste and LULUCF (Forest Land remaining Forest

Land) sector. Uncertainties 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.

Latvia plans to undertake a tier 2 uncertainty analysis in future as a part of the programme "European Economic Area Financial Mechanism 2009-2014 – "National Climate Policy".

Detailed about uncertainty assessment is described in the each sub sector.

1.8 GENERAL ASSESSMENT OF THE COMPLETENESS

1.8.1 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 and SF_6), 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.

Assessment of completeness is included in Annex 5.

1.8.2 KP-LULUCF inventory

All territory of Latvia is covered by the inventory. All sources and sinks included in the IPCC Guidelines are covered.

1.8.3 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.

CHAPTER 2: TRENDS IN GREENHOUSE GAS EMISSIONS

Detailed information on emission trends is provided in the description of IPCC sectors in chapters 3-8 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 the four gases defined in the Kyoto Protocol, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and sulphur hexafluoride (SF_6). The emission levels are presented in Gg of carbon dioxide equivalents (Figure 2.1).

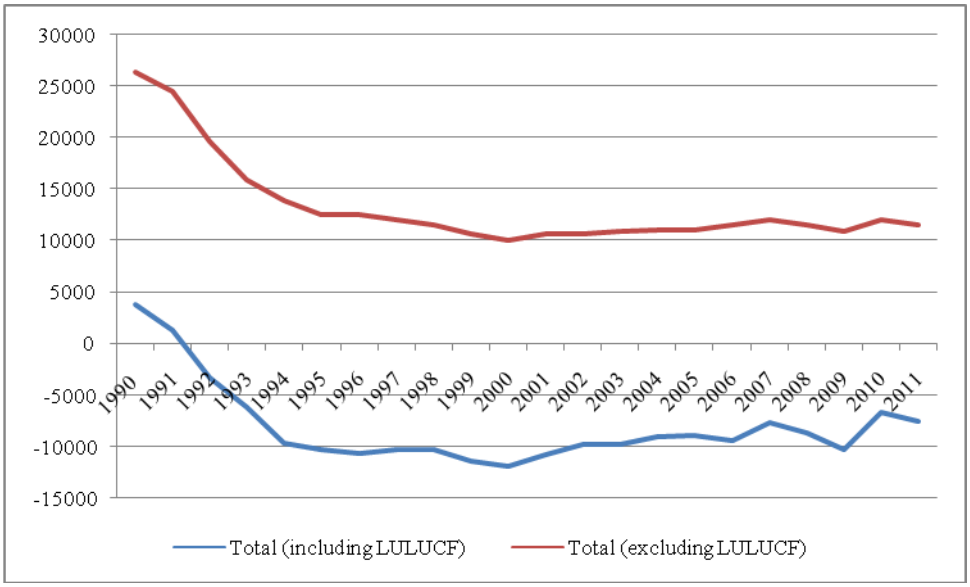


Figure 2.1 Latvia's aggregated greenhouse gas emissions in 1990-2011 (Gg CO_2 eq)

As illustrated in Figure 2.1, Latvia's GHG emissions have decreased considerably since the 1990-ties. This decrease influenced the economical 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.

Latvia should limit its emissions during the Kyoto Agreement's first commitment period between 2008 and 2012 by 8% of 1990 level.

2.2 DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS BY GAS AND CATEGORY

Carbon dioxide (CO_2) is the main greenhouse gas causing the climate change. In 2011, CO_2 emissions contribute 70.3% of Latvia's total greenhouse gas emissions. In 2011, total CO_2 emissions had decreased by approximately 57.5% since 1990.

The most important source of CO_2 emissions (Gg) in 2011 was fossil fuel combustion – 91.7%, including Energy Industries – 25.7%; Manufacturing Industries and Construction – 10.8%; Transport – 38.2%, Other sectors (Agriculture, Forestry, etc.) – 17%.

Other anthropogenic emission sources of CO_2 are Industrial Processes – 7.8%, Solvent and Other Product Use approximately 0.4%.

CO_2 removals take place by green plants absorbing CO_2 in the process of photosynthesis. In 2011, LULUCF in Latvia removed -17179.20 Gg CO_2 eq.

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 2011 contribute approximately 13.7% of total GHG emissions (excluding LULUCF). The methane emissions (Gg) decreased by 55% in 2011 since 1990.

Agricultural soils are the main source of N_2O emission in Latvia generating 89.7% of all N_2O emissions (Gg) in 2011. 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 54.5% in 2011, mainly due the decrease in the emissions from agriculture.

Emissions from HFCs and sulphur hexafluoride (SF_6) consumption are reported for the period 1995-2011. Total HFCs emissions (Gg CO_2 eq) increased in 2011 compared with 2010. SF_6 emissions from electrical equipment are reported and contribute 12.45 Gg CO_2 eq in 2011.

Emissions by sources are illustrated in the following Figure 2.2. As it is shown, the Energy sector covers the largest part of all greenhouse gas emissions in Latvia.

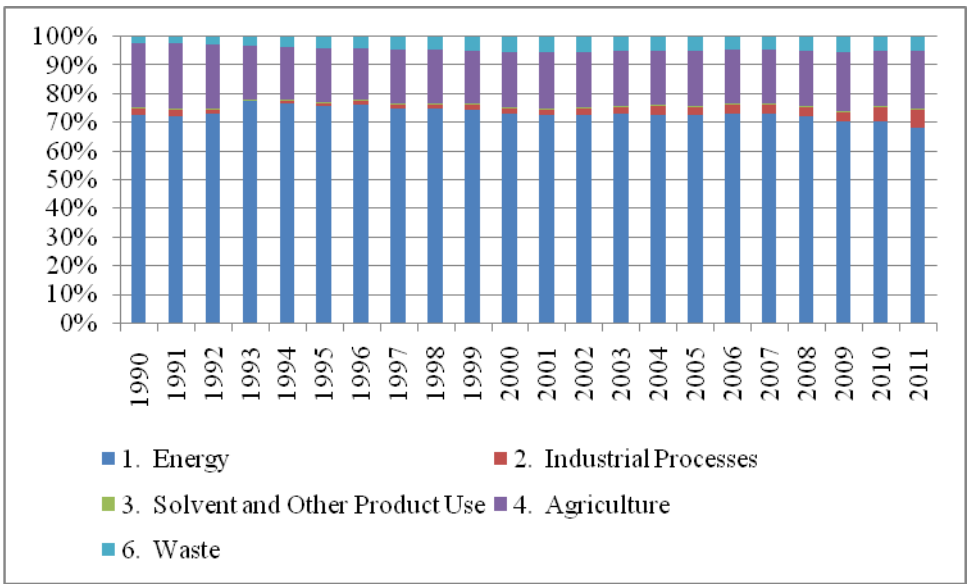


Figure 2.2 Latvia's greenhouse gas emissions by source 1990–2011 excluding LULUCF

2.3 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 2.3.

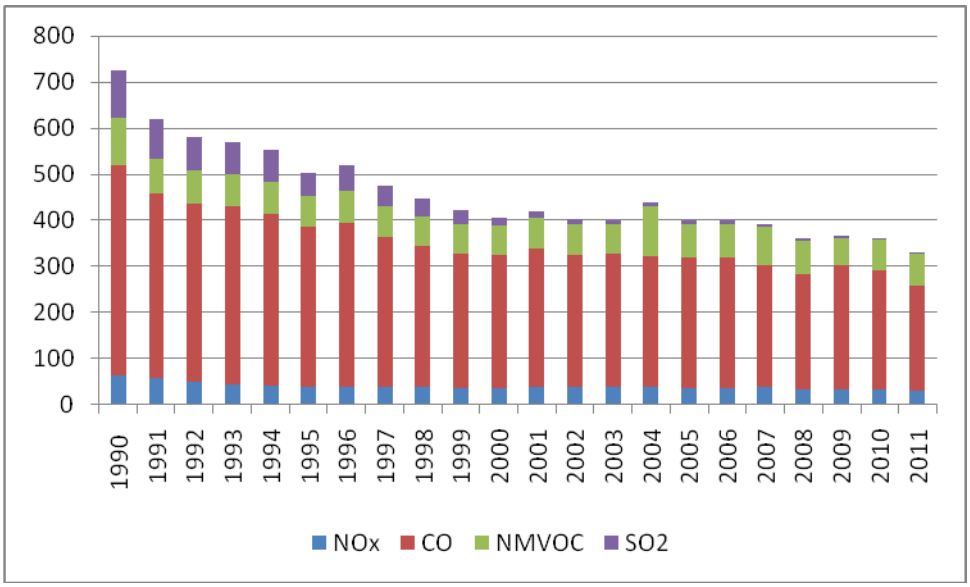


Figure 2.3 Total indirect greenhouse gas emissions trend 1990-2011 (Gg)

In 2011, the **sulphur dioxide emissions** were 3.17 Gg from which 87.3% originated in the Energy sector and 12.6% from Industrial Processes.

Nitrogen oxides were generated generally in the Energy sector (94%) and 5.7% in the Industrial Processes. In 2011, the total emissions were 31.66 Gg. The Transport sector was responsible for 60.5% of the total emissions.

In 2011, **Carbon monoxide** emissions were 225.3 Gg, originated generally in the Energy sector (98%).

In 2011, total emissions of **non-methane volatile organic compounds** were 69.91 Gg from which Energy sector generated 49.2%, Solvent and Other Product Use approximately 17.7%, but Industrial Processes 32.5%.

2.4 DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS FOR KP-LULUCF INVENTORY IN AGGREGATE AND BY ACTIVITY, AND BY GAS

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.

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)

.

CHAPTER 3: ENERGY (CRF 1)

3.1 OVERVIEW OF SECTOR

3.1.1 Quantitative overview

Both the imported (natural gas, liquid gas, oil and oil products, coal) and local fuels (wood, peat, hydro resources) are used by the Energy sector in Latvia (Table 3.1). Mainly the imported fuels (natural gas and heavy oil) are used in heat generation. Smaller boiler houses burn local fuel and coal as well.

Table 3.1 Consumption of energy resources in Latvia (TJ)[3]

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Energy consumption	333182	191421	163848	191883	199043	204607	196517	188972	200548	188736
Shale oil		79	2440	157	118	118	79	39	39	79
Liquefied petroleum gas	3689	1548	2140	2550	2687	2414	2186	2003	2103	2414
Gasoline and aviation gasoline	26796	18128	14831	15126	16753	18299	16672	13941	12667	11222
Jet kerosene	3067	1166	1123	2463	2852	3414	4105	4297	4926	4925
Other kerosene	648	432	31							
Diesel oil (including gasoil)	43000	17166	20693	32887	36371	41343	39133	36500	38994	39262
Residual fuel oil	63092	36134	9460	3167	2152	1624	1096	1421	1069	735
White spirits	84	84	126	126	126	84	84	42	40	42
Lubricants	1633	963	879	1088	1088	1088	1047	628	586	795
Bitumen	1633	712	2009	2512	3098	3349	3600	2218	1967	2930
Paraffin waxes			126	335	251	251	209	293	461	293
Petroleum coke				429	627	132		165	627	66
Other liquids	2637	712	2553	209	1088	963	795	711	1005	0
Used oils	879			848	263	234	263	117	95	88
Liquid fuels, total	*147158*	*77124*	*56411*	*61897*	*67474*	*73313*	*69269*	*62375*	*64579*	*62851*
Coal	26098	7172	2761	3146	3409	4248	4248	3409	4378	4903
Peat	3286	3838	2452	80	70	90	90	30	100	40
Peat briquettes	867	403	31			1	1	6	6	3
Coke	290	211	290	188	161	107	134	134	80	80
Oil shale	28									
Solid fuels, total	*29702*	*11221*	*5503*	*3414*	*3640*	*4446*	*4473*	*3579*	*4564*	*5026*
Natural gas	*99653*	*42279*	*45635*	*56852*	*58892*	*56922*	*55814*	*51381*	*61313*	*54034*
Wood and wood products	27581	42102	39695	49396	49748	48706	46018	52591	51354	46901
firewood				34351	34257	33808	32696	36354	33993	29741
wood remains				8421	8102	7011	6129	7687	7829	8008
wood chips				6134	6934	7361	6667	8112	8596	8221
wood briquettes				221	221	238	238	204	374	343

[3] http://data.csb.gov.lv/DATABASE/vide/Ikgadējie%20statistikas%20dati/Enerģētika/Enerģētika.asp

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
wood pellets				270	234	288	288	234	562	588
Charcoal				60	30	45	60	60	60	60
Bioethanol					43	0	1	108	350	318
Biodiesel				107	60	73	82	73	808	1513
Landfill gas				246	230	224	277	293	421	818
Sewage sludge gas				95	87	92	92	115	137	102
Straws					11	16	14	29	60	43
Biomass, total	*27581*	*42102*	*39695*	*49844*	*50179*	*49111*	*46484*	*53209*	*53130*	*49695*
Used tires				183	131	210	210	26	105	504
Municipal wastes								62	1076	1735
Other fuels, total				*183*	*131*	*210*	*210*	*88*	*1181*	*2239*

The use of natural gas as a primary energy resource has grown increasingly since middle of the 90ties. The largest consumers of natural gas are combined heat and power plant, and heat generation enterprises as well as industrial enterprises.

Oil products have an important place in the Latvian energy resource market; their market share is about 33.3% in 2011, including heavy fuel – residual fuel oil and shale oil, with about 0.43% of total energy consumption. The residual fuel oil consumption has a significant decrease - in 1990 it was 18.94% from total fuel consumption, but in 2011 it is 0.38%. The essential decrease of heavy oil share in energy balance is explained with implementation of the EU Directive 1999/32/EC prescribing that sulphur content of heavy oil must not exceed 1%. The biggest part from liquid fuel consumption contributes to gasoline and diesel oil with approximately 80% from total liquid fuel consumption when 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 – 78.8%, and combusted in stationary combustion installations – 21.2% from total diesel oil consumption.

Total share of solid fuels in national market is quite low – approximately 2.66%. The solid fuel consumption in last years is stable although the consumption had decreased by 83.08% since 1990. From 2009 to 2011 solid fuel consumption had increased by 40.43% that is mainly explained with an increase of coal consumption.

Natural gas consumption has a stable place in total fuel consumption when natural gas consumption is 29.91% in 1990 and 28.63% in 2011. Natural gas consumption has decreased by 45.78% in 1990-2011. In the last years natural gas consumption has an increasing tendency – from 2009 to 2010 even by 19%, but in the year 2011 there can be seen a decrease of natural gas by 11.87% which can be explained with a relatively warm winter therefore the fuel consumption in 1.A.1 sector was smaller and also with significant changes in 1.A.2.a sector where can be seen a decrease of natural gas almost by 70% comparing with year 2010.

Biomass fuels are wood and wood products, straw, charcoal and biofuels. In the total fuel consumption the share of firewood and other wood products is quite substantial and has reached its peak point 26.49% in 2010 by the side of 1990 when firewood consumption was only about 8.28% from total energy consumption. However, in 2011 the consumption of wood and wood products has decreased and is about 26.33% from overall consumption.

In latest years liquid and gaseous biofuels are becoming more popular and from 0.23% in 2005 to 2011 their consumption has reached 1.45%. To compare, in year 2010 the consumption was 0.86%. In latest years also such biomass fuels as straws are used, and it has an increasing tendency with fluctuations, especially in year 2011, which can mainly be explained with warm winter.

There are also used tires and municipal wastes used as fuel in the latest years, and the most significant increase can be observed in year 2011 – comparing with year 2010 the consumption of other fuels has increased by almost 90% and it has reached 1.19% from total share.

Hydroelectric power plants (HPP) and combined heat and power plants (CHP) produce part of the electrical power, while part is imported (Table 3.2, Table 3.3). 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 3.2 Electricity production and consumption in Latvia (TJ)[4]

	Production	Own use and losses	Import	Export	Final consumption			
					CRF 1.A.2.	CRF 1 A.3.	CRF 1.A.4.	TOTAL
1990	16 186	6 883	25 700	12 798	11 484	918	17 550	29 952
1991	11 790	6 682	15 217	7	10 807	785	17 255	28 847
1992	9 076	5 645	14 688	7	8 316	745	13 777	22 838
1993	10 350	6 102	9 619	612	5 440	688	10 904	17 032
1994	11 898	6 681	9 533	2 988	5 076	670	10 102	15 848
1995	10 573	6 372	9 529	1 408	5 130	677	10 267	16 074
1996	6 700	7 989	12 377	760	4 975	641	9 266	14 882
1997	10 634	7 694	6 566	4	5 519	634	8 935	15 088
1998	15 545	6 559	3 290	1 382	5 296	612	10 310	16 218
1999	9 932	5 774	9 349	2 311	5 130	554	10 375	16 059
2000	10 163	5 202	7 589	1 159	5 159	547	10 411	16 117
2001	10 210	5 688	8 424	1 645	5 562	623	10 314	16 499
2002	8 906	5 188	10 217	1 764	5 494	518	11 563	17 575
2003	8 330	5 065	9 616	137	5 778	490	12 456	18 724
2004	11 369	4 975	9 839	2 290	5 882	500	13 072	19 454
2005	12 139	4 767	10 278	2 545	6 120	533	13 972	20 625
2006	9 878	4 522	10 116	1 087	6 332	540	15 242	22 114
2007	10 030	4 194	17 870	7 070	6 538	504	16 740	23 782
2008	11 405	4 198	16 715	7 643	6 127	497	17 237	23 861
2009	12 625	4 032	15 333	9 378	5 421	436	16 114	21 971
2010	12 848	4 626	14 303	11 160	5 724	453	16 197	22 374
2011	10649	4137	14432	9950	6012	446	15829	22287

Table 3.3 Heat production and consumption in Latvia (TJ)[5]

	Production	Own use and losses	Final consumption		
			CRF 1.A.2	CRF 1.A.4	TOTAL
1990	99439	15171	32929	51339	84268
1991	96120	16096	33394	46630	80024
1992	75442	10953	22632	41857	64489
1993	54846	9954	7154	37738	44892
1994	46822	7330	1998	37494	39492
1995	46112	8215	1969	35928	37897
1996	47137	8838	2046	36253	38299
1997	45721	8317	1976	35428	37404
1998	42872	8950	1940	31982	33922
1999	36191	8115	1162	26914	28076
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

[4] http://data.csb.gov.lv/DATABASE/vide/Ikgadējie%20statistikas%20dati/Enerģētika/Enerģētika.asp
[5] http://data.csb.gov.lv/DATABASE/vide/Ikgadējie%20statistikas%20dati/Enerģētika/Enerģētika.asp

	Production	Own use and losses	Final consumption		
			CRF 1.A.2	CRF 1.A.4	TOTAL
2005	31144	5886	684	24574	25258
2006	30056	5454	634	23968	24602
2007	28685	4911	554	23220	23774
2008	26402	4010	349	22043	22392
2009	26308	4063	298	21947	22245
2010	28662	4414	387	23861	24248
2011	25000	3953	268	20779	21047

Types of fuels used for combustion in Latvia:

- Liquid Fuels are mainly imported from Latvia's neighbourhood 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;
    - other liquids:
    - used oils,
    - pyrolysis resin,
    - petroleum coke,
- Solid fuels consist of coal and coke imported from Commonwealth of Independent States (countries of former Union of Soviet Socialist Republics) and local fuels – peat and peat briquettes that are mainly produced inside country but not imported;
- Gaseous Fuels (natural gas) are 100% imported from Russian Federation;
- Biomass Fuels:
    - solid biomass – wood and other wood products, charcoal, straws, 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,
    - liquid biofuels – biogasoline, biodiesel, that are mainly imported from Latvia's neighbourhood countries and other liquid biofuels – glycerine, that are remaining product in chemical industry.
- Other Fuels are municipal wastes and industrial wastes – used tires, collected by and combusted in cement production plant in Latvia.

Types of fuels used as feedstocks in Latvia:

- Liquid Fuels – 100% imported from Latvia's oil importers from neighbourhood countries and Scandinavian countries:
    - white spirits;
    - lubricants;
    - bitumen;
    - paraffin waxes.

3.1.2 Description

The Energy sector is the most significant source of GHG emissions with 68.19 % share of the total emissions in the 2011.

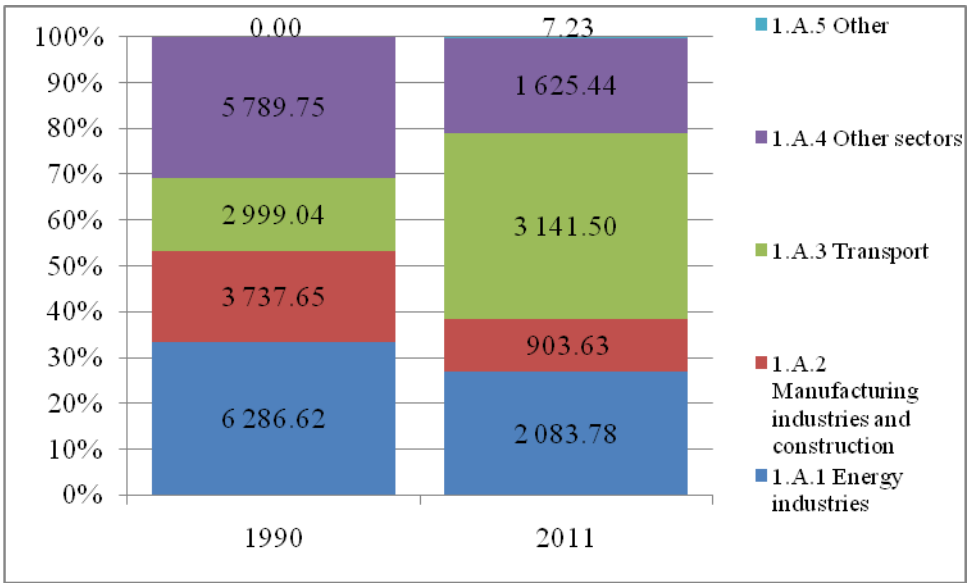


Figure 3.1 Emissions from the Energy sector in 1990 and 2011 (Gg CO_2 eq)

As it can be seen on the Figure 3.1, there are significant differences between percentage of subsectors in the Energy sector, 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.

In 2011 the biggest part of GHG emissions in Energy sector consists of Transport sector with 39.98% of total Energy sector's GHG emissions (Figure 3.1). Energy Industries and Other sectors make 2nd and 3rd place with 26.52% and 20.69% of total Energy sector's GHG emissions. In comparison with year 1990, there can be seen differences in all of the sectors – the greatest part with 33.42% was 1.A.1. Energy Industries, the second with 30.78% was 1.A.4. Other Sectors, and third with 19.87% - 1.A.2. Manufacturing Industries and construction, which can be explained with a consumption of fuel with high sulphur percentage and a great consumption of fossil fuels. However, the emissions from the Transport sector were the least – only 15.94%, which can be explained with relatively small amount of cars. There were no emissions from 1.A.5. Other sector in 1990.

Table 3.4 GHG emissions from Energy sector in 1990–2011 (Gg)

	A Fuel combustion			Aggregate GHGs	B Fugitive emissions from fuels	
	CO_2	**CH_4**	**N_2O**	**CO_2, CH_4, N_2O, HFCs, PFCs, SF6**	**CH_4**	**CO_2**
	Gg			Gg CO_2 equivalent	Gg	
1990	18392.34	12.52	0.509	18813.06	15.39	0.01784
1991	16903.78	13.89	0.502	17351.16	14.91	0.01784
1992	13706.81	12.61	0.447	14110.17	13.81	0.01789
1993	11618.52	13.23	0.391	12017.45	13.33	0.01806
1994	10044.73	13.08	0.371	10434.53	13.27	0.01949
1995	8840.17	13.53	0.379	9241.87	12.99	0.01949
1996	8916.92	13.90	0.388	9328.94	12.61	0.01949
1997	8383.55	13.20	0.387	8780.63	11.93	0.01946
1998	7999.12	12.31	0.371	8372.57	11.55	0.01946
1999	7367.07	12.02	0.348	7727.44	11.13	0.01946
2000	6776.84	11.34	0.340	7120.40	10.51	0.01957
2001	7169.60	12.51	0.367	7546.14	10.26	0.01990
2002	7168.06	12.22	0.374	7540.52	10.26	0.01990
2003	7382.91	12.76	0.401	7775.35	8.49	0.01990
2004	7402.69	13.11	0.420	7808.15	8.19	0.01990

	A Fuel combustion			Aggregate GHGs	B Fugitive emissions from fuels	
	CO_2	**CH_4**	**N_2O**	**CO_2, CH_4, N_2O, HFCs, PFCs, SF6**	**CH_4**	**CO_2**
	Gg			Gg CO_2 equivalent	Gg	
2005	7506.57	13.09	0.423	7912.43	7.94	0.02050
2006	7950.17	12.75	0.413	8346.08	6.93	0.02050
2007	8272.01	12.70	0.424	8670.16	6.98	0.01987
2008	7847.11	11.74	0.403	8218.50	6.43	0.01979
2009	7159.22	12.85	0.396	7551.94	6.62	0.01982
2010	7968.21	12.17	0.395	8346.11	6.71	0.01982
2011	7419.10	10.55	0.390	7761.59	4.54	0.01982

Decrease of emissions depends on economical and social situation in the beginning and ending of the 90-ties. Since 2000, fuel consumption as well as emissions from fuel combustion has increased due to development of national economy (Table 3.4).

GHG emissions from the Energy sector in the latest years are fluctuating with a peak point in 2007 (since 2000) that is explained with a sharp increase of national economy (Figure 3.2). GHG emissions in 2000-2007 have increased by 21.76% in the Energy sector. In the second half of 2008 recession in national economy started caused by the crisis. That is the main reason why all GHG emissions in Energy sector decreased in 2007-2009 by 12.9%. In 2010, total GHG emissions again increased by 10.52% compared with 2009 as consumption of fuel increased, too.

However, in year 2011 the emissions decreased again because of increase of temperature – in 2011 it was 1.6°C above normal temperature, which was especially because of the warm winter where the average temperature in January was lower by 8.5°C comparing to January, 2010, and also the end ot the year where the average temperature in December was lower by 8.6°C, therefore the consumption of energy resources has significantly reduced.

Decrease of methane fugitive emissions is explained with a constant improvement of natural gas supply infrastructure.

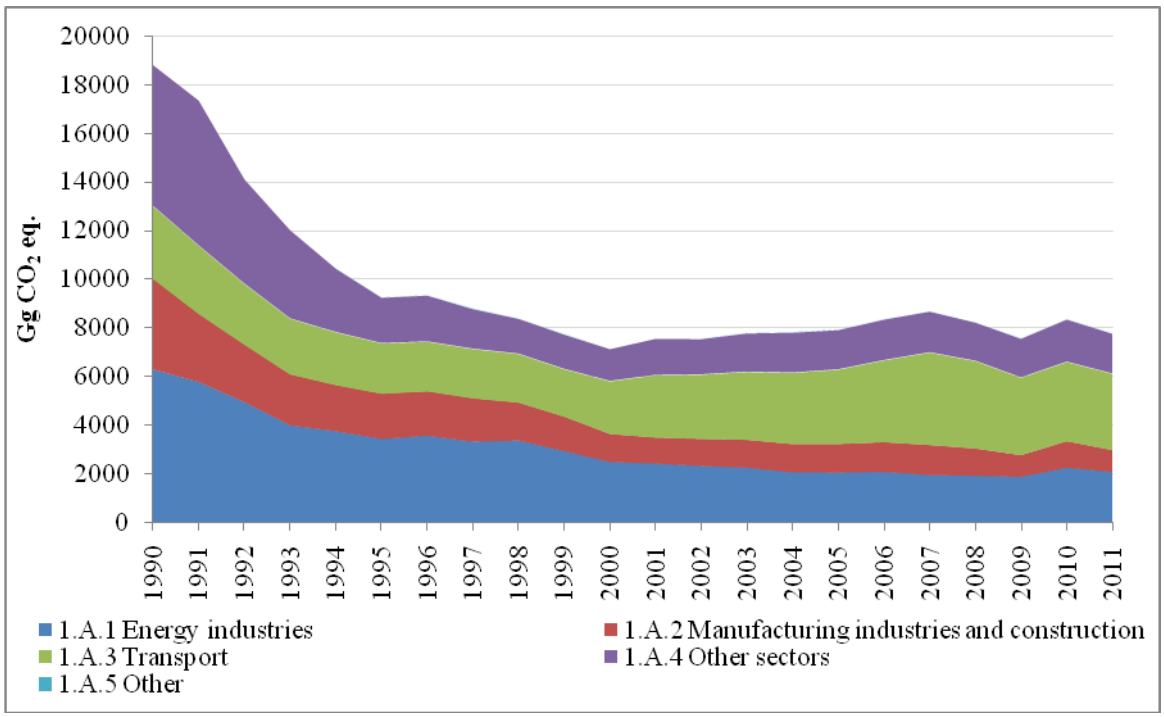


Figure 3.2 GHG emissions from Energy sector 1990–2011 (Gg CO_2 eq)

The sharp decrease in 2008-2009 is also explained with the crisis in national economy caused by global financial crisis, also the winter in 2009 was quite warm with 0.8°C above normal therefore in 2009 GHG aggregated emissions in CRF 1.A.1 were less (2.66%) than in 2008 but in 2010 an increase of emissions by 20.44% 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 7.02% if compared with year 2010.

The decrease of industrial production was influenced by economical situation when development of national economy was made in financial and real estate sectors but the import dominated over export. Increase of cost and price as well as total inflation led to a total decrease of industry. Therefore the GHG emissions from CRF 1.A.2 sector had decreased by 19.90% in 2008-2009, but in 2010 emissions increased by 20.06% as fuel consumption increased. In year 2011 the emissions have decreased by 17.32% that can be explained with great reconstructions in the enterprise "Liepājas Metalurgs" under 1.A.2.a sector which is the main reason why the fuel consumption in this subsector decreased by 74.02%.

For Transport sector (1.A.3) emissions decreased from 2008 to 2009 by 11.38% that was influenced by sharp increase of fuel price and economy crisis. Decrease is also explained with improvement of car park in country and use of mostly new cars. Starting from 2010 growth of emissions from transport sector is observed by 2.32% comparing to 2009, although in year 2011 the emissions decrease again and if compared with year 2010 the decrease is -3.61%.

The emissions in 1.A.4 Other sectors have decreased by 5.83% in 2011 which can be explained with a relatively warm winter. There can be seen fluctuations in emissions in the time scale which mostly depend on the temperatures in winter.

The emissions in 1.A.5 Other have decreased by 8.24% in 2011, and it is not related neiter with financial circumstances nor weather conditions, and the trend is not predictable.

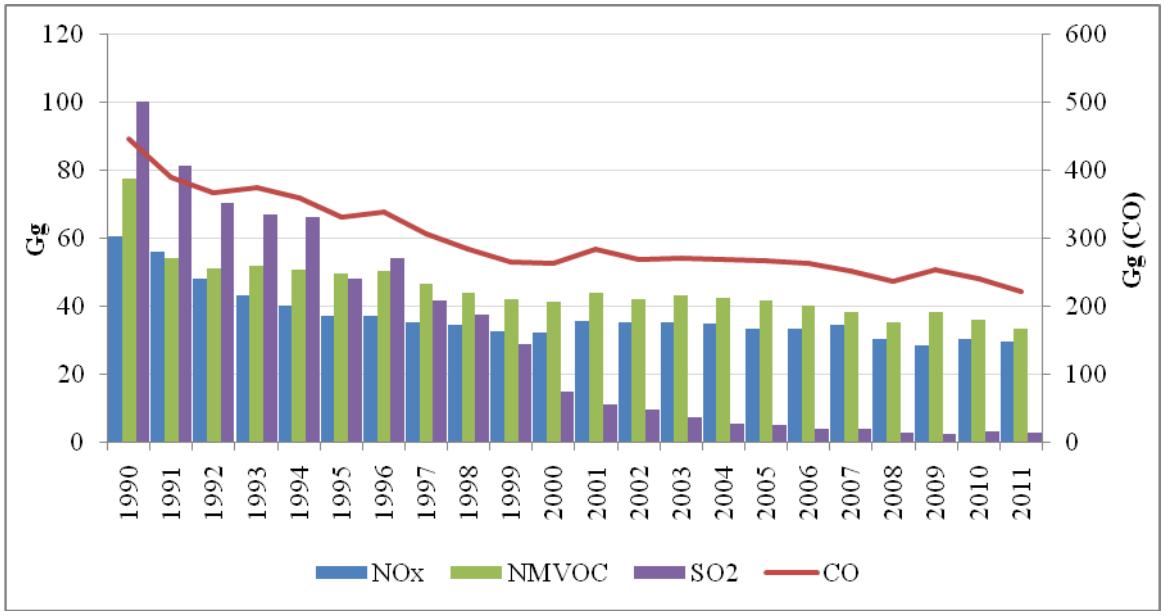


Figure 3.3 Total indirect GHG emissions from fuel combustion in 1990–2011 (Gg)

In 2011, the largest part of indirect emissions contributes CO then NMVOC and NOx emissions (Figure 3.3). Most CO and NMVOC emissions come from wood combustion in the Residential sector while most of NOx emissions comes from Transport sector.

The biggest decrease is observed in SO_2 emissions where emissions decreased from 100.11 Gg in 1990 to 2.77 Gg emissions in 2011. It is explained with changes in type of fuels combusted in Energy sector as well as with rules of national legislations for sulphur content in liquid fuels used for transport.

The indirect emissions in general are lower if compared with 2010: CO emissions have decreased by 8.53%, NMVOCs have decreased by 7.47%, NOx emissions have decreased by 1.86%, but the greatest decrease in emissions can be seen in SOx -10.44% which is explained

with not as much as warm winter than because of changes in sulphur content in liquid fuels, especially in 1.A.1.a Public Electricity and Heat Production subsector.

Key categories

Key categories reported in the Table 3.5 are estimated without taking into account LULUCF sector by using Tier1 estimation level. Tier 1 approach for determination of the key source is used by incorporating category uncertainty estimates developed under Tier 1 uncertainty analysis.

Table 3.5 Key categories in fuel combustion sector in 2011

IPCC GHG Source and Sink Categories (LULUCF not included)	Gas	L	T	Q
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	x	x	x
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2		x	
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2		x	
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	x		x
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	x		x
1.A.2.c Chemicals - Liquid Fuels	CO_2		x	
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	x		x
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2		x	
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2		x	
1.A.2.f Other - Biomass Fuels	N_2O		x	
1.A.2.f Other - Gaseous Fuels	CO_2	x	x	x
1.A.2.f Other - Liquid Fuels	CO_2	x	x	x
1.A.2.f Other - Other Fuels	CO_2	x		x
1.A.2.f Other - Solid Fuels	CO_2	x	x	x
1.A.3.b Road Transportation - Diesel Oil	CO_2	x	x	x
1.A.3.b Road Transportation - Diesel Oil	N_2O		x	
1.A.3.b Road Transportation - Gasoline	CO_2	x		x
1.A.3.b Road Transportation - LPG	CO_2	x		x
1.A.3.c Railways - Liquid Fuels	CO_2	x		x
1.A.4.a Commercial/Institutional - Biomass	CH_4		x	
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	x	x	x
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	x	x	x
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	x	x	x
1.A.4.b Residential - Biomass	CH_4	x	x	x
1.A.4.b Residential - Biomass	N_2O		x	
1.A.4.b Residential - Gaseous Fuels	CO_2	x	x	x
1.A.4.b Residential - Liquid Fuels	CO_2	x	x	x
1.A.4.b Residential - Solid Fuels	CO_2	x	x	x
1.A.4.b Residential - Solid Fuels	CH_4		x	
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2		x	
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	x	x	x
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2		x	
1.A.5.b Mobile - Liquid Fuels	CO_2		x	
1.B.2.b Natural Gas	CH_4	x		x

3.2 FUEL COMBUSTION

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).

Reported greenhouse gas emissions are listed in Table 3.6.

Table 3.6 Reported emissions from fuel combustion in Latvia in 2011

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	√	√	√	√	√	√	√
	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
	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
c. Manufacture of Solid Fuels and Other Energy Industries								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	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	√	√	√	√	√	√	√
	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
	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
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
d. Pulp, Paper and Print								
	Liquid Fuels	NO	NO	NO	NO	NO	NO	NO
	Solid Fuels	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	√	√	√	√	√	√	√
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
f. Other								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	√	√	√	√	√	√	√
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	√	√	√	√	√	√	√
1.A.3 Transport								
a. Civil Aviation								
	Aviation Gasoline	√	√	√	√	√	√	√
	Jet Kerosene	√	√	√	√	√	√	√

Source	Fuel Type	Emissions						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
b. Road Transportation								
	Gasoline	√	√	√	√	√	√	√
	Diesel Oil	√	√	√	√	√	√	√
	LPG	√	√	√	√	√	√	√
	Other Liquid Fuels	√	√	√	√	√	√	√
	Gaseous Fuels	√	√	√	NO	NO	NO	NO
	Biomass	√	√	√	NO	NO	NO	NO
	Other Fuels	NA	NA	NA	NA	NA	NA	NA
c. Railways								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	NO	NO	NO	NO	NO	NO	NO
	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
	Solid Fuels	NO	NO	NO	NO	NO	NO	NO
	Gaseous Fuels	NO	NO	NO	NO	NO	NO	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
e. Other Transportation								
	Liquid Fuels	NO	NO	NO	NO	NO	NO	NO
	Solid Fuels	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
1.A.4 Other Sectors								
a. Commercial/Institutional								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	√	√	√	√	√	√	√
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
b. Residential								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	√	√	√	√	√	√	√
	Gaseous Fuels	√	√	√	√	√	√	NO
	Biomass	√	√	√	√	√	√	NO
	Other Fuels	NO	NO	NO	NO	NO	NO	NO
c. Agriculture/Forestry/Fisheries								
	Liquid Fuels	√	√	√	√	√	√	√
	Solid Fuels	√	√	√	√	√	√	√
	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
	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
	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 7419.10 Gg (including Transport sector) in 2011 and accounted 91.7% of the total CO_2 emissions.

CH_4 emissions from fuel combustion were 10.55 Gg (including Transport sector) in 2011 that makes 14.01% from total CH_4 emissions. The biggest part of CH_4 emissions contributes Other sectors – 9.69 Gg. It is related with wood fuel combustion, especially in the Residential sector. Until now Latvia uses IPCC 1996 default CH_4 emission factor for wood combustion in Residential sector. According to Expert review team IPCC 1996 default CH_4 emission factor for biomass is very high.

N_2O emissions from fuel combustion were 0.39 Gg (including Transport sector) and accounted 6.99% of the total N_2O emissions in 2011.

Table 3.7 GHG emissions from fuel combustion in 1990–2011 (Gg CO_2 eq.)

	Total fuel combustion GHG emissions	Energy industries	Manufacturing Industries and Construction	Transport	Other Sectors	Other	CH_4	N_2O
	Gg CO_2 equivalent						Gg	Gg
1990	18813.06	6286.62	3737.65	2999.04	5789.75	NO	12.52	0.51
1991	17351.16	5769.58	2813.64	2811.07	5956.87	NO	13.89	0.50
1992	14110.17	4943.92	2376.82	2503.37	4286.05	NO	12.61	0.45
1993	12017.45	3990.12	2109.15	2294.11	3624.07	NO	13.23	0.39
1994	10434.53	3749.42	1909.85	2174.74	2600.51	NO	13.08	0.37
1995	9241.87	3433.97	1873.31	2072.86	1855.56	6.18	13.53	0.38
1996	9328.94	3567.00	1837.59	2038.68	1882.39	3.28	13.90	0.39
1997	8780.63	3324.49	1791.62	2031.80	1620.27	12.45	13.20	0.39
1998	8372.57	3368.71	1570.64	2004.98	1424.97	3.28	12.31	0.37
1999	7727.44	2940.21	1422.03	1954.88	1400.91	9.42	12.02	0.35
2000	7120.40	2489.94	1160.60	2168.24	1301.48	0.14	11.34	0.34
2001	7546.14	2431.46	1073.36	2563.82	1477.33	0.17	12.51	0.37
2002	7540.52	2327.22	1120.26	2644.54	1441.71	6.79	12.22	0.37
2003	7775.35	2260.40	1149.87	2793.97	1564.75	6.36	12.76	0.40
2004	7808.15	2070.41	1163.21	2934.90	1628.10	11.53	13.11	0.42
2005	7912.43	2058.71	1179.41	3060.25	1606.42	7.64	13.09	0.42
2006	8346.08	2085.41	1229.29	3365.08	1657.37	8.93	12.75	0.41
2007	8670.16	1955.82	1239.87	3805.48	1666.14	2.84	12.70	0.42
2008	8218.50	1928.29	1127.11	3593.93	1565.75	3.42	11.74	0.40
2009	7551.94	1876.91	902.77	3185.05	1581.87	5.35	12.85	0.40
2010	8346.11	2260.64	1092.92	3259.09	1725.57	7.88	12.17	0.39
2011	7761.59	2083.78	903.63	3141.50	1625.44	7.23	10.55	0.39
Share of total 2011 GHG emission	67.53%	18.07%	7.86%	27.24%	14.09%	0.063%	0.092%	0.0034%

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 – Annual questionnaires for 1990-2011 prepared for EUROSTAT[6] (Table 3.8).

Difference between CO_2 emissions estimated with RA and SA for liquid fuels is quite high from 3.59% in 1995 to -20.03% in 2011. Difference for solid fuels is smaller than for liquid fuels still it varies from -9.26% in 2011 to 6.93% in 2003.

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

[6] EUROSTAT Annual Questionnaire by CSB, 2013

emission estimation from Energy sector. Amount of used tires combusted in cement production plant is reported as Other fuels.

Amount of used tires combusted in cement production plant is reported as Other fuels as well as municipal wastes combusted in the same cement production plant for years 2008-2011.

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

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Fuel consumption - Liquid fuels											
RA	143.92	124.69	105.15	97.81	94.66	78.72	81.53	69.91	69.52	58.52	45.53
SA	139.01	123.99	103.96	96.93	91.10	74.30	80.21	68.90	67.76	63.12	51.88
Diff., %	1.13	-0.79	0.10	-0.48	2.12	3.59	-0.75	-2.30	-2.10	-12.73	-18.30
CO_2 emissions - Liquid fuels											
RA	10437.56	9102.52	7697.96	7144.35	6913.50	5709.34	5924.72	4986.94	4913.79	4107.17	3108.24
SA	10280.35	9158.97	7675.96	7157.75	6751.29	5492.65	5949.08	5085.36	4993.76	4629.89	3764.16
Diff., %	1.53	-0.62	0.29	-0.19	2.40	3.95	-0.41	-1.94	-1.60	-11.29	-17.43
Fuel consumption - Solid fuels											
RA	30.57	26.66	23.62	21.38	16.04	11.60	10.94	9.70	7.07	5.36	5.53
SA	30.39	26.53	23.50	21.29	16.04	11.60	10.94	9.70	7.06	5.35	5.47
Diff., %	0.61	0.50	0.53	0.41	0.00	0.00	0.00	0.00	0.14	0.19	1.10
CO_2 emissions - Solid fuels											
RA	2677.59	2341.40	2095.92	1894.90	1433.60	1066.76	1005.10	897.47	651.25	484.25	517.99
SA	2651.11	2322.16	2077.07	1881.53	1429.88	1062.47	1000.59	893.85	648.26	482.05	511.09
Diff., %	1.00	0.83	0.91	0.71	0.26	0.40	0.45	0.41	0.46	0.46	1.35
Fuel consumption - Gaseous fuels											
RA	98.80	99.61	72.24	47.60	34.64	42.30	36.58	44.58	43.71	41.86	45.84
SA	98.70	98.02	70.78	46.17	33.65	41.32	35.59	43.54	42.67	40.85	45.07
Diff., %	0.10	1.62	2.07	3.09	2.96	2.36	2.77	2.39	2.44	2.46	1.70
CO_2 emissions - Gaseous fuels											
RA	5469.28	5513.98	4038.03	2660.53	1919.93	2340.45	2022.93	2463.33	2416.13	2309.03	2534.79
SA	5460.88	5422.65	3953.78	2579.25	1863.56	2285.05	1967.25	2404.34	2357.10	2252.09	2490.74
Diff., %	0.15	1.68	2.13	3.15	3.02	2.42	2.83	2.45	2.50	2.53	1.77
Fuel consumption - Other fuels											
RA	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.04	0.13
SA	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.04	0.13
Diff., %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO_2 emissions - Other fuels											
RA	NO	NO	NO	NO	NO	NO	NO	NO	NO	3.04	10.85
SA	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	3.04	10.85
Diff., %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Continuation of Table 3.8

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Fuel consumption - Liquid fuels											
RA	50.96	47.97	52.16	54.70	54.63	58.95	64.46	60.88	50.25	49.03	47.25
SA	52.53	52.63	54.39	55.79	55.59	60.27	65.27	60.38	55.04	56.76	54.01
Diff., %	-8.01	-14.90	-10.26	-8.03	-9.03	-9.76	-8.55	-7.34	-14.49	-19.00	-20.03
CO_2 emissions - Liquid fuels											
RA	3531.81	3272.45	3583.55	3736.62	3644.43	3969.21	4343.76	4069.24	3422.75	3365.58	3144.42
SA	3795.94	3805.86	3955.65	4059.91	4043.71	4362.07	4715.27	4362.18	4019.50	4155.15	3940.04
Diff., %	-6.96	-14.02	-9.41	-7.96	-9.87	-9.01	-7.88	-6.72	-14.85	-19.00	-20.19
Fuel consumption - Solid fuels											
RA	5.17	4.18	3.72	2.85	3.41	3.64	4.45	4.47	3.54	4.46	4.56
SA	5.17	4.18	3.48	2.84	3.41	3.64	4.45	4.41	3.57	4.51	5.02
Diff., %	0.00	0.00	6.93	0.35	0.00	0.00	-0.02	1.45	-0.73	-1.05	-9.26
CO_2 emissions - Solid fuels											
RA	463.60	374.15	353.15	262.53	314.71	335.56	410.46	412.76	325.95	410.76	421.31
SA	463.14	373.89	327.85	261.31	314.49	335.32	410.28	406.10	328.38	415.32	463.20
Diff., %	0.10	0.07	7.72	0.47	0.07	0.07	0.05	1.64	-0.74	-1.10	-9.04
Fuel consumption - Gaseous fuels											
RA	53.27	54.15	56.41	55.86	56.93	58.98	57.02	55.89	51.49	61.31	54.00
SA	52.37	53.59	55.68	55.33	56.77	58.72	56.69	55.33	50.85	60.86	53.37
Diff., %	1.72	1.05	1.32	0.96	0.28	0.44	0.58	1.02	1.26	0.75	1.18
CO_2 emissions - Gaseous fuels											
RA	2941.72	2993.95	3117.75	3086.68	3144.66	3258.86	3149.88	3087.30	2844.36	3403.83	2997.72

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
SA	2890.23	2960.85	3075.33	3055.49	3133.84	3242.38	3129.79	3054.12	2807.00	3363.92	2949.19
Diff., %	1.78	1.12	1.38	1.02	0.35	0.51	0.64	1.09	1.33	1.19	1.65
Fuel consumption - Other fuels											
RA	0.25	0.33	0.29	0.31	0.18	0.13	0.21	0.37	0.08	0.96	2.24
SA	0.25	0.33	0.29	0.31	0.18	0.13	0.21	0.37	0.08	0.94	1.86
Diff., %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.53	20.56
CO_2 emissions - Other fuels											
RA	20.29	27.46	24.08	25.99	14.53	10.40	16.67	24.72	4.34	34.30	87.29
SA	20.29	27.46	24.08	25.99	14.53	10.40	16.67	24.71	4.33	33.81	66.68
Diff., %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	1.46	30.91

3.2.1.1 Explanation of the difference

Energy balance

In the Annual questionnaires statistical differences and distribution losses are reported for certain fuels, whereas in the RA table only stock changes are possible to input. These data are not taken into account and not input in stock changes cells of CRF Reporter RA tables. That's why the difference for liquid, solid and gaseous fuels is quite significant for many years as for example distribution losses for natural gas are quite visible (Table 3.8).

CSB estimate total consumption data by taking production, import, export and international bunkering data into account. Final consumption data is estimated by taking into account sectoral consumption data reported by fuel consumers excluding reported distribution losses 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 solid fuels and natural gas 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 interproducts transfer but this amount wasn't also reported in RA tables that's why in RA tables consumption of fuel is reported although no fuel consumption was in practice in Latvia, for example other kerosene in 2004-2008. For Lubricants total fuel consumption reported as feedstocks is higher than fuel consumption reported in RA because interproducts transfer is not taken into account.

CO_2 emissions

Default country specific emission factor for gasoline is used in reference approach but in the sectoral approach carbon emission factor differs for the gasoline used in road transport, domestic navigation and off-roads.

Paraffin Wax and White Spirit data is reported in 1.B tables under "Other Liquid fuels" and in 1.D tables as "Other Fuels". Emissions from Paraffin Wax and White Spirit in RA tables have to be estimated as "0" because these emissions are "CO_2 not emitted". But emissions from these two types of fuels in these two tables – 1.B and 1.D, are not linked so emissions from liquid fuels in 1.B tables are higher that it should be.

Due to fact that interproducts transfer amount is not taken into account, in RA carbon and CO_2 emissions from Lubricants consumption resulted in negative number because fuel consumption in RA tables doesn't include amount of fuel reported in interproducts transfer but fuel consumption given in feedstocks table is reported with this amount.

3.2.1.2 Explanation of the fluctuations

Fluctuations of emissions estimated with Sectoral and Reference Approach are more or less equal. Both trends show a decrease in 1990-2000 after what the emissions have an increasing tendency till 2007 when emissions started to decrease due to economical and financial situation. Still after 1998 Sectoral Approach CO_2 emissions constantly are higher than Reference Approach emissions. This situation is explained with the black market of liquid fuels.

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 – after crisis in national economy of neighbourhood Russian Federation and due to development of national economy that was prepared for joining European Union.

3.2.1.3 Methodological issues

The IPCC 1996 Tier1 Reference approach for the CO_2 emission estimations and comparison of CO_2 emissions were used. CRF Reporter software developed by experts from UNFCCC was used to report emission data. Annual import, export, production, international bunkers and stock changes data divided by fuel types is input in the RA tables of CRF Reporter as well as carbon emission factor 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 of the fuels are taken from EUROSTAT Annual Questionnaire 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. However, NCV for other liquid fuels have been calculated by energy expert – starting from year 2011 all the NCVs have changed because CSB after the recommendations from IEA for calculating NCV started to use shale oil, but in the inventory shale oil has reported separately. Therefore the NCVs for other fuels (including used oils and petroleum coke) have been calculated taking only these fuels into account. Also the NCV from natural gas has been taken from the enterprise "Latvijas Gāze" which reports NCVs of natural gas consumed to LEGMC every year.

For several fuels NCV changes once in whole time series in 2003-2004 or 2002-2003 but for natural gas and biogas NCV and also carbon emission factor changes for every year in whole time series. NCV of other liquid fuels changes in every year in time series are explained with the fluctuation of other oil fuel structure.

Carbon emission factor for bitumen and lubricants taken from IPCC 1996[7] was used. Emission factor for paraffin wax were taken from Lithuanian submission but white spirit emissions factor were taken from Denmark submission. Finland's carbon emission factor for peat briquettes was used as characterization of peat used for in-country production of peat briquettes is very similar in Latvia and Finland. Carbon emission factor for industrial wastes (used tires) was estimated based on CO_2 emission factor reported by cement production plant within ETS (Table 3.9).

Table 3.9 Carbon emission factors (t/TJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
gasoline	18.893	18.893	18.893	18.893	18.893	18.893	18.893	18.893	18.893	18.893	18.893
diesel oil	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
LPG	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126
jet kerosene	19.718	19.718	19.718	19.718	19.718	19.718	19.718	19.718	19.718	19.718	19.718
other kerosene	19.715	19.715	19.715	19.715	19.715	19.715	19.715	19.715	19.715	19.715	19.715
other oil	20.012	20.633	20.633	20.633	20.012	20.122	20.012	20.012	20.012	20.204	20.652
shale oil	NO	NO	NO	NO	NO	21.047	NO	NO	NO	21.047	21.047
bitumen	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000
lubricants	20.012	20.012	20.012	20.012	20.012	20.012	20.012	20.012	20.012	20.012	20.012
petroleum coke	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

[7] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref1.pdf, page 1.13

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
gasoline type jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
paraffin waxes	NO	NO	NO	NO	NO	NO	NO	NO	NO	22.000	22.000
used oils	20.013	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
white spirit	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
coal	23.654	23.654	23.654	23.654	23.654	23.654	23.654	23.654	23.654	23.654	23.654
lignite	23.654	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
coke	24.221	24.221	24.221	24.221	24.221	24.221	24.221	24.221	24.221	24.221	24.221
peat briquettes	NO	26.473	26.473	26.473	26.473	NO	NO	NO	26.473	26.473	NO
peat	28.925	28.925	28.925	28.925	28.925	28.925	28.925	28.925	28.925	28.925	28.925
natural gas	15.173	15.173	15.321	15.321	15.190	15.167	15.158	15.146	15.151	15.121	15.157
solid biomass	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015
biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
liquid biofuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
industrial wastes	NO	NO	NO	NO	NO	NO	NO	NO	NO	23.030	23.030
municipal wastes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Continuation of Table 3.9

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
gasoline	18.893	18.893	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
RFO	21.113	21.113	21.113	21.113	21.113	21.113	21.113	21.113	21.113	21.113	21.113
LPG	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126	17.126
jet kerosene	19.718	19.718	19.713	19.713	19.713	19.713	19.713	19.713	19.713	19.713	19.713
other kerosene	19.715	19.715	19.715	19.711	19.711	19.711	19.711	19.711	NO	NO	19.711
other oil	20.432	20.300	21.887	22.627	26.222	21.670	21.659	22.103	22.103	22.103	22.103
shale oil	21.047	21.047	21.047	21.047	21.047	21.047	21.047	21.047	21.047	21.047	21.047
bitumen	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000
lubricants	20.012	20.012	20.012	20.012	20.012	20.012	20.012	20.012	20.012	20.012	20.012
petroleum coke	NO	27.500	27.500	27.500	27.500	27.500	27.500	NO	27.500	27.500	27.500
gasoline type jet fuel	NO	NO	NO	NO	19.352	19.352	19.352	NO	NO	NO	NO
paraffin waxes	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000	22.000
used oils	20.013	20.013	20.013	20.013	20.013	20.013	20.013	20.013	20.013	20.013	20.013
white spirit	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000	20.000
coal	23.654	23.654	25.675	25.675	25.675	25.675	25.675	25.675	25.675	25.675	25.675
lignite	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
coke	24.221	23.841	23.841	23.841	23.841	23.841	23.841	23.841	23.841	23.841	23.841
peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
peat	28.925	28.925	28.925	28.925	28.925	28.925	28.925	28.925	NO	NO	28.925
natural gas	15.136	15.155	15.148	15.146	15.139	15.144	15.142	15.140	15.141	15.141	15.141
solid biomass	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015	30.015
biogas	NO	14.919	14.920	14.750	14.773	14.402	14.773	14.625	14.625	14.625	14.625
liquid biofuels	NO	NO	NO	NO	19.300	19.300	19.300	19.300	19.300	19.300	19.300
industrial wastes	23.030	23.030	23.030	23.030	21.655	21.655	21.655	23.198	23.198	16.625	16.625
municipal wastes	NO	NO	NO	NO	NO	NO	NO	12.052	12.314	8.894	8.894

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.

Municipal wastes structure also influenced carbon emission factor change in 2008-2011.

3.2.1.5 Source-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 Annual Questionnaires that CSB prepares and reports to the EUROSTAT and IEA. CSB 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 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.
- By comparing used carbon emission factor with in Sectoral Approach used CO_2 emission factors.

3.2.2 International bunker fuels

International bunkers cover international aviation and navigation according to the 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. Total GHG emissions of International Bunkering are shown in the Figure 3.4.

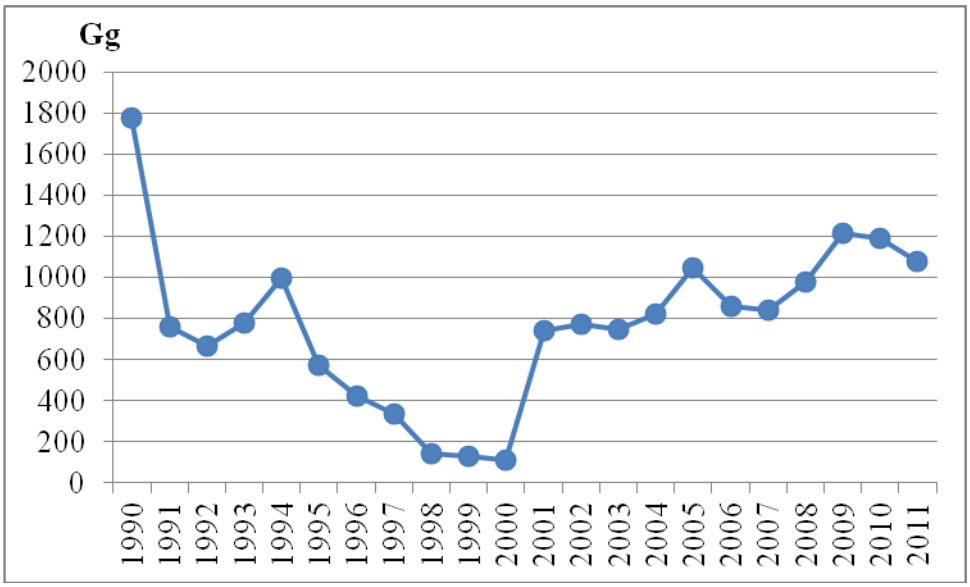


Figure 3.4 Emissions from International Bunkers (Gg CO_2 eq.)

Fuel consumption is obtained from CSB (Table 3.10). To provide the consistent allocation of fuel consumption between domestic and international mode in the navigation and aviation, CSB each month collects and summarises the information which is submitted by every one of enterprises which perform 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 (TJ)[8]

	Aviation	Navigation	
	Jet Kerosene	Diesel Oil	RFO
1990	3067,2	5013,8	14737,8
1991	4147,2	807,3	5075,0
1992	1166,4	637,4	6820,8
1993	1166,4	1402,2	7429,8
1994	1080,0	2974,3	8688,4
1995	1080,0	1104,7	5156,2
1996	1382,4	934,8	3126,2
1997	1382,4	849,8	2111,2
1998	1252,8	552,4	81,2
1999	1252,8	424,9	0,0
2000	1123,2	339,9	0,0
2001	1123,2	4249,0	3938,2
2002	1166,4	3611,7	4993,8
2003	1685,2	3101,8	4750,2
2004	2031,0	3186,8	5278,0
2005	2463,0	3824,1	7064,4
2006	2765,0	2761,9	5481,0
2007	3371,0	2506,9	4953,2
2008	4062,0	1912,1	6699,0
2009	4278,0	2591,9	8850,8
2010	4907,0	2932,0	7592,0
2011	4926,0	3171,0	5806,0

The emission factors are shown in Table 3.11.

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

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ	Gg/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 IPCC 1996 Tier 2a (as denominated in accordance with 2000 GPG), where the amount of LTO/cruises is crucial. Emissions from international navigation are calculated in pursuance with IPCC 2006 Tier 1.

The relevant emission factors are taken from different sources. All of the international aviation emission factors are derived from the IPCC 1996. CO_2 emission factors in international navigation are country-specific; CH_4 and N_2O factors are taken from IPCC 1996, while the remaining factors – from EMEP/EEA 2009 (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 (Gg/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

[8] CSB. Annual Eurostat Energy Questionnaire, 2012

2008-2011	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 (Gg/PJ)
1990-2007	2.8	40.6	1.352
2007-2011	0.2	40.6	0.724

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

3.2.3.1 Source 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, Paraffin Waxes and White Spirits is reported in 1.D tables for all years in time series 1990–2011.

Paraffin Waxes and White Spirits are not default types of fuels in CRF 1.A(d) tables so these fuels are reported under "Other Fuels" what caused some discrepancies with 1.A(b) tables that is described in Chapter 3.2.1.

3.2.3.2 Methodological issues

Emission factors used in different neighbourhood countries during preparation of submission were used in emission estimations due to lack of national carbon emission factors. It was assumed that neighbourhood countries are importing their liquid fuels from the same liquid fuels supplying countries therefore liquid fuels with similar characteristics are used in countries of one region.

Bitumen and Lubricants emission factors are taken from the IPCC 1996. Emission factor for Paraffin Wax were taken from Lithuanian submission. White Spirit emissions factor were taken from Denmark submission.

Activity data prepared by CSB and reported to EUROSTAT in EUROSTAT Annual Questionnaire formats were used (Table 3.14).

Table 3.14 Activity data for Feedstock's and non-energy use of fuels in 1990–2011 (TJ)

	Bitumen	Lubricants	Paraffin Wax	White Spirit
1990	1632.54	1632.54	-	83.72
1991	544.18	1046.5	-	83.72
1992	83.72	920.92	-	83.72
1993	167.44	1088.36	-	83.72
1994	544.18	1004.64	-	83.72
1995	711.62	962.78	-	83.72
1996	879.06	962.78	-	83.72
1997	1632.54	879.06	-	83.72
1998	2051.14	1004.64	-	125.58
1999	2344.16	879.06	125.58	83.72
2000	2009.28	879.06	125.58	125.58
2001	1506.96	837.2	167.44	125.58
2002	2093	837.2	167.44	83.72
2003	2176.72	920.92	167.44	83.72
2004	2009.28	1004.64	251.16	125.58
2005	2511.6	1088.36	334.88	125.58
2006	3097.64	1088.36	251.16	125.58
2007	3348.8	1088.36	251.16	83.72

	Bitumen	Lubricants	Paraffin Wax	White Spirit
2008	3599.96	1046.5	209.3	83.72
2009	2218.58	627.9	293.02	41.86
2010	1967.42	586.04	460.46	41.86
2011	2930.2	795.34	293.02	41.86

Constant increase of bitumen since 2004 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.

Coke consumption isn't included in this sector as coke is not used as feedstock but is combusted during crude iron and scrap metal melting to decrease carbon content in final crude steel.

Lubricants are mainly are used in transport sector. According to Transport sector expert the percentage amount of lubricants that are combusted in mobile vehicles system was estimated using the amount if lubricants combusted. Approximately 99.7% in 2011 from total lubricants consumption are used as feedstocks and therefore 49.7% of carbon (taking into account that emission factor for lubricants is 0.5) 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.

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

3.2.3.3 CO_2 capture from flue gases and subsequent CO_2 storage

During the second period of EU-ETS there was reported CO_2 direct transfer into greenhouse from one heat plant. However this subject isn't taken into account in the inventory as further studying is necessary.

3.2.3.4 Country Specific issues

Country specific issues regarding fuel combustion mainly are related to fuel characteristics – net calorific values and carbon contents that are used in estimation of country specific CO_2 and carbon emission factors. Also plant specific fuel characteristics are used to estimate CO_2 and carbon emission factors for sludge gas and landfill gas. Enterprises estimated and reported emissions are used in several categories – NO_2 and SO_2 emissions from public CHP and heat plants, fugitive NMVOC emissions from operations with liquid fuels and fugitive methane emissions from operations with natural gas.

All country specific issues are explained in details under relevant chapters of source categories and in Annexes.

3.2.4 Energy Industries (CRF 1.A.1)

3.2.4.1 Source category description

1.A.1 Energy industries sector include emissions from fuel combustion in point sources in energy production including emissions from off–road. Fuel consumption in autoproducer combustion installations is excluded from this sector and included in particular sectors of 1.A.2, 1.A.4.a and 1.A.4.c sectors according to IPCC 1996.

Emissions from combustion installations with NACE2 codes 35.11 and 35.30 are reported in 1.A.1.a sector. There are no direct electricity production only plants in Latvia. 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 (Table 3.15). There is no petroleum refining in Latvia.

Table 3.15 Emissions from 1.A.1 Energy industries in 1990–2011 (Gg)

	CO_2	CH_4	N_2O	GHGs (CO_2 eq)	NO_x	CO	NMVOC	SO_2
1990	6266.63	0.27	0.05	6286.62	13.97	5.50	0.50	37.21
1991	5751.17	0.26	0.04	5769.58	12.40	5.54	0.45	30.19
1992	4925.94	0.25	0.04	4943.92	10.68	5.71	0.44	27.54
1993	3973.07	0.24	0.04	3990.12	9.21	5.03	0.42	28.70
1994	3731.92	0.24	0.04	3749.42	9.18	4.46	0.44	32.47
1995	3417.88	0.23	0.04	3433.97	7.65	5.29	0.40	23.12
1996	3549.52	0.25	0.04	3567.00	8.49	4.78	0.43	28.84
1997	3305.68	0.29	0.04	3324.49	7.52	5.56	0.38	19.62
1998	3349.94	0.28	0.04	3368.71	8.04	4.62	0.34	20.44
1999	2924.94	0.23	0.03	2940.21	7.01	3.47	0.25	15.66
2000	2475.88	0.22	0.03	2489.94	5.23	4.44	0.23	7.16
2001	2418.22	0.21	0.03	2431.46	5.23	3.69	0.18	5.19
2002	2313.69	0.22	0.03	2327.22	5.15	3.52	0.17	4.87
2003	2246.11	0.23	0.03	2260.40	5.11	3.46	0.15	3.52
2004	2057.56	0.21	0.03	2070.41	4.79	2.78	0.12	2.12
2005	2047.55	0.18	0.02	2058.71	4.15	2.59	0.10	2.16
2006	2073.32	0.20	0.03	2085.41	3.84	2.78	0.10	1.22
2007	1943.80	0.19	0.03	1955.82	4.45	2.70	0.10	1.24
2008	1916.58	0.19	0.02	1928.29	3.37	2.67	0.09	0.74
2009	1865.12	0.19	0.03	1876.91	3.32	2.62	0.09	0.74
2010	2247.73	0.21	0.03	2260.64	3.13	3.02	0.11	0.78
2011	2071.74	0.20	0.03	2083.78	3.12	2.95	0.10	0.34

Emissions from 1.A.1 sector (Table 3.15) have a decreasing tendency with few peak points from which the most recent is in 2010. In the beginning of 90-ties it is explained with economical crisis caused by changes of political and social situation in the country when national economy was totally reorganized. Decrease in the end of 90-ties is explained with economical crisis in Russian Federation with whom Latvia has close economical collaboration. Decrease of emissions in 2008-2009 years is explained with crisis in national economy caused by global financial crisis. Although the heat and electricity production for population use is influenced by crisis in national economy in smaller level than industrial production the emissions are decreasing as population is using less electricity and residential sector is switching from central district heating to individual heating. The increase of GHG emissions in 2010 is by 20.45% comparing with 2009. That can mostly be explained with a relatively cold winter. In 2011 the emissions are decreasing again because of much warmer winter when the temperature was 1.6°C above average.

Still in 2008-2010 CH_4 and N_2O emissions have increased by 10.81% and 10.03% respectively due to increase of liquid, solid and biomass fuel consumption and share of liquid and solid fuel consumption in total amount of fuel combusted in CRF 1.A.1 sector. In year 2011 the amount of emitted CH_4 and N_2O have decreased comparing with year 2010 by 6.79% and 6.64% respectively.

Lasting decrease of emissions is explained with high standards of physical characterization of fuels and fuel switching to the fuels with lower costs and emissions – natural gas and biomass.

Also indirect GHG emissions from 1.A.1 Energy Industries were estimated (Table 3.15). SO_2 had the biggest decrease by 99.08% in 1990–2011, where decrease in 2010-2011 by 55.76% is observed. It is explained with fuel switching from coal, peat and heavy fuel oils to natural gas and biomass from what sulphur dioxide emissions aren't emitted. Also strict national legislation was approved to improve quality of used liquid fuels in country. The most recent decrease in SO_2 emissions in 2011 is because of the largest company which uses residual fuel oil – the fuel was replaced with one which contains less sulphur therefore the emissions decreased even by 2.26 times if compared with previous year.

Other indirect GHG emissions in 2009–2011 had also decreased which is explained with a decrease of total fuel consumption combusted in stationary combustion installations. NMVOC and CO emissions have increased in 2010 due to increase of solid fuels consumption, although in year 2011 the amount of NMVOC and CO has decreased by 6.36% and 2.22% respectively.

3.2.4.2 Methodological issues

Methods

IPCC 1996 Tier1 Sectoral approach was used to calculate GHG emissions from the 1.A.1 sector. IPCC GPG 2000 Tier2 method was used to estimate CO_2 emissions from natural gas combustion as country specific parameters were used to estimate CO_2 emission factor for natural gas.

As sludge gas consists almost 50% of non-combustible components such as CO_2, sulphur and others and only approximately 50% of sludge gas is combustible methane, emissions from biogas was 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 this methane is obtained from sludge it is considered as biomass combustion and CO_2 neutral. Tier 2 method from IPCC GPG 2000 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. CRF Reporter software developed by experts from UNFCCC was used to report emission data.

The general method for preparing inventory data was used:

$$\boxed{Em = EF \times B_q}$$

where:
Em – total emissions (Gg)
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 2005-2011 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.

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 1996;
- IPCC 2006;
- EMEP/EEA 2009.

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 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 was used:[9]

$$E'_{CO_2} = \frac{C^d \times M_{CO_2} \times 1000}{Q_z^d \times M_C \times 100}$$

where:

E'_{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 2013, 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

Type of fuel	Carbon content in working mass of fuel (C^d), %	NCV (Q_z^d), MJ/kg	Oxidation factor (p)	Emission factor with oxidation factor (EF CO_2), kg/GJ
Coal	67.32	28.46 (1990-2002) 26.22 (2003-2011)	0.98	**84.93868** **92.19508**
Peat, W^d = 40%[10]	29.07	10.05	0.98	**103.86645**
Peat briquettes[11]		15.49	0.98	**95.06**
Coke	63.87	26.37 (1990-2001) 26.79 (2002-2011)	0.98	**86.97273** **85.60921**
Motor gasoline (for off-roads)	83.13	44 (1990-2002) 43.97 (2003-2011)	0.99	**68.53470** **68.58146**
Diesel oil	86.68	42.49	0.99	**74.001**
LPG	77.99	45.54	0.995	**62.43659**
Residual fuel oil	85.72	40.6	0.99	**76.58815**
Jet fuel	85.18	43.2 (1990-2002 43.21 (2003-2010)	0.99	**71.52524** **71.50869**
Shale oil	82.82	39.35	0.99	**76.34769**
Other kerosene	85.17	43.2 (1990-2000) 43.21 (2004) 43.2 (2005-2011)	0.99	**71.51684** **71.50029** **71.51684**
Wood, W^{d*} = 55%	20.11	6.70[12]	0.98	**107.77886**

Fuel characteristics for other liquid fuels and estimated CO_2 emission factor changes for every year in time series (Table 3.17). The fuel characteristics depend on structure of other liquid fuels. CSB reported average NCV from the information obtained from fuel consumers.

Table 3.17 Characteristics of other liquid fuels and estimated CO_2 emission factors

	1990	1991-1993	1994-2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Carbon content in working mass of fuel (Cd) %	83.77	83.77	83.77	83.77	83.77	83.77	83.77	83.77	83.77	83.77	83.77	83.77	83.77
NCV (Q_z^d) MJ/kg	41.86	40.6	41.86	41.632	41.86	41.463	40.593	41	41.267	38.273	37.022	31.947	38.658
Oxidation factor (p)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99

[9] "Guidance manual for CO_2 emission estimations (Developed in accordance with UNFCCC and IPCC recommendations and physical characteristics of fuels used in Latvia)"

[10] moisture content

[11] emission factor was taken from GHG inventory of Finland

[12] for wood – Q_z^d is TJ/1000m^3

	1990	1991-1993	1994-2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
EF with oxidation factor (EF CO_2) kg/GJ	72.59	74.85	72.59	72.99	72.59	73.29	74.86	74.12	73.64	79.40	82.08	95.12	78.61

Natural gas

For calculating CO_2 emission factors for natural gas following equation was used:[13]

$$E'_{CO_2} = \frac{C^d \times M_{CO_2} \times 1000}{Q_z^d \times M_C \times 100} \times \rho$$

where:
E'_{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)
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, NCV and natural gas density for all years in 1990-2011 was obtained from only natural gas supplier JSC "Latvijas Gāze" that collects / measures these data by themselves (Table 3.18).

Table 3.18 Characteristics of natural gas and estimated CO_2 emission factors

	Carbon content in working mass of fuel (C^d) %	NCV (Q_z^d) TJ/1000m^3	Oxidation factor (p)	Natural gas density (ρ) t/1000m^3	Emission factor with oxidation factor (EF CO_2) kg/GJ
1990	74.33	33.64	0.995	0.6867	55.3183
1991	74.33	33.64	0.995	0.6867	55.3183
1992	74.36	33.6	0.995	0.6923	55.8583
1993	74.15	33.71	0.995	0.6965	55.8556
1994	74.04	33.7	0.995	0.6914	55.3808
1995	74.26	33.73	0.995	0.6889	55.2953
1996	74.3	33.62	0.995	0.6859	55.2644
1997	74.39	33.62	0.995	0.6845	55.2184
1998	74.35	33.65	0.995	0.6857	55.2361
1999	74.31	33.62	0.995	0.6841	55.1268
2000	74.32	33.73	0.995	0.6879	55.2596
2001	74.36	33.78	0.995	0.6876	55.1835
2002	74.36	33.65	0.995	0.6858	55.2516
2003	74.38	33.64	0.995	0.6851	55.2265
2004	74.39	33.59	0.995	0.6839	55.2192
2005	74.4	33.59	0.995	0.6835	55.1944
2006	74.39	33.59	0.995	0.6838	55.2112
2007	74.38	33.54	0.995	0.6828	55.2052
2008	74.38	33.57	0.995	0.6833	55.1962
2009	74.37	33.696	0.995	0.686	55.1997
2010	74.42	33.6477	0.995	0.6855	55.2758
2011	74.43	33.6645	0.995	0.6856	55.2637

Sludge gas

CO_2 emission factor was estimated for the methane obtained from biogas, it means that the CO_2 emission factor estimated below is estimated for pure methane that is obtained from collected sludge gas.

[13] "Guidance manual for CO_2 emission estimations (Developed in accordance with UNFCCC and IPCC recommendations and physical characteristics of fuels used in Latvia)"

As wastewater treatment plant wasn't able to provide the information of carbon content percentage in working mass of fuel that's why constant methane value was used estimated basing on moll mass of components. Following equation was used to calculate this methane number:

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

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 sludge gas 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 3.18).

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

Carbon content in working mass of sludge gas (C^d) %	NCV of sludge gas (Q_z^d) TJ/1000m^3	Amount of methane in sludge gas (%)	Default carbon content in working mass of methane (C^d) %	NCV of methane (Q_z^d) TJ/1000m^3	Oxidation factor (p)	Natural gas density (ρ) t/1000m^3	Emission factor with oxidation factor (EF CO_2) kg/GJ
41.92582%	22.0	56.00%	74.867543%	35.88	0.995	0.6687	50.870474

SO_2 emissions factors

SO_2 emissions factors were calculated by formula taken from IPCC Guidelines 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 2).

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, N_2O, NO_x, CO, NMVOC emission factors used in estimation of emission were taken from IPCC 1996 (Table 3.20). Emission factors for sludge gas were equalled to natural gas emission factors due to unavailability of particular emission factors for sludge gas.

Gasoline emission factors given in Table 3.20 below are used for emission estimation from off-roads.

Table 3.20 CH_4, N_2O, NO_x, CO, NMVOC emission factors (Gg/PJ)

	CH_4	N_2O	NO_x	CO	NMVOC
Gasoline	0.05	0.002	0.21	27	1
Diesel oil	0.003	0.0006	0.18	0.015	0.0008
RFO	0.003	0.0006	0.215	0.005	0.008
LPG	0.003	0.0006	0.18	0.015	0.0008
Jet fuel	0.003	0.0006	0.18	0.015	0.0008
Other kerosene	0.003	0.0006	0.18	0.015	0.0008
Other liquid	0.003	0.0006	0.18	0.015	0.0008
Shale oil	0.003	0.0006	0.18	0.015	0.0008
Coal	0.001	0.0014	0.36	0.113	0.0017
Coke	0.001	0.0014	0.31	0.15	0.0012
Peat briquettes	0.03	0.004	0.1	1	0.05
Peat	0.03	0.004	0.1	1	0.05
Natural gas	0.001	0.0001	0.089	0.039	0.0015
Solid biomass	0.03	0.004	0.211	0.258	0.0073
Sludge gas	0.001	0.0001	0.15	0.02	0.005

SO_2 emission factors for fuel combustion are presented in Annex 3.1.

Activity data

Mainly emissions from fuel combustion are calculated using fuel consumption data from the CSB prepared within Annual questionnaires for 1990-2011 sent to EUROSTAT.

The CSB data collection system is based on detailed compulsory surveys 1–EK (semi-annual) and 2-EK (annual). Form 1-EK "Survey on acquisition and consumption of energy resources" is collected from about 5000 enterprises and organizations (with all kind of economic activity) that are included in the lists of suppliers of statistical information. Consumption of fuel in sectors of national economy is surveyed in State and local government enterprises of all sectors regardless the number of employed, and in other enterprises employing 50 and more persons. Every half-year about 5000 respondents are surveyed. Data on enterprises and organizations employing less than 50 persons are obtained once a year with the help of random sampling and generalizing received results (survey 2–EK). 1–EK and 2–EK represents the basic tool for creating energy balances at a country level.

Table 3.21 Fuel consumption in 1.A.1 Energy industries in 1990−2011 (PJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.1. Energy Industries											
Liquid Fuels	40.466	33.302	28.475	27.214	30.860	20.519	27.334	17.438	20.662	17.491	7.901
Solid Fuels	5.261	4.746	5.508	5.579	4.517	5.211	4.149	3.965	2.782	1.765	2.752
Gaseous Fuels	48.609	49.859	39.792	24.255	16.779	24.117	18.828	28.442	27.088	25.720	28.868
Biomass	0.436	0.590	0.673	0.865	1.300	1.065	1.637	3.413	4.112	3.700	3.235
1.A.1.a. Public Electricity and Heat Production											
Liquid Fuels	40.127	33.051	28.224	26.963	30.426	20.266	26.110	17.107	18.115	14.485	6.350
Diesel oil	5.524	5.226	3.824	0.935	0.382	0.085	0.042	0.297	0.085	0.085	0.127
RFO	32.561	26.146	23.183	24.563	30.044	20.016	25.984	16.768	17.905	14.007	5.278
LPG	0.046	0.046	0.046	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	1.997	1.633	1.172	1.465	NO	0.126	0.084	0.042	0.126	NO	NO
Shale oil	NO	NO	NO	NO	NO	0.039	NO	NO	NO	0.394	0.944
Solid Fuels	3.683	3.440	3.880	4.544	3.613	4.085	3.144	3.141	2.191	1.415	2.340
Coal	2.305	1.736	1.935	2.106	1.366	1.395	0.740	0.541	0.427	0.370	0.370
Peat briquettes	0.031	0.015	0.015	0.015	0.015	0.077	0.062	0.077	0.015	NO	NO
Peat	1.347	1.688	1.930	2.422	2.231	2.613	2.342	2.523	1.749	1.045	1.970
Natural gas	47.802	49.234	39.162	23.631	16.143	23.172	17.785	27.871	26.347	25.080	28.059
Biomass	0.436	0.590	0.673	0.865	1.300	1.065	1.637	3.387	4.078	3.599	3.235
Wood	0.436	0.590	0.673	0.831	1.300	1.045	1.595	3.363	4.060	3.558	3.191
Sludge Gas	NO	NO	NO	0.034	0.000	0.020	0.042	0.024	0.018	0.041	0.044
Landfill gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other Biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries											

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Liquid Fuels	0.339	0.251	0.251	0.251	0.433	0.253	1.224	0.330	2.547	3.005	1.551
Diesel oil	0.212	0.170	0.170	0.170	0.170	0.212	0.127	0.127	0.127	0.212	0.127
RFO	0.081	0.081	0.081	0.081	0.081	0.041	1.096	0.203	0.487	0.731	NO
LPG	0.046	NO	NO	NO	0.182	NO	NO	NO	NO	NO	NO
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	0.216	0.346	NO
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	1.716	1.716	1.423
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid Fuels	1.578	1.307	1.628	1.035	0.905	1.126	1.005	0.824	0.591	0.350	0.412
Coal	NO	NO	NO	NO	NO	NO	NO	NO	0.028	0.028	NO
Peat	1.578	1.307	1.628	1.035	0.905	1.126	1.005	0.824	0.563	0.322	0.412
Natural gas	0.808	0.625	0.630	0.624	0.637	0.944	1.042	0.572	0.740	0.639	0.809
Wood	NO	NO	NO	NO	NO	NO	NO	0.026	0.034	0.101	NO

Continuation of Table 3.21

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.A.1. Energy Industries											
Liquid Fuels	5.265	5.064	3.606	3.144	2.395	1.512	1.389	0.905	1.214	0.932	0.866
Solid Fuels	1.645	1.290	0.873	0.280	0.244	0.135	0.371	0.466	0.482	0.430	0.430
Gaseous Fuels	33.579	32.544	34.078	32.415	33.355	35.235	32.668	32.698	31.303	38.662	35.583
Biomass	4.152	4.667	5.558	5.530	4.732	5.323	5.297	5.179	5.267	5.790	5.715
1.A.1.a. Public Electricity and Heat Production											
Liquid Fuels	5.095	4.851	3.437	2.932	2.183	1.300	1.219	0.692	1.044	0.719	0.611
Diesel oil	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	NO	NO	0.042
RFO	4.425	4.425	3.207	2.801	2.111	1.218	1.137	0.650	1.015	0.690	0.568
LPG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	0.155	0.029	0.029	0.088	0.029	NO	NO	NO	0.029	0.029	NO
Shale oil	0.472	0.354	0.157	NO	NO	0.039	0.039	NO	NO	NO	NO
Solid Fuels	1.524	1.280	0.863	0.270	0.224	0.125	0.361	0.466	0.482	0.430	0.430
Coal	0.398	0.285	0.210	0.210	0.184	0.105	0.341	0.446	0.472	0.420	0.420
Peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	1.126	0.995	0.653	0.060	0.040	0.020	0.020	0.020	0.010	0.010	0.010
Natural gas	32.700	31.737	33.203	31.542	32.481	34.295	32.098	31.892	30.805	37.787	34.641
Biomass	3.670	4.185	4.700	4.672	4.250	4.841	4.754	4.636	4.510	5.287	5.085
Wood	3.617	4.097	4.644	4.570	4.132	4.741	4.675	4.556	4.390	5.084	4.581
Sludge Gas	0.053	0.088	0.056	0.102	0.118	0.100	0.079	0.080	0.120	0.119	0.104
Landfll gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.020	0.019
Other Biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.064	0.381
1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries											
Liquid Fuels	0.170	0.212	0.170	0.212	0.212	0.212	0.170	0.212	0.170	0.212	0.255
Diesel oil	0.170	0.212	0.170	0.212	0.212	0.212	0.170	0.212	0.170	0.212	0.255
RFO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid Fuels	0.121	0.010	0.010	0.010	0.020	0.010	0.010	NO	NO	NO	NO
Coal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	0.121	0.010	0.010	0.010	0.020	0.010	0.010	NO	NO	NO	NO
Natural gas	0.878	0.808	0.875	0.873	0.873	0.940	0.571	0.806	0.498	0.875	0.942
Wood	0.482	0.482	0.858	0.858	0.482	0.482	0.543	0.543	0.757	0.503	0.630

[1] under this category only methane obtained from sludge gas is reported

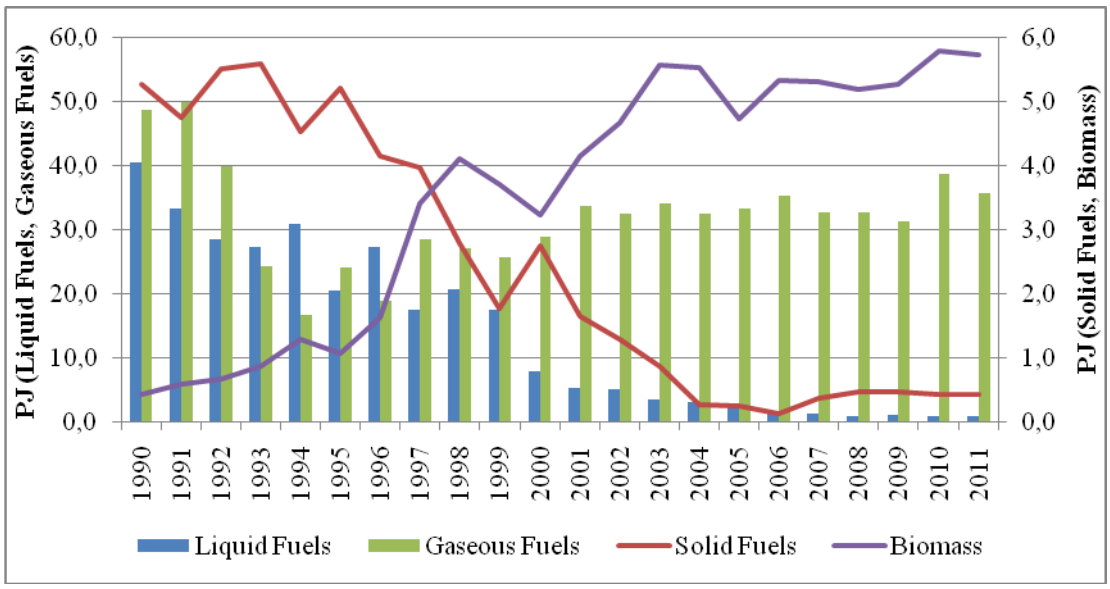


Figure 3.5 Fuel consumption in 1.A.1 Energy industries in 1990–2011 (PJ)

The biggest decrease in time period 1990–2011 for the two sub-sectors of 1.A.1 Energy industries sector was for liquid fuel consumption in 1.A.1.a subsector – 97.86% (Table 3.21, Figure 3.5). It is explained with fuel switching processes when liquid fuels were switched to other more low-costs fuels. Also stronger legislation contributed fuel switching to the type of fuels with lower level of emissions. And that's why also consumption of solid fuels decreased. In the latest years consumption of solid fuels have increased that is explained with the increase of coal consumption in Energy industries – 300% in 2006-2011. 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 and diesel oil.

Consumption of biomass fuel has increased by 1210.76% in 1990–2011. Solid biomass has lower costs, therefore liquid and solid fuels replaced with biomass and natural gas.

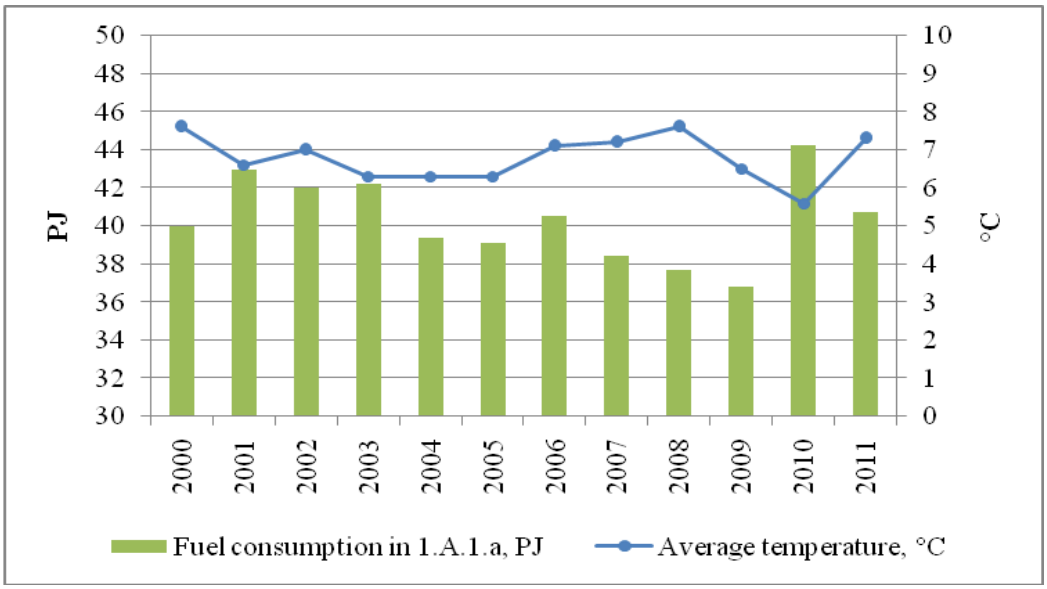


Figure 3.6 Fuel consumption in 1.A.1.a and average temperature in Latvia (2000-2011)[14]

As it can be seen in Figure 3.6, the fuel consumption in 1.A.1.a sector is related with the average temperature with an exception of years 2006 and 2009 where the correlation is not observed which can be explained with a decrease of central heating supply consumers when

[14] Average temperatures are taken from CSB on-line database (see link in the Reference Chapter).

they switched to individual heating supply. Years 2006-2009 had quite high average temperature therefore the fuel consumption for combined heat plants and heat plants for heat production decreased as there wasn't any need of high heat production amount, but in year 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.

3.2.4.3 Uncertainties and time series consistency

Uncertainty in activity data of fuel combustion in 1.A.1 sector is ±2% in 2011. CSB gives approximately 2% statistical sample error for statistical data. 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 15% because biomass activity data were collected by CSB with questionnaires sent by enterprises consumed biomass. Uncertainty of biogas 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 by the wastewater treatment plant that's why final uncertainty of combusted sludge gas is assumed as 20%. Taking into account uncertainties of solid biomass and biogas consumption total biomass fuel consumption uncertainty is assumed as 20%.

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%. For combustion of solid fuels uncertainty of CO_2 emission factor was assigned higher to 15% because CO_2 emission factor of peat briquettes was taken from GHG inventories of Finland. As well as 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 factor for sludge gas was assigned as 10% because constant carbon content was used in emission estimation but plant specific NCV value is used. CO_2 emission factor for biomass is assigned as 50% because emission factor is estimated by using default net calorific values still activity data is estimated by using net calorific values for specific wood products, wood types and moisture content of fuelwood. Taking into account uncertainties of solid biomass and biogas emission factors total biomass emission factor uncertainty is assumed as 50%.

CH_4 and N_2O emission factor used in estimation of emissions was taken from IPCC 1996 so uncertainty was assigned as very high about 50% according IPCC GPG 2000.

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 Source-specific QA/QC and verification

Quality control procedures according to the IPCC GPG 2000 Tier 1 method for Energy sector were performed. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers. All findings were documented by using check-lists and introduced in GHG inventory. All corrections are archived.

3.2.4.4.1 General QA/QC checks for 1.A.1 sector

For stationary fuel combustion following QA/QC checks are performed for all parts of national inventory.

There are several steps for activity data verification:

1. Activity data check at the data providing institution:

- CSB has the internal QA/QC procedures based on mathematical model and analysis to avoid logic mistakes.

2. Activity data checked at the institution responsible for the emission estimation and reporting:
   - During the activity data is input in emission estimation database done by sectoral expert all the data changes comparing to previous inventory are agreed with CSB and the data changes reason in explained.
   - After the data is input in emission estimation database activity data is verified using diagrams that is the best way to reflect all the illogical data fluctuations.
   - 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.
3. Activity data used in Sectoral Approach estimation methodology is compared to the activity data used in Reference Approach estimations. 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.

Estimated emissions verification:

1. 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.
2. NO_2 and SO_2 emissions from national database "2-Air" are verified and approved by Regional Environmental Boards.

3.2.4.4.2 Additional QA/QC checks for Tier2 methodology

Country specific CO_2 emission factors

Mainly Tier1 methodology is reported as used in the CO_2 emission estimation but according to IPCC 2006 it would be Tier2 methodology as country or plant specific emission factors are used. Country specific emission factors are estimated using NCV values reported by CSB. CSB collects these data from fuel combustion enterprises and reports annual average number in Annual Questionnaire tables. Carbon content values of the fuels are determined in local expert's research. Detailed CO_2 emission factors estimation data is used and CO_2 emission factor is estimated to the last decimal place. Estimated CO_2 emission factors are within IPCC range. Even if the estimated CO_2 EFs are almost equal to IPCC default EFs or don't differ at all the EFs are reported as country specific.

Plant specific CO_2 emission factors and Tier2 CO_2 emission estimation methodology

Tier2 methodology is used for CO_2 emission from natural gas and sludge gas combustion estimation as plant specific NCVs are used in CO_2 EF estimation. The parameters are reported to LEGMC by only natural gas supplier "Latvijas Gāze" and sludge gas collecting plant and the companies confirm that the data is reasonable and useful.

Natural gas supplying company measures NCV every day and reports the average annual number to LEGMC and CSB. All the measuring equipments are checked and verified.

The parameters also are verified by CSB comparing the data natural gas supplier and sludge gas collecting plant has reported within annual Energy balance surveys.

Also CO_2 emission estimation methodology differs from IPCC default because only methane obtained from sludge gas only is taken into account.

3.2.4.5 Source-specific recalculations

Activity data updates for 1990-2011 because of updates of activity data given by CSB and incorrectnesses found in database therefore corrections were done. Also other liquid fuels' activity data and CO_2 emission factor were updated because of changed NCV and also natural gas activity data because of précised NCVs were updated.

3.2.4.6 Source-specific planned improvements

The summarized necessary improvements are:

- Implement the country specific emission factors obtained in research of CH_4 emissions from solid biomass combustion in the Submission 2014.
- Analyse the possibility to use plant specific data from national database "2-AIR" where facilities that perform any of pollution activities have to report all emissions they create.
- Update NCVs for solid fuels in the next inventory (Submission 2014).

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

3.2.5.1 Source category description

CRF 1.A.2 Manufacturing industries and construction sector include 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 IPCC 1996 (Table 3.22).

Under CRF 1.A.2 f Other sector emissions from following industrial sectors are reported:

- Non-Metallic Minerals
- Transport Equipment
- Machinery
- Mining and Quarrying
- Wood and Wood Products
- Construction
- Textiles and Leather
- Non-specified (Industry)

Table 3.22 Emissions from 1.A.2 CRF Manufacturing industries and construction in 1990–2011 (Gg)

	CO_2	CH_4	N_2O	GHGs (CO_2 eq)	NOx	CO	NMVOC	SO_2
1990	3724.11	0.26	0.03	3737.65	5.13	27.98	1.45	23.19
1991	2804.05	0.19	0.02	2813.64	3.81	9.17	0.64	14.07
1992	2368.39	0.17	0.02	2376.82	3.24	9.06	0.61	13.00
1993	2098.92	0.18	0.02	2109.15	3.13	11.37	0.83	14.38
1994	1899.68	0.17	0.02	1909.85	2.90	9.33	0.77	15.54
1995	1863.11	0.17	0.02	1873.31	2.85	6.71	0.66	14.88
1996	1826.91	0.18	0.02	1837.59	2.85	9.41	0.77	14.47
1997	1780.98	0.17	0.02	1791.62	2.80	8.30	0.73	13.97
1998	1559.86	0.18	0.02	1570.64	2.56	8.85	0.76	10.82
1999	1411.70	0.17	0.02	1422.03	2.37	7.58	0.70	8.80
2000	1151.91	0.16	0.02	1160.60	1.94	6.51	0.58	4.37
2001	1062.62	0.20	0.02	1073.36	1.99	8.31	0.73	2.33
2002	1110.09	0.19	0.02	1120.26	1.97	8.75	0.70	1.78
2003	1140.00	0.19	0.02	1149.87	1.96	7.35	0.64	1.39
2004	1150.61	0.23	0.02	1163.21	2.19	10.78	0.89	0.87
2005	1165.21	0.26	0.03	1179.41	2.37	12.72	1.07	1.11

	CO_2	CH_4	N_2O	GHGs (CO_2 eq)	NOx	CO	NMVOC	SO_2
2006	1213.16	0.29	0.03	1229.29	2.61	14.52	1.24	1.23
2007	1225.26	0.27	0.03	1239.87	2.51	13.38	1.13	1.25
2008	1111.76	0.28	0.03	1127.11	2.41	14.03	1.19	1.00
2009	883.50	0.33	0.04	902.77	2.52	16.71	1.49	0.65
2010	1069.24	0.40	0.05	1092.92	2.92	19.05	1.71	0.95
2011	876.11	0.46	0.06	903.63	2.89	21.48	1.93	0.89

Emissions from 1.A.2 were increasing in 2001-2008 due to sharp development of nation economy and industry as well as increase of demand of industrial production and improvement of well-being of population. Increase of CO_2 emissions are also caused by constant increase of solid fuels – coal, and other fuels (used tires) consumption that mostly is combusted in mineral and steel production industry. Decrease of emissions in 2007-2008 is influenced by the features of national economy development when in-country industrial production already started to decrease due to increase of costs of the production and dominance of imported products. Crisis in national economy in the second part of 2008 also influenced decrease of total emissions. Also increase of solid biomass consumption influenced the decrease of CO_2 emissions. Large crisis of national economy caused by global financial crisis in 2008-2009 influenced quite significant decrease of CO_2 emissions in 2008-2009 – by 19.90 %. The crisis and development of EU ETS influenced increase of biomass consumption for 2008-2009 in 1.A.2 sector, when almost all other fuels have decreased. Due to this significant increase of biomass consumption all emissions with exception of CO_2 and SO_2 increased in 2009-2010. In year 2011 the GHG emissions have reduced by 18.06%, mostly because of significant decrease of liquid fuels and natural gas in 1.A.2.a sector. At the same time the CH_4, N_2O, CO and NMVOCs emissions have increased by 13.67%, 17.67%, 12.72% and 12.61% accordingly, which can be explained with an increased use of biomass, solid fuels and other fuels whose consumption has almost doubled.

Also indirect GHG emissions from 1.A.2 sector were estimated (Table 3.22). In this sector SO_2 emissions decrease by 96.15% in 1990–2011. It is explained with fuel switching to natural gas and biomass from what sulphur dioxide emissions aren't emitted.

3.2.5.2 Methodological issues

Methods

IPCC 1996 Tier1 Sectoral approach was used to calculate GHG emissions from the 1.A.2 sector. IPCC 2006 was used in the calculation of emissions from liquid biofuels used in chemical industry. IPCC GPG 2000 Tier2 method was used to estimate CO_2 emissions from natural gas combustion as country specific parameters were used to estimate CO_2 emission factor.

Calculation of all emissions from fuel combustion is done with Excel databases developed by experts from LEGMC. CRF Reporter software developed by experts from UNFCCC was used to report emission data.

The general method for preparing inventory data was used:

$$\boxed{Em = EF \times B_q}$$

where:
Em – total emissions (Gg)
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 1996;
- IPCC 2006;
- EMEP/EEA 2009.

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 1.A.2 Manufacturing Industries and Construction sector are estimated with the same equations and using same method as for 1.A.1 Energy industries sector with the exception for liquid biofuels and used tires that are not combusted in 1.A.1 Energy industries.

Liquid biofuels

Liquid biofuels – glycerine, CO_2 emission factor is taken from IPCC 2006 as there is no information available of used biofuels characteristics to estimate country or plant specific CO_2 emission factor. CO_2 emission factor 79.6 Gg/PJ from IPCC 2006 is used as for other liquid biofuels is used.

Used tires

EF for CO_2 emission estimation for other fuels – used tires, combusted in CRF 1.A.2.f Other Manufacturing Industries – cement production, category for years 1999–2011 is taken from GHG emission reports that plant submitted under ETS (Table 3.23). This CO_2 emission factor is 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. EF for CH_4 and N_2O emissions estimations are taken from IPCC 2006.

Table 3.23 CO_2 emission factor (Gg/PJ)

	1999-2004	2005	2006	2007	2008-2009	2010-2011
Used tires	82.7556	79.44	79.4	79.44	85	60.9

As it was mentioned since 2005 the cement production plant is participating in EU Emission trading scheme so estimated CO_2 EF is verified by accredited verifiers and the approved by Regional Environmental Board.

Municipal wastes

CO_2 emission factor of municipal wastes combusted in cement production plants is taken from plant's annual GHG report within EU ETS for 2008-2011 IPCC 2006 as there is no information available of such fuel type. This CO_2 emission factor is 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. EF for CH_4 and N_2O emissions estimations are taken from IPCC 2006.

Table 3.24 CO_2 emission factor (Gg/PJ)

	2008	2009	2010			2011		
Municipal wastes - Plant 1	85.19	82.81						
Municipal wastes - Plant 2		120.95	82.69	117.6	155.97	113.22	81.13	135.3

SO_2 emissions factors

SO_2 emission factors for 1.A.2 Manufacturing Industries and Construction sector are estimated with the same equations and using same method as for 1.A.1 Energy industries sector.

SO_2 emissions factors were calculated by formula taken from IPCC Guidelines 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 3.1).

Other emission factors

The default CH_4, N_2O, NO_x, CO, NMVOC emission factors used in estimation of emission were taken from IPCC 1996 (Table 3.25).

Gasoline emission factors given in Table 3.25 below are used for emission estimation from off-roads.

Table 3.25 CH_4, N_2O, NO_x, CO, NMVOC emission factors (Gg/PJ)

	CH_4	N_2O	NO_x	CO	NMVOC
Gasoline	0.05	0.002	0.21	27	1
Diesel oil	0.002	0.0006	0.1	0.04	0.01
RFO	0.002	0.0006	0.1	0.04	0.01
LPG	0.002	0.0006	0.2	0.01	0.005
Jet fuel	0.002	0.0006	0.1	0.04	0.01
Other kerosene	0.002	0.0006	0.1	0.04	0.01
Other liquid	0.002	0.0006	0.1	0.04	0.01
Shale oil	0.002	0.0006	0.1	0.04	0.01
Coal	0.01	0.0014	0.173	0.931	0.0888
Coke	0.01	0.0014	0.173	0.931	0.0888
Peat briquettes	0.03	0.004	0.1	1	0.05
Peat	0.03	0.004	0.1	1	0.05
Natural gas	0.005	0.0001	0.07	0.025	0.0025
Solid biomass	0.03	0.004	0.15	1.596	0.1464
Liquid biofuels	0.003	0.0006	0.07	0.025	0.0025
Used tires	0.03	0.004	-	-	-
Municipal wastes	0.03	0.004	-	-	-

Activity data

Emissions from CRF 1.A.2 sector are calculated using fuel consumption data from the CSB prepared within Annual questionnaires for 1990-2011 sent to EUROSTAT. The data collection system for 1.A.2 sector is the same as for 1.A.1 sector (Table 3.26).

Autoproducers data prepared by CSP are taken into account into the calculation of the emissions from CRF 1.A.2 sector according to IPCC 1996.

Only gasoline combustion is reported as off-roads in 1.A.2 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.

Table 3.26 Fuel consumption in CRF 1.A.2 Manufacturing industries and construction in 1990–2011 (PJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.2 Manufacturing Industries and Construction											
Liquid Fuels	28.710	18.770	16.010	16.571	16.022	16.300	15.981	15.687	12.669	11.157	7.334
Solid Fuels	1.598	1.008	1.110	1.748	1.645	0.824	0.767	0.740	0.686	0.702	0.518
Gaseous Fuels	25.610	23.489	19.006	12.431	9.761	9.990	9.885	9.548	9.791	9.144	9.858
Biomass	0.617	0.603	0.616	1.779	2.101	2.414	2.664	2.740	3.188	3.176	2.696
Other Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.037	0.131
1.A.2.a. Iron and Steel											
Liquid Fuels	*1.804*	*1.017*	*0.733*	*0.745*	*0.913*	*0.705*	*0.785*	*1.162*	*1.088*	*1.130*	*1.173*
Diesel oil	0.042	0.042	0.042	NO	0.042	NO	NO	NO	NO	NO	0.042

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
RFO	1.177	0.974	0.690	0.284	0.284	0.203	0.325	0.325	NO	NO	NO
Other liquid	0.585	NO	NO	0.460	0.586	0.502	0.460	0.837	1.088	1.130	1.130
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid Fuels	*0.053*	*0.105*	*0.132*	*0.134*	*0.185*	*0.158*	*0.158*	*0.264*	*0.264*	*0.264*	*0.264*
Coal	NO	NO	NO	0.028	NO	NO	NO	NO	NO	NO	NO
Coke	0.053	0.105	0.132	0.105	0.185	0.158	0.158	0.264	0.264	0.264	0.264
Natural gas	4.238	3.602	3.426	2.893	3.109	2.361	2.521	3.955	4.038	3.900	3.913
1.A.2.b. Non-Ferrous Metals											
Diesel oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	NO	NO	NO	NO	NO	NO	NO	NO	0.054	0.101	0.169
1.A.2.c. Chemicals											
Liquid Fuels	*3.642*	*2.059*	*1.684*	*2.964*	*3.250*	*4.547*	*3.451*	*3.207*	*0.325*	*0.164*	*0.122*
Diesel oil	*0.127*	*0.127*	*0.085*	NO	*0.042*	NO	NO	NO	NO	*0.042*	NO
RFO	*3.126*	*1.543*	*1.340*	*2.964*	*3.207*	*4.547*	*3.451*	*3.207*	*0.325*	*0.122*	*0.122*
LPG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other kerosene	*0.389*	*0.389*	*0.259*	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	NO	NO	NO	*0.028*	*0.028*	NO	NO	NO	NO	NO	NO
Natural gas	*0.423*	*0.578*	*0.414*	*0.643*	*0.693*	*1.091*	*0.703*	*0.304*	*0.302*	*0.365*	*0.318*
Biomass	*NO*	*NO*	*NO*	*0.004*	*0.007*	*0.007*	*0.013*	*0.020*	*0.020*	*0.054*	*0.047*
Wood	NO	NO	NO	0.004	0.007	0.007	0.013	0.020	0.020	0.054	0.047
Other Liquid Biofuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.d. Pulp, Paper and Print											
RFO	0.203	0.162	0.122	0.122	0.041	0.081	NO	NO	NO	NO	NO
Coal	0.028	0.028	0.028	0.114	0.057	0.057	0.057	0.057	0.028	0.028	NO
Natural gas	2.701	2.614	2.412	0.654	0.044	0.101	0.119	0.105	0.095	0.101	0.101
Wood	NO	NO	NO	0.065	0.188	0.087	0.020	0.020	0.020	0.040	0.023
1.A.2.e. Food Processing, Beverages and Tobacco											
Liquid Fuels	*10.547*	*7.700*	*7.045*	*6.807*	*4.419*	*4.653*	*5.429*	*5.205*	*5.239*	*4.133*	*2.809*
Diesel oil	3.229	3.229	3.102	3.229	0.765	0.552	0.510	0.807	0.722	0.552	0.552
RFO	7.105	4.425	3.898	3.532	3.654	4.019	4.791	4.222	4.385	3.492	1.583
LPG	0.046	0.046	0.046	0.046	NO	NO	NO	0.046	0.046	0.046	NO
Jet fuel	NO	NO	NO	NO	NO	NO	0.043	0.086	0.043	NO	NO
Other kerosene	NO	NO	NO	NO	NO	NO	0.043	0.043	0.043	0.043	0.043
Other liquid	0.167	NO	NO	NO	NO	0.042	0.042	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	39.35	NO	NO	NO	NO	629.60
Solid Fuels	*1.069*	*0.598*	*0.655*	*0.593*	*0.581*	*0.309*	*0.309*	*0.267*	*0.184*	*0.239*	*0.140*
Coal	0.911	0.598	0.655	0.541	0.512	0.256	0.256	0.199	0.142	0.171	0.114
Coke	0.158	NO	NO	0.053	0.053	0.053	0.053	0.053	0.026	0.053	0.026
Peat briquettes	NO	NO	NO	NO	0.015	NO	NO	0.015	0.015	0.015	NO
Natural gas	3.149	2.698	2.511	3.500	2.831	3.066	3.282	3.042	2.723	2.604	2.613
Biomass	*0.228*	*0.231*	*0.230*	*0.238*	*0.316*	*0.327*	*0.330*	*0.325*	*0.328*	*0.349*	*0.450*
Wood	0.228	0.231	0.230	0.238	0.316	0.327	0.330	0.325	0.328	0.349	0.450
Other Liquid Biofuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.2.f. Other											
Liquid Fuels	*12.513*	*7.832*	*6.427*	*5.934*	*7.400*	*6.314*	*6.316*	*6.113*	*6.017*	*5.730*	*3.230*
Gasoline	0.880	0.220	0.220	0.220	0.132	0.044	0.132	0.088	0.088	0.044	0.044
Diesel oil	2.167	2.209	0.807	0.552	0.765	0.935	0.807	0.935	0.935	0.935	0.892
RFO	9.297	5.359	5.400	5.075	6.415	5.116	5.197	4.913	4.994	4.588	1.462
LPG	NO	NO	NO	NO	0.046	0.091	0.137	0.091	NO	0.046	0.046
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other kerosene	0.043	0.043	NO	0.086	0.043	0.086	0.043	86.40	NO	NO	NO
Other liquid	125.58	NO	NO	NO	0.00	41.86	NO	NO	NO	NO	NO
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.118	787.00
Solid Fuels	*0.448*	*0.276*	*0.295*	*0.878*	*0.795*	*0.300*	*0.243*	*0.152*	*0.209*	*0.171*	*0.114*
Coal	0.369	0.256	0.285	0.825	0.768	0.285	0.228	0.142	0.199	0.171	0.114

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Coke	0.079	NO	NO	0.053	0.026	NO	NO	NO	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	NO	0.015	0.015	NO	NO	NO	NO
Peat	NO	0.020	0.010	NO	NO	NO	NO	0.010	0.010	NO	NO
Natural gas	15.099	13.997	10.243	4.741	3.083	3.371	3.260	2.141	2.581	2.073	2.745
Biomass	*0.389*	*0.372*	*0.386*	*1.472*	*1.590*	*1.993*	*2.301*	*2.375*	*2.820*	*2.733*	*2.176*
Wood	0.389	0.372	0.386	1.472	1.590	1.993	2.301	2.375	2.820	2.733	2.176
Landfill gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid biofuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other Fuels	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*	*NO*	*0.037*	*0.131*
Industrial wastes (used tires)	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.037	0.131
Municipal wastes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Continuation of Table 3.26

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.A.2 Manufacturing Industries and Construction											
Liquid Fuels	4.804	4.423	4.741	4.530	3.654	4.280	4.050	3.309	3.073	3.558	2.451
Solid Fuels	0.518	0.496	0.397	0.407	1.105	1.498	2.074	2.128	1.497	1.956	2.309
Gaseous Fuels	11.600	12.848	12.726	13.093	13.550	13.263	12.884	11.607	9.281	10.495	7.543
Biomass	3.856	3.393	3.309	4.706	5.535	6.429	5.388	5.798	8.641	9.810	11.207
Other Fuels	0.245	0.332	0.291	0.314	0.183	0.131	0.210	0.365	0.078	0.945	1.86
1.A.2.a. Iron and Steel											
Liquid Fuels	*1.071*	*0.963*	*0.963*	*0.963*	*0.652*	*0.963*	*0.963*	*0.917*	*0.793*	*1.005*	*NO*
Diesel oil	NO	NO	NO	NO	42.49	NO	NO	NO	NO	NO	NO
RFO	NO	NO	NO	NO	NO	NO	NO	0.122	0.081	NO	NO
Other liquid	0.992	0.963	0.963	0.963	0.610	0.963	0.963	0.795	0.712	1.005	NO
Shale oil	0.079	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid Fuels	*0.264*	*0.241*	*0.134*	*0.188*	*0.161*	*0.134*	*0.107*	*0.134*	*0.134*	*0.107*	*0.107*
Coal	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.026	0.026
Coke	0.264	0.241	0.134	0.188	0.161	0.134	0.107	0.134	0.134	0.080	0.080
Natural gas	4.066	3.904	3.970	4.031	4.131	4.098	4.125	3.827	3.403	3.835	1.178
1.A.2.b. Non-Ferrous Metals											
Diesel oil	0.042	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	0.190	0.269	0.302	0.269	0.203	0.204	0.201	0.134	0.101	0.134	0.168
1.A.2.c. Chemicals											
Liquid Fuels	*0.164*	*0.162*	*0.122*	*NO*	*NO*	*NO*	*NO*	*0.153*	*0.126*	*0.094*	*0.131*
Diesel oil	NO	NO	NO	NO	NO	NO	NO	0.042	0.085	0.085	0.085
RFO	0.122	0.162	0.122	NO	NO	NO	NO	0.081	0.041	0.009	NO
LPG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.046
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	0.042	NO	NO	NO	NO	NO	NO	0.029	NO	NO	NO
Coal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	0.270	0.279	0.309	0.406	0.443	0.480	0.381	0.514	0.519	0.603	0.404
Biomass	*0.046*	*0.029*	*0.019*	*0.047*	*0.029*	*0.059*	*0.073*	*0.188*	*0.130*	*0.188*	*0.170*
Wood	0.046	0.029	0.019	0.047	0.029	0.056	0.072	0.187	0.127	0.187	0.169
Other Liquid Biofuels	NO	NO	NO	NO	NO	0.003	0.001	0.001	0.003	0.001	0.001
1.A.2.d. Pulp, Paper and Print											
RFO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	0.028	0.028	0.026	0.026	0.026	0.026	NO	NO	NO	NO	NO
Natural gas	0.135	0.134	0.168	0.168	0.202	0.235	0.201	0.201	0.101	0.101	0.101
Wood	0.013	0.020	0.020	0.020	0.027	0.020	0.016	0.007	0.163	0.156	0.107
1.A.2.e. Food Processing, Beverages and Tobacco											
Liquid Fuels	*1.650*	*1.470*	*1.122*	*0.960*	*0.999*	*1.003*	*0.788*	*0.507*	*0.616*	*0.614*	*0.435*
Diesel oil	0.467	0.340	0.340	0.340	0.297	0.255	0.212	0.212	0.212	0.170	0.085
RFO	0.974	0.893	0.609	0.406	0.406	0.447	0.329	0.122	0.244	0.284	0.122
LPG	0.046	0.046	0.046	0.046	0.046	0.091	0.091	0.046	0.091	0.091	0.091
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	0.084	0.113	0.088	0.130	0.171	0.171	0.117	0.088	0.029	0.029	0.058
Shale oil	0.079	0.079	0.039	0.039	0.079	0.039	0.039	0.039	0.039	0.039	0.079
Solid Fuels	*0.140*	*0.141*	*0.158*	*0.105*	*0.132*	*0.105*	*0.079*	*0.079*	*0.052*	*0.055*	*0.026*
Coal	0.114	0.114	0.131	0.105	0.105	0.079	0.079	0.079	0.052	0.052	0.026
Coke	0.026	0.027	0.027	NO	0.027	0.027	NO	NO	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.003	NO
Natural gas	2.781	2.989	2.765	3.242	3.154	3.254	2.688	2.142	1.935	1.904	1.871
Biomass	*0.800*	*0.842*	*0.719*	*0.916*	*1.034*	*0.772*	*0.701*	*0.394*	*0.488*	*0.339*	*0.361*
Wood	0.800	0.842	0.719	0.916	1.034	0.772	0.701	0.394	0.483	0.333	0.361
Other Liquid Biofuels	NO	NO	NO	NO	NO	NO	NO	NO	0.005	0.006	0.000
1.A.2.f. Other											
Liquid Fuels	*1.877*	*1.827*	*2.534*	*2.607*	*2.003*	*2.314*	*2.299*	*1.733*	*1.500*	*1.845*	*1.885*
Gasoline	0.044	0.088	0.044	0.088	0.088	0.088	0.088	0.088	0.044	0.044	0.044
Diesel oil	0.850	0.892	0.850	1.020	1.062	1.275	1.785	1.402	1.232	1.105	1.615
RFO	0.447	0.122	0.081	0.041	0.122	0.081	0.122	0.041	NO	0.041	0.041
LPG	NO	NO	NO	0.046	0.046	0.046	0.046	0.046	NO	NO	0.091
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	0.301	0.607	1.441	1.335	0.646	0.785	0.220	0.117	0.223	0.656	0.095
Shale oil	0.236	0.118	0.118	0.079	0.039	0.039	0.039	0.039	NO	NO	NO
Solid Fuels	*0.085*	*0.085*	*0.079*	*0.089*	*0.787*	*1.232*	*1.888*	*1.915*	*1.311*	*1.794*	*2.176*
Coal	0.085	0.085	0.079	0.079	0.787	1.232	1.888	1.915	1.311	1.783	2.176
Coke	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	1.00	NO
Peat	NO	NO	NO	10.05	NO	NO	NO	NO	NO	10.05	NO
Natural gas	4.157	5.274	5.212	4.977	5.419	4.992	5.286	4.790	3.223	3.917	3.821
Biomass	*2.997*	*2.502*	*2.551*	*3.723*	*4.445*	*5.578*	*4.598*	*5.209*	*7.860*	*9.126*	*10.569*
Wood	2.997	2.502	2.551	3.723	4.445	5.578	4.598	5.209	7.860	9.125	10.550
Landfill gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.019
Other liquid biofuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.001	NO
Other Fuels	*0.245*	*0.332*	*0.291*	*0.314*	*0.183*	*0.131*	*0.210*	*0.365*	*0.078*	*0.945*	*1.86*
Industrial wastes (used tires)	0.245	0.332	0.291	0.314	0.183	0.131	0.210	0.210	0.021	0.107	0.424
Municipal wastes	NO	NO	NO	NO	NO	NO	NO	0.155	0.057	0.838	1.433

All fuel types with an exception of biomass fuels have decreased in 1990-2011 where liquid fuels had the biggest decrease in time period – 91.46% (Table 3.26, Figure 3.7). It is explained with fuel switching processes when liquid fuels were switched to other more low-costs fuels. Also stronger legislation contributed fuel switching 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.

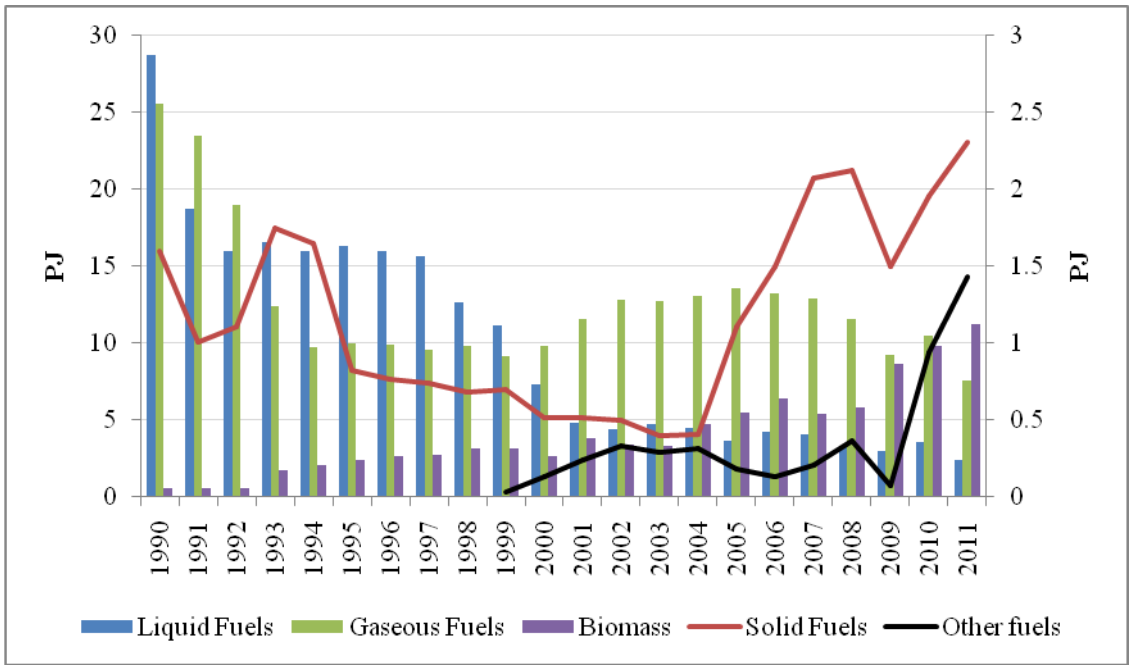


Figure 3.7 Fuel consumption in 1.A.2 Manufacturing industries and construction in 1990–2011 (PJ)

After the crisis in the beginning of 90-ties natural gas consumption steadily increased with some small exceptions due to fuel switch processes and development of national economy.

However, the consumption of solid fuels (mainly coal) has increased in 1990-2011 by 44.46%. The increase is explained with the development of mineral production sector in Latvia – cement production where coal consumption increased more than four times. Solid fuels consumption steadily were growing – since 2003 with 482.04% increase. 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.

Consumption of biomass fuel has increased very significantly – by 1716.37% in 1990–2011. 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 reason for liquid and solid fuels replacement with biomass and natural gas. In year 2011 there were relevant reconstructions in "Liepājas Metalurgs" which is responsible for the greatest part of 1.A.2.a sector emissions and the decrease of fuel consumption comparing with year 2010 is quite sharp – there are no liquid fuels used in 2011 and the decrease for natural gas is -69.28%.

Consumption of used tires and municipal wastes in Mineral production reported as Other Fuels had increased in 1999-2011 by 3804.47%. The increase was influenced by a sharp increase of cement production that was caused by increasing demand of construction materials and sharp development of construction sector.

3.2.5.3 Uncertainties and time series consistency

Uncertainty in activity data of fuel combustion in 1.A.2 sector is ±2% in 2011. CSB gives approximately 2% statistical sample error for statistical data. 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 15% because biomass activity data were collected by CSB with questionnaires sent by enterprises consumed biomass.

Uncertainty of other fuels consumption – municipal and industrial wastes, 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 was assigned as quite low about 10%. For combustion of solid fuels uncertainty of CO_2 emission factor was assigned higher to 15% because CO_2 emission factor of peat briquettes was taken from GHG inventories of Finland. As well as 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 factor for biomass is assigned as 50% because emission factor is estimated by using default net calorific values still activity data is estimated by using net calorific values for specific wood products, wood types and moisture content of fuel wood.

CO_2 emission factors for other fuels and mineral production sector is assumed as 5% as were determined in accredited laboratory of cement production company.

CH_4 and N_2O emission factor used in estimation of emissions was taken from IPCC 1996 so uncertainty was assigned as very high about 50% according IPCC GPG 2000.

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 Source-specific QA/QC and verification

Quality control procedures according to the IPCC GPG 2000 Tier 1 method for Energy sector were performed. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers. All findings were documented by using check-lists and introduced in GHG inventory. All corrections are archived.

3.2.5.4.1 General QA/QC checks for 1.A.2 sector

For stationary fuel combustion following QA/QC checks are performed for all parts of national inventory.

There are several steps for activity data verification:

1. Activity data check at the data providing institution:
    - CSB has the internal QA/QC procedures based on mathematical model and analysis to avoid logic mistakes.
2. Activity data checked at the institution responsible for the emission estimation and reporting:
    - During the activity data input in emission estimation database done by sectoral expert all the data changes are compared to previous inventory and agreed with CSB. The reasons of data changes are explained.
    - After the data is input in emission estimation database activity data is verified using diagrams that is the best way to reflect all the illogical data fluctuations.
    - 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. Still the data reporting requirements of IPCC 1996 make difficult the activity data comparison as autoproducers have to be excluded from Energy industries sector and included in relevant sectors.
3. Activity data used in Sectoral Approach estimation methodology is compared to the activity data used in Reference Approach estimations. 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.

Estimated emissions verification:

1. 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.
2. Emissions are checked using time series consistency check for the IEF estimated in CRF Reported and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

3.2.5.4.2 Additional QA/QC checks for Tier2 methodology

Country specific CO_2 emission factors

Mainly Tier1 methodology is reported as used in the CO_2 emission estimation but according to IPCC 2006 it would be Tier2 methodology as country or plant specific emission factors are used. Country specific emission factors are estimated using NCV values reported by CSB. CSB collects these data from fuel combustion enterprises and reports annual average number in Annual Questionnaire tables. Carbon content values of the fuels are determined in local expert's research. Detailed CO_2 emission factors estimation data is used and CO_2 emission factor is estimated to the last decimal place. Estimated CO_2 emission factors are within IPCC range. Even if the estimated CO_2 EFs are almost equal to IPCC default EFs or don't differ at all the EFs are reported as country specific.

Plant specific CO_2 emission factors and Tier2 CO_2 emission estimation methodology

Tier2 methodology is used for CO_2 emission from natural gas combustion estimation as plant specific NCVs are used in CO_2 EF estimation. The parameters are reported to LEGMC by only natural gas supplier "Latvijas Gāze" and the company confirms that the data is reasonable and useful. Natural gas supplying company measures NCV every day and reports the average annual number to LEGMC and CSB. All the measuring equipments are checked and verified. The parameters also are verified by CSB comparing the data natural gas supplier has reported within annual Energy balance surveys.

Activity data, CO_2 EF and estimated emissions of used tires and municipal wastes are taken from cement production plant's annual GHG reports within EU ETS. The data is verified by accredited verifier and then checked and approved by Regional Environmental Boards.

3.2.5.5 Source-specific recalculations

Activity data updates were done because of changed NCV of other liquid fuels and also CO_2 EF was changed. CO_2 emissions for gasoline years 2009-2010 have been recalculated. Recalculations have been done due to an updated specific CO_2 EF. Instead 68.6 kg/GJ now 71.18 kg/GJ is implemented.

Activity data updates of natural gas were done because of precised NCVs for time series from 1992 to 2010. Also some small input mistakes were corrected.

3.2.5.6 Source-specific planned improvements

The summarized necessary improvements are:

- Implement the country specific emission factors obtained in research of CH_4 emissions from solid biomass combustion in the Submission 2014.
- Update NCVs for solid fuels in the next inventory (Submission 2014).

- Researches of possibility to use plant specific data from national database "2-AIR" where facilities that perform any of pollution activities have to report all emissions they create.

3.2.6 Transport (CRF 1.A.3)

3.2.6.1 Source category description

This section describes GHG emissions resulting from transport fuel combustion. In 2011, this source category was responsible for 27.5% of total GHG emissions in Latvia, reaching 3163 Gg.

Total GHG emissions in the transport sector after the dramatic drop in year 2009 has stabilised (see Figure 3.8). This development can be described by revival of economy after the recession that had caused sudden decrease in fuel consumption in the period of 2008 – 2009, which was mostly projected in the road transport sector.

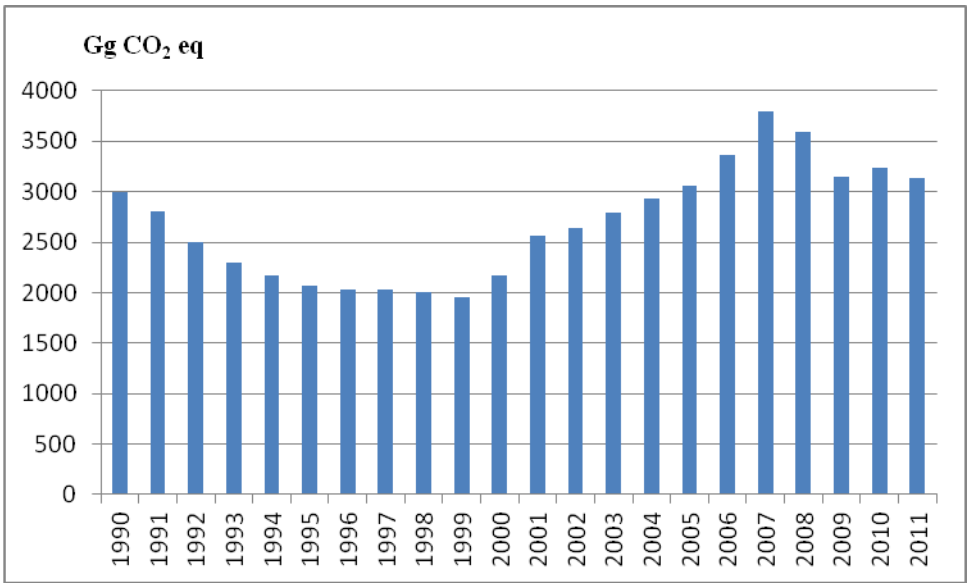


Figure 3.8 GHG emissions development in transport 1990 – 2011

The road transport constitutes a convincing majority of the total GHG emissions in the transport sector. In 2011, it gave 90.52 % of total emissions but the next largest emission source is a railroad – 8,9 % (see Figure 3.9).

CO_2 emissions constitute nearly 98.1% of the total GHG emissions in the transport sector and they are key sources in road transport and railway (Figure 3.10).

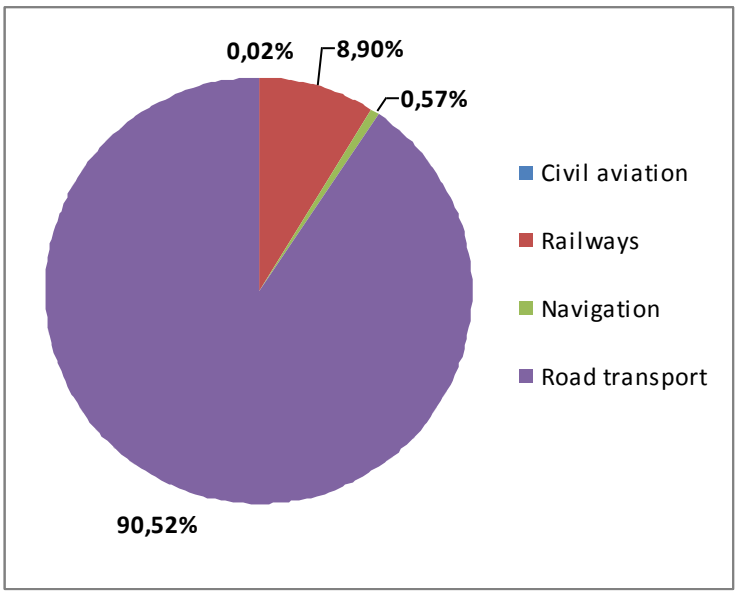


Figure 3.9 GHG emissions in transport by sub-sectors (year 2011)

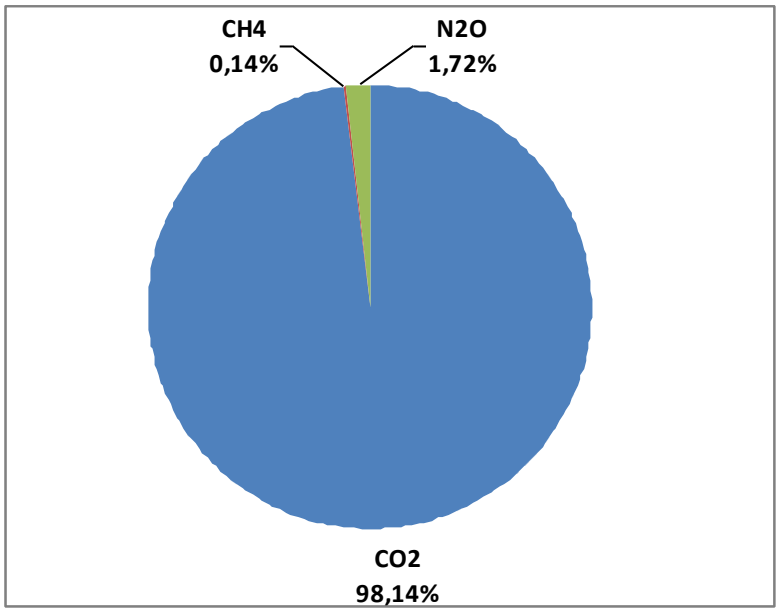


Figure 3.10 GHG emissions in transport sector by gases (year 2011)

One of the critical factors influencing CO_2 emission is the amount and type of the consumed fuel. In 2011, total fuel consumption in the transport sector, compared to 2010 level, has decreased by 2 %. In different subsectors various changes have taken place in 2011. In civil aviation the fuel consumption has increased by 47%, whereas in the road transport it has decreased by 2.3 %. In the railway the fuel consumption has increased by 19 %, but in navigation it has decreased by 28%.

In total, road transport consumes about 92%, railway – about 7.2% and civil aviation and navigation – the remaining share of fuel.

Diesel oil is the major fuel type in the transport sector and it constitutes 69 %, and is followed by gasoline – 24.3 %, but LPG constitutes 2.7% and biofuels (biodiesel and bioethanol) 4.0% of the total fuel consumption in the transport sector. A share of biofuels has increased from 2.6% in year 2010 up to 4.0% in year 2011. Biofuel mainly is used in road transport but small portion is consumed in railway as well.

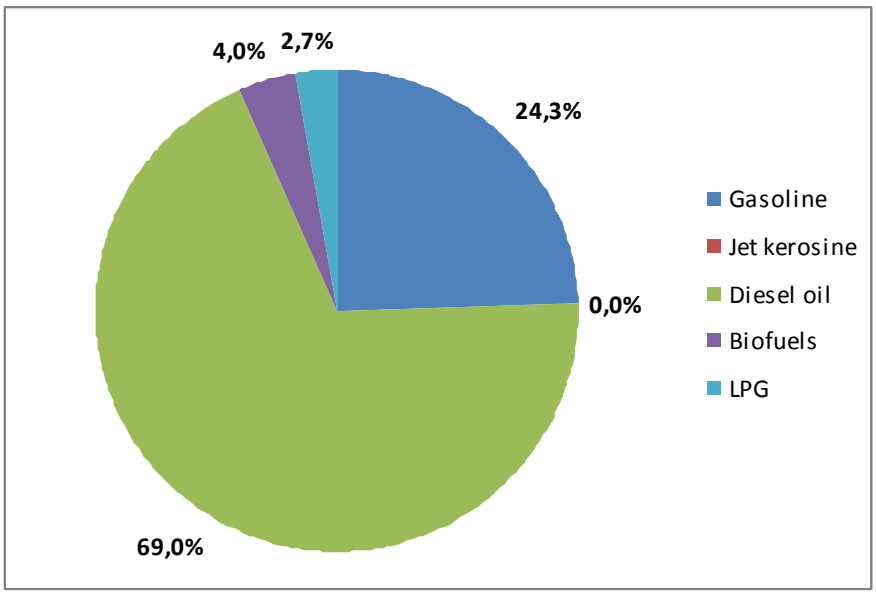


Figure 3.11 Fuel consumption in transport by fuel type (2011)

3.2.6.2 Civil avitation (CRF 1.A.3.a)

3.2.6.2.1 Source category description

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 0.02% of GHG emissions from transport sector in year 2011 (Figure 3.12).

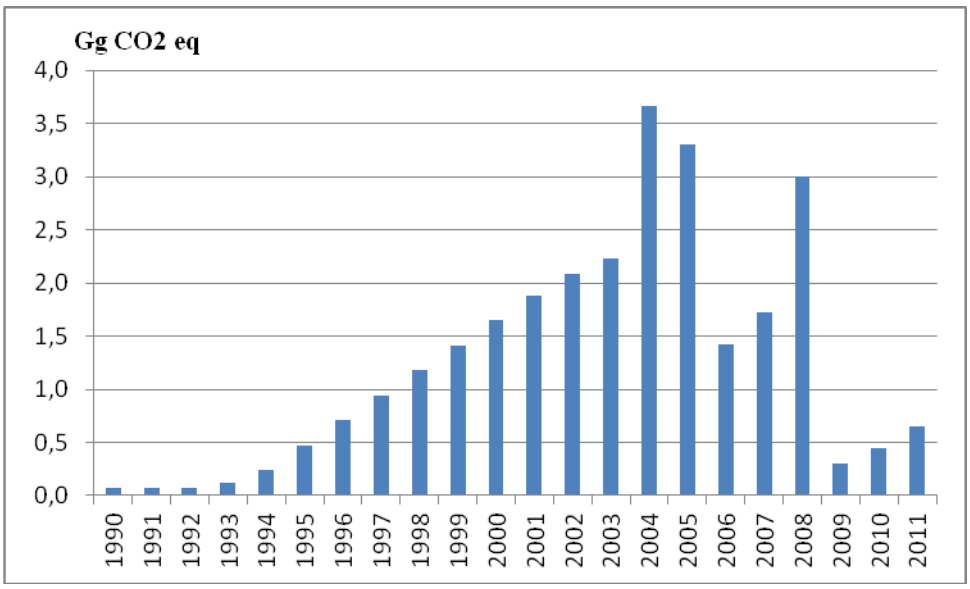


Figure 3.12 GHG emissions in civil aviation (Gg CO_2 eq)

In Latvia, there are four airports for commercial aviation, of which the largest is the Riga International Airport. 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 turbo jets and turbo props engines. 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. The main activities in civil navigation relates with private flights.

3.2.6.2.2 Methodological issues

Methods

When calculating emissions from civil aviation, two approaches have been applied. Taking into consideration the different properties of aviation gasoline and jet kerosene, IPCC 1996 Tier 1 method has been applied when estimating emissions from aviation gasoline, and IPCC 1996 Tier 2– when calculating emissions from jet kerosene. 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 emission inventory guidebook — 2009 http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009).

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*

Activity data

The data about fuel consumption in aviation is derived from the CSB. CSB has started to collect data 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.

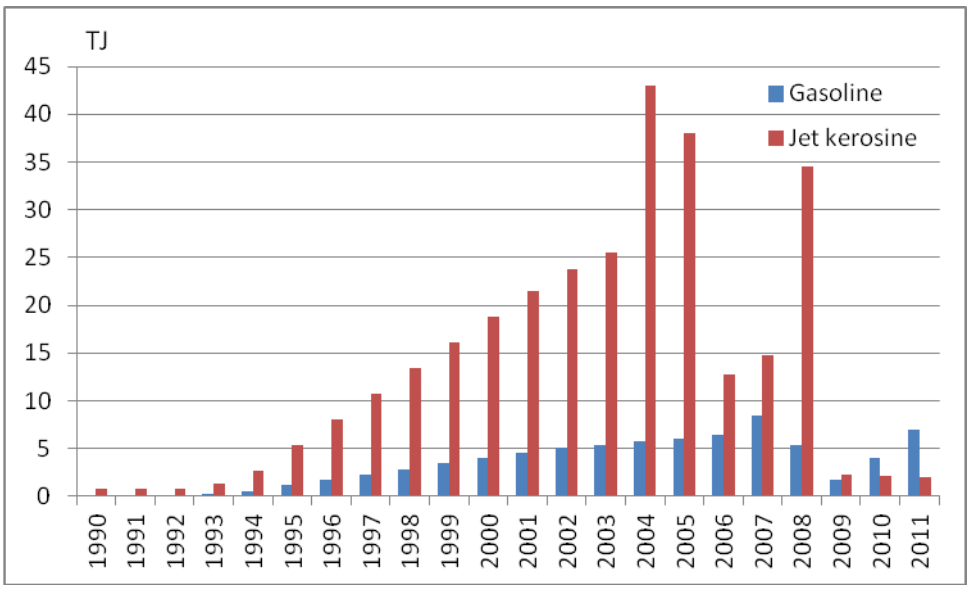


Figure 3.13 Fuel consumption in domestic civil aviation (TJ)

Table 3.27 Fuel consumption in domestic civil aviation (TJ)

	Jet kerosene (TJ)	Aviation gasoline (TJ)
1990	0,8	0,2
1991	0,8	0,2
1992	0,8	0,2
1993	1,3	0,3
1994	2,7	0,6
1995	5,4	1,1
1996	8,0	1,7
1997	10,7	2,3
1998	13,4	2,8
1999	16,1	3,4

	Jet kerosene (TJ)	Aviation gasoline (TJ)
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	12,8	6,4
2007	14,8	8,4
2008	34,5	5,4
2009	2,3	1,7
2010	2,1	4,0
2011	2,0	7,0

Emission factors

Default EFs of LTO and cruise (jet kerosene) for civil aviation is used (EMEP/EEA emission inventory guidebook – 2009).

Table 3.28 Emission factors used in the calculation of emissions from civil aviation

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	Gg/PJ	**Gg/PJ**	**Gg/PJ**	**Gg/PJ**	**Gg/PJ**	**Gg/PJ**	**Gg/PJ**
Aviation gasoline	70.2	0.0005	0.002	0.25	0.1	0.05	0.02293

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

3.2.6.3.1 Source category description

The road transport constituted 90.52 % of GHG emissions in the transport sector in 2011. After the rapid growth in the period 2000 – 2007, 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 49% (2011) of the total freight in the country. It is in a place increasing of this share by approximately 14,5%, compare with year 2011. 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 decreased by 3.2% in year 2011 compare with 2010. In different fuels various changes have taken place in 2011 compare with 2010. Gasoline consumption has decreased by 12.8% and diesel consumption has decreased by 1,9 %, whereas LPG consumption has increased by 18.2%. The main feature in 2011 were a sharp increase of biofuel consumption, by 50%.

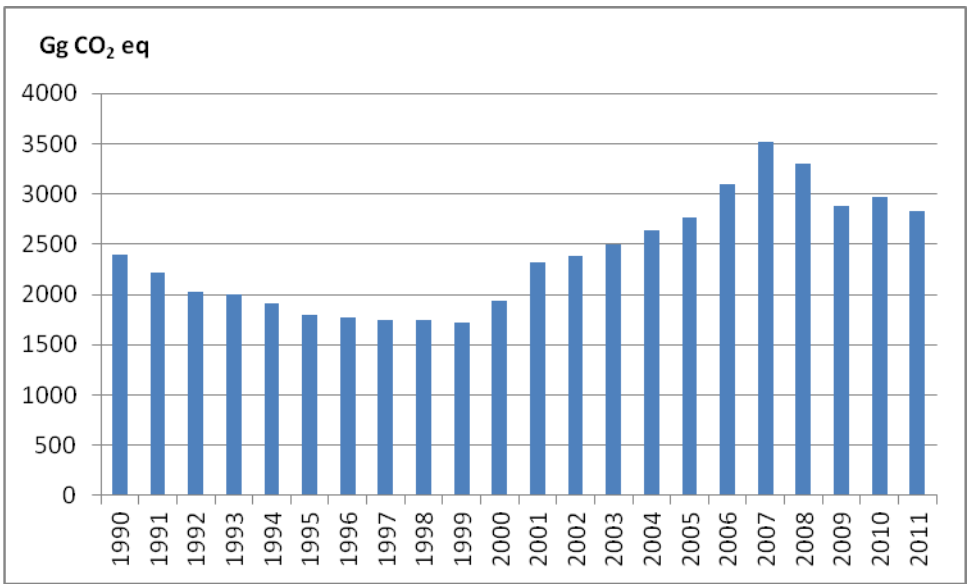


Figure 3.14 GHG emissions in road transport (Gg CO_2 eq)

In time period 1990 – 2011, essential changes have taken place in the structure of GHG emissions created by the road transport (see Table 3.29). In 2011, the gasoline consumption emissions created by passenger cars were less than of 1990 level, while the diesel oil fuel consumption created by the emissions of 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.

Table 3.29 GHG emissions in road transport by vehicle types (Gg CO_2 eq)

	Passenger Cars		LDV		HDV	
	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel
1990	1108,02	42,51	158,00	54,20	380,33	439,82
1991	1003,70	39,63	160,16	59,87	341,08	419,10
1992	1027,65	27,75	139,62	37,30	260,18	347,75
1993	1023,25	34,47	136,35	41,87	226,47	348,27
1994	975,50	33,34	139,49	43,29	189,31	345,09
1995	903,58	35,26	89,42	38,46	184,28	352,23
1996	860,73	43,58	101,23	35,88	187,39	344,02
1997	814,66	74,32	83,24	41,93	160,66	364,73
1998	799,59	120,24	69,90	49,14	153,73	384,39
1999	768,00	124,25	66,18	50,88	141,15	436,24
2000	810,55	118,00	45,25	76,95	116,95	567,99
2001	894,75	249,99	41,03	100,71	92,19	699,25
2002	899,13	282,12	34,89	116,04	75,86	717,67
2003	914,98	355,60	30,30	120,80	67,62	741,36
2004	941,06	443,88	26,78	129,25	54,08	778,00
2005	934,22	515,47	22,84	128,74	46,28	852,01
2006	1048,59	614,85	22,17	146,27	42,70	955,77
2007	1160,51	759,75	21,19	178,07	38,84	1090,49
2008	1061,64	760,75	18,74	178,06	31,41	989,19
2009	939,41	706,09	16,33	169,43	19,18	999,80
2010	882,39	752,03	15,04	183,64	16,39	1110,85
2011	766,56	703,46	14,99	184,79	15,68	1121,42
Trend 2011/1990(%)	-30,82	1554,83	-90,51	240,97	-95,88	154,97

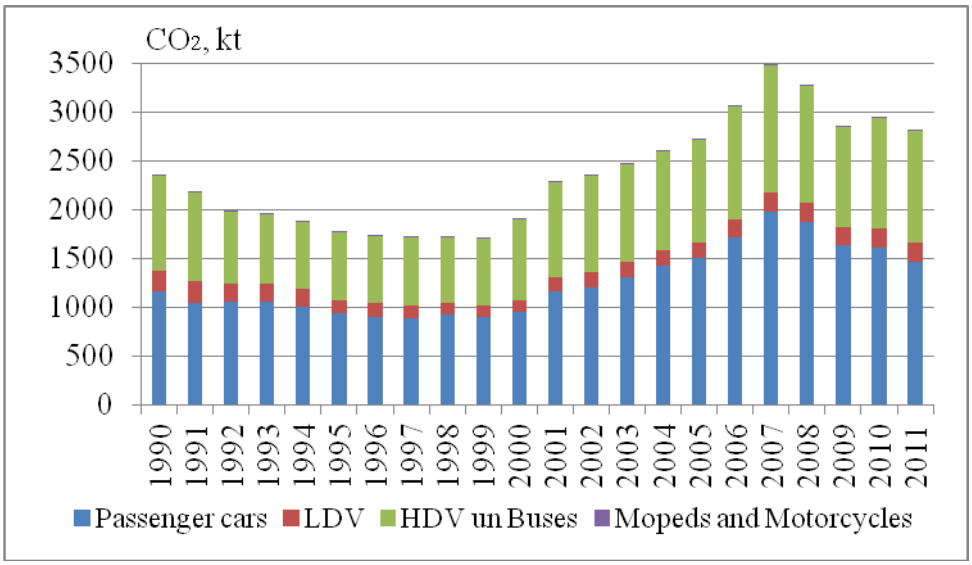


Figure 3.15 CO_2 emissions in road transport by vehicle types (Gg)

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 3.15, 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 52%, HDV 40% and LDV 7% in year 2011.

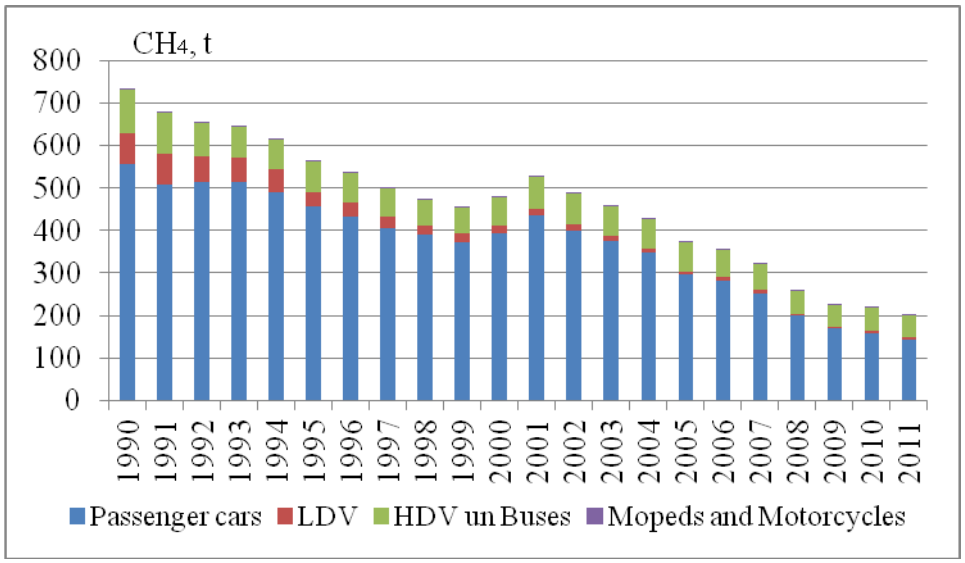


Figure 3.15 CH_4 emissions in road transport by vehicle types

CH_4 emissions present consistent decrease trend within the whole period. The majority of CH_4 emissions from the road transport come from gasoline passenger cars. The substantial emission drop from 2001 onwards is explained by the sharp penetration of EURO 3 and EURO 4 passenger cars into the Latvia fleet and additionally in years 2009 and 2011 with decreasing of gasoline consumption by passenger cars.

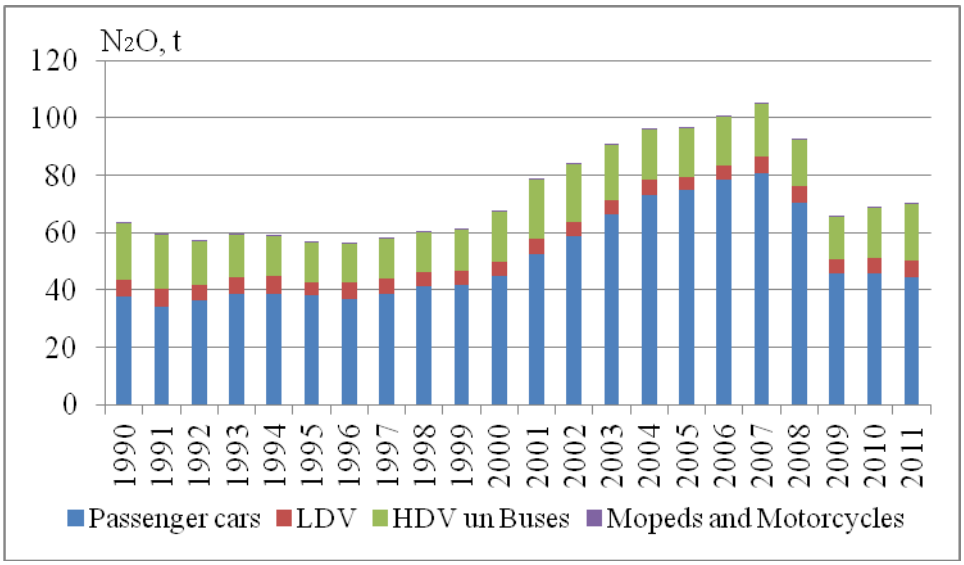


Figure 3.16 N_2O emissions in road transport by vehicle types

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 contribute 63.5%, the freight transport -36% of total N_2O emission in Latvia road transport. Thus the N_20 emission trend is mainly determined by the change in the technologies and fuel used by passenger cars.

Regarding total N_20 emission created by the fleet of Latvia passenger cars, gasoline fuelled passenger cars contribute slightly above 43%, 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. The N_20 emission factor (g/km) of gasoline fuelled passenger cars of the EURO 1 and EURO 2 classes is more then twice higher compared to the factor of gasoline fuelled passenger cars of the EURO 3 and EURO 4 classes. The mileage share in 2011, calculated by summing the shares of EURO3 and EURO4 gasoline passenger cars, has increased almost twice – from 29.5% to 56.4% 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 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 and EURO4 cars – from 24% (year 2005) up to 54% (year 2011) of the total diesel passenger cars mileage, the average N_2O emission factor (t/TJ) for diesel passenger cars has also slightly increased.

3.2.6.3.2 Methodological issues

Methods

For road transport, the detailed methodology is used to make annual estimates of the Latvian emissions, as described in the EMEP/EEA emission inventory guidebook – 2009. The actual calculation is made with a COPERT IV model. 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 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 standarts 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 fleet are grouped into vehicle classes, subclasses and layers. 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.

Activity data

As a basis for model input information, CSB data have been used considering the fuel consumption, LR Road Traffic Safety Directorate (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 1996-2011.

Table 3.30 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 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 and 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 and safety and 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_20	CO_2 emission factors is based on carbon content in fuel. 1990 – 2008 EF gasoline is 68.6; 2009-2011 EF gasoline is 71.18

General information about activity data is presented in Figure 3.18 (number of cars and them split by sub-classes and layers). Before emission calculation COPERT IV model was calibrated to be consistent with actual fuel consumption (energy statistics). 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 sell fuel amount.

Table 3.31 Fuel consumption in road transport (TJ)

	Gasoline, TJ	Diesel oil TJ	LPG, TJ	Natural gas, TJ	Biofuel (biodiesel and bioathanol), TJ
1990	24217	8326	592	339	-
1991	22191	8116	501	195	-

	Gasoline, TJ	Diesel oil TJ	LPG, TJ	Natural gas, TJ	Biofuel (biodiesel and bioathanol), TJ
1992	21266	6587	228	172	-
1993	20651	6798	273	93	-
1994	19640	6798	91	75	-
1995	17994	6884	91	37	-
1996	17596	6796	91	37	-
1997	16193	7859	91	37	-
1998	15222	8710	137	37	-
1999	14683	9091	273	37	-
2000	14505	11471	865	75	-
2001	15251	15930	866	112	-
2002	14950	17168	865	75	-
2003	14950	18609	956	75	-
2004	15038	20222	1047	75	-
2005	14729	22180	1093	75	107
2006	16311	25240	1184	75	57
2007	17854	29485	1093	74	71
2008	16267	28255	956	37	81
2009	13587	25154	865	4	173
2010	12308	27449	1002	-	1102
2011	10729	26939	1184	-	1659

As seen in Figure 3.17, the fuel consumption has essentially changed in the time period 1990 – 2011. The gasoline consumption from the highest consumption in 1990 has decreased till 1999, reaching the lowest consumption and after six year stabilisation the increase was seen in 2006 and 2007. Consumption of gasoline had decreased in 2011 by 12.8 % compare with year 2010. Whereas the diesel fuel consumption starting from 1997 has increased all the time till 2007. While it decreased in 2008 and 2009. Diesel fuel consumption has decreased in 2011 by 1.9 % compare with year 2010. It was in place substantial biofuel consumption increasing in year 2010 and 2011 in road transport.

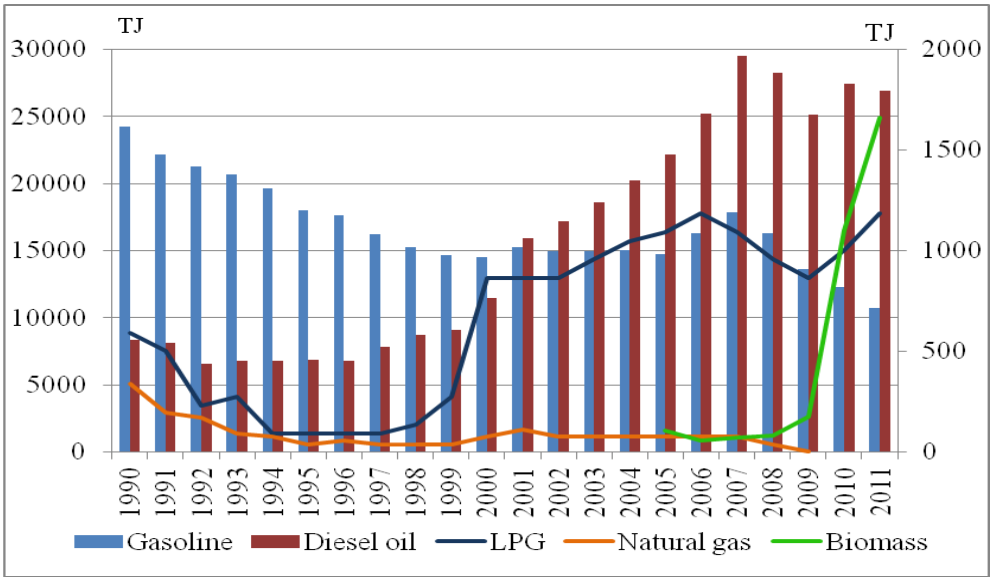


Figure 3.17 Development of Fuel consumption in road transport (TJ)

LPG, natural gas and biomass on right axes

The vehicle numbers per passenger cars sub-class and layers are shown in Figure 3.18.

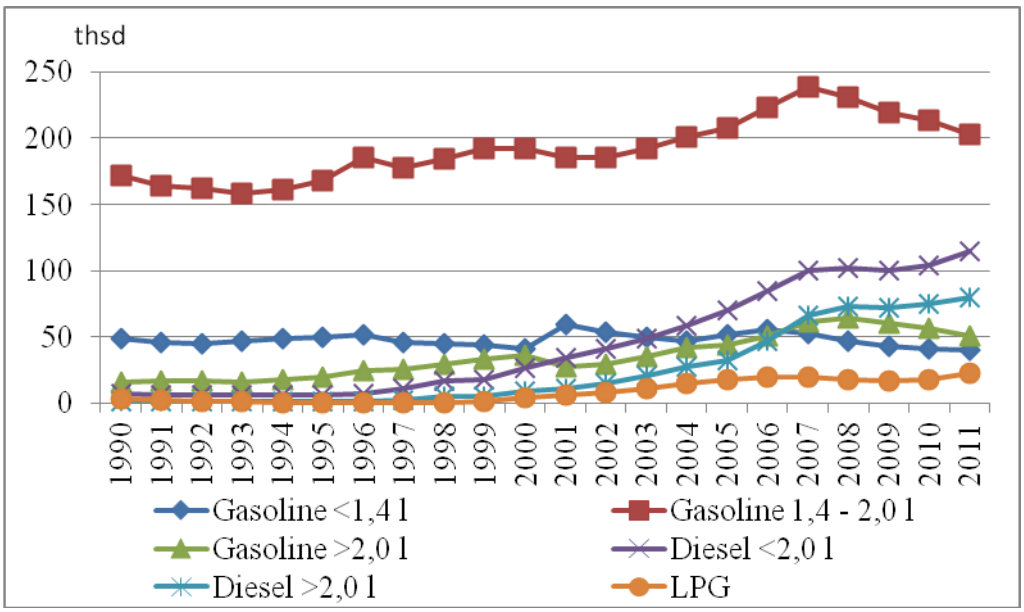


Figure 3.18 Distribution of passenger cars fleet by sub-classes

The vehicle numbers per passenger cars sub-class and layers are shown in Figure 3.18 (for more detailed information see Annex 3.2).

Analysing the development of the passenger car fleet in the time period 1990 – 2011, 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 but they are decreasing;
- As of 2000, the number of cars with diesel engines, both, < 2.0l and > 2.0l, grow rapidly;
- As of 2005, in the car fleet with a gasoline engine, the number of EIRO 3 and EIRO 4 cars grow rapidly. In 2011 a share of EIRO 3 and EIRO 4 cars constitute 31%;
- As of 2005, in the car fleet with a diesel engine, the number of EIRO 3 and EIRO 4 cars grow rapidly. In 2011 a share of EIRO 3 and EIRO 4 cars constitute 43%;.

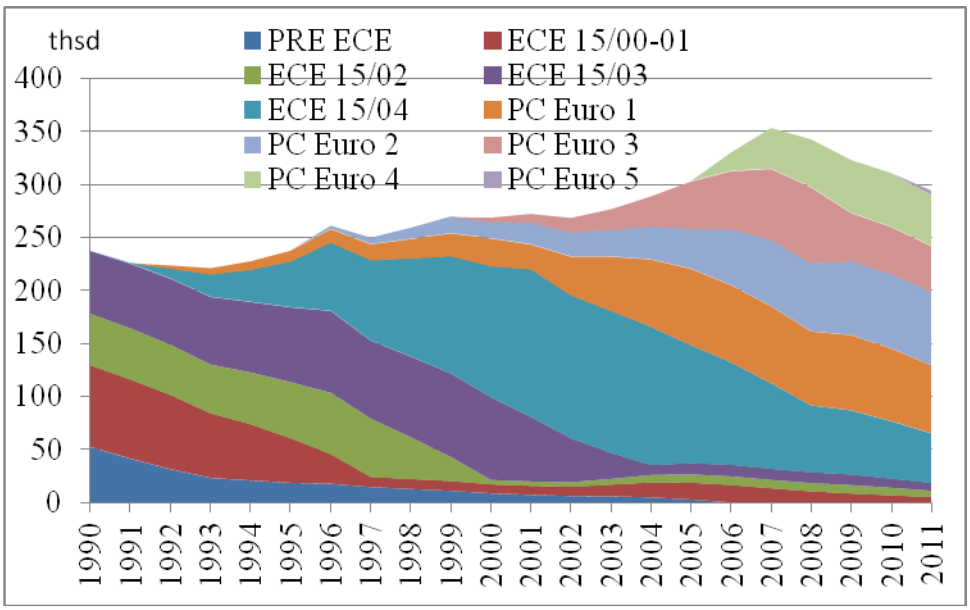


Figure 3.19 Distribution of gasoline passenger cars fleet by layers

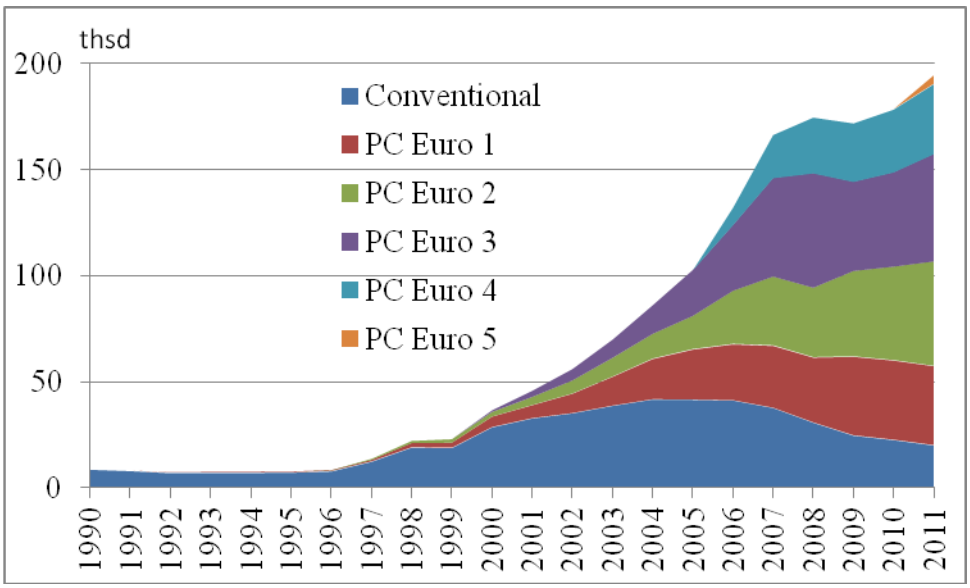


Figure 3.20 Distribution of diesel oil passenger cars fleet by layers

- Analysing the development of LDV fleet in the following time period, major features can be noted as follows:
- As of 1996, the number of cars with a gasoline engine decreases;
- As of 2000, the number of cars with a diesel engine rapidly increases. In 2011 a share of diesel cars is 91% ;
- As of 2002, the number of EURO 3 and EIRO 4 cars rapidly increases. In 2011 a share of EIRO 3 and EIRO 4 cars constitute 48%;

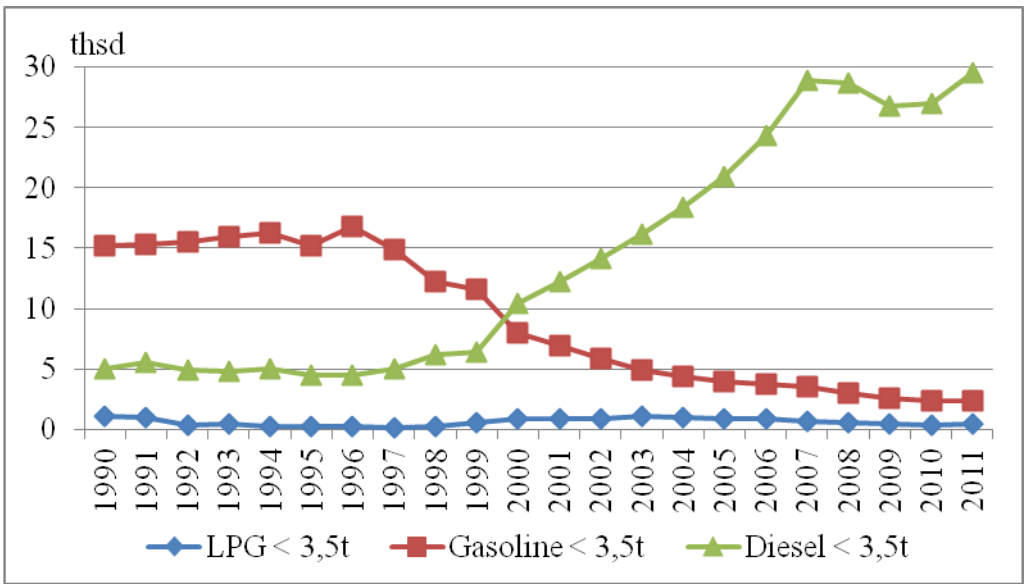


Figure 3.21 Distribution of light duty vehicles fleet by sub-classes

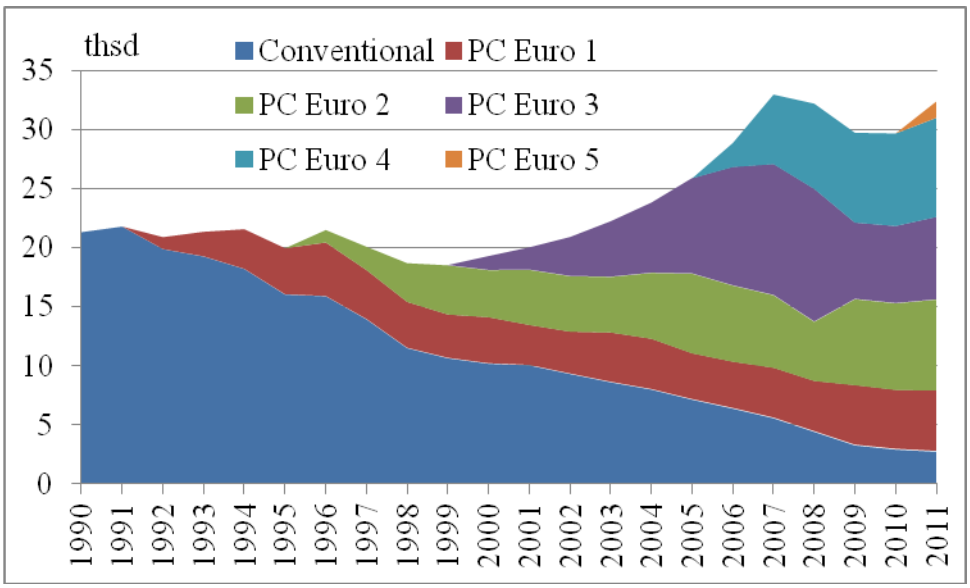


Figure 3.22 Distribution of light duty vehicles fleet by layers

The vehicle numbers per HDV sub-classes and layers are presented in Figure 3.23 and Figure 3.24.

- Analysing the development of HDV fleet in the following time period, major features can be noted as follows:
- As of 1999, the number of cars with a gasoline engine rapidly decreases. A share of gasoline cars has decreased from 33% to 7 % corresponding years 2000 and 2011;
- As of 1999, 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.

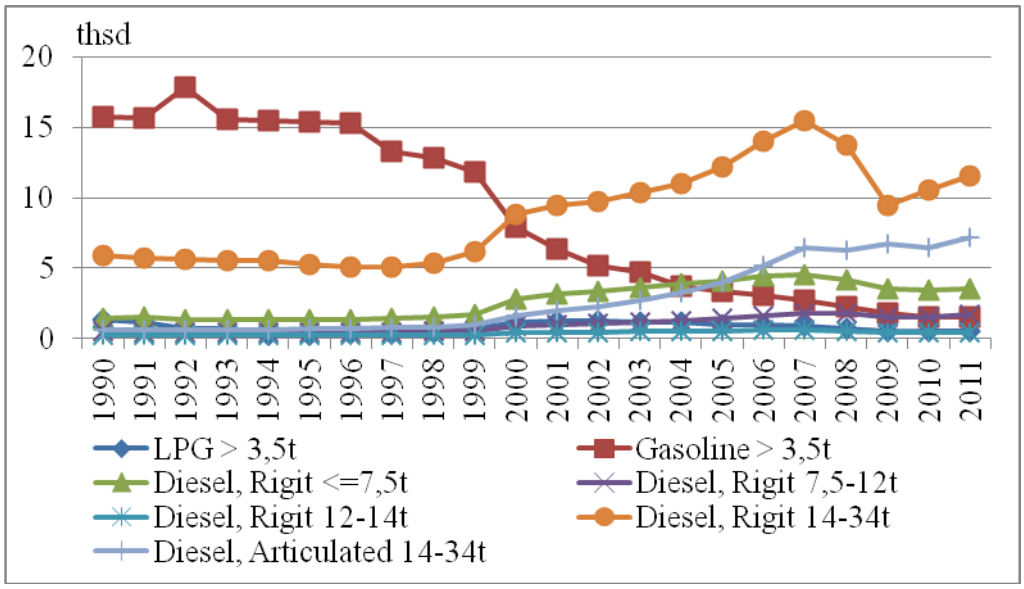


Figure 3.23 Distribution of heavy duty vehicles fleet by sub-classes

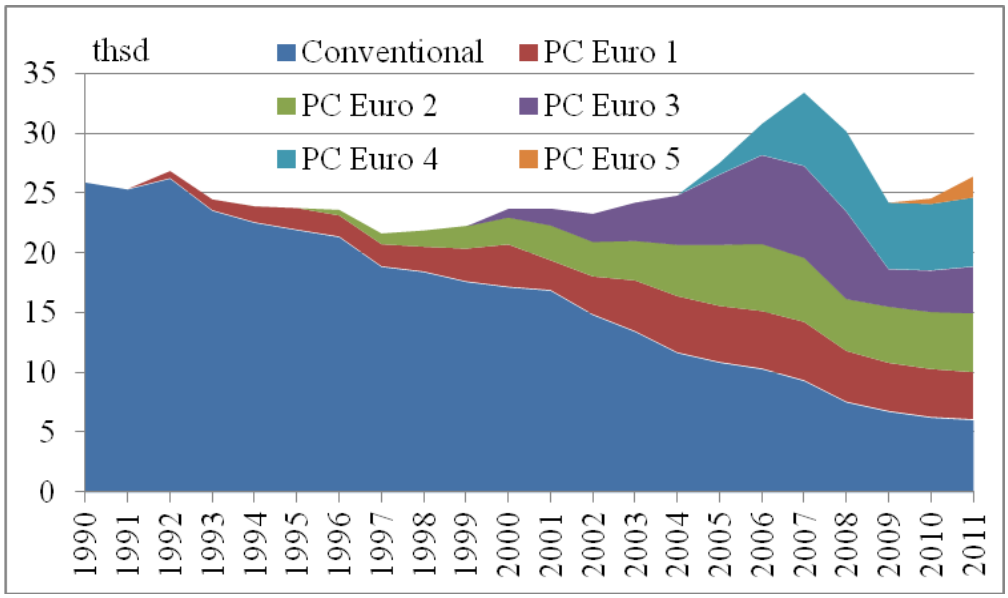


Figure 3.24 Distribution of heavy duty vehicles fleet by layers

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. 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%, it is calculated NCV for gasoline (43.97 MJ/kg) and estimated CO_2 emission factor in accordance Requirements from the IPCC 1996 Guidelines. Estimated Emission factor with oxidation factor is 71.18 CO_2 kg/GJ. Considering that a new requirement for gasoline quality is in force from 01.01.2009, the updated CO_2 EF is implemented for emissions calculation 2009-2011. Rest of emission factors comes from the COPERT IV model.

3.2.6.4 Railway (CRF 1.A.3.C)

3.2.6.4.1 Source category description

In 2011, the fuel consumption in railway constituted 8.9 % of GHG emissions from the total GHG emissions in transport. Freight transport has a dominant role in railway. The railway transport accomplishes approximately 51% (2011) of freight transport in Latvia 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. Fuel consumption has increased by approximately 14% in 2011 compare with year 2010. Railway transport includes railway transport operated by diesel locomotives.

Railway related fuel consumption is key sources for CO_2 emissions (Figure 3.25).

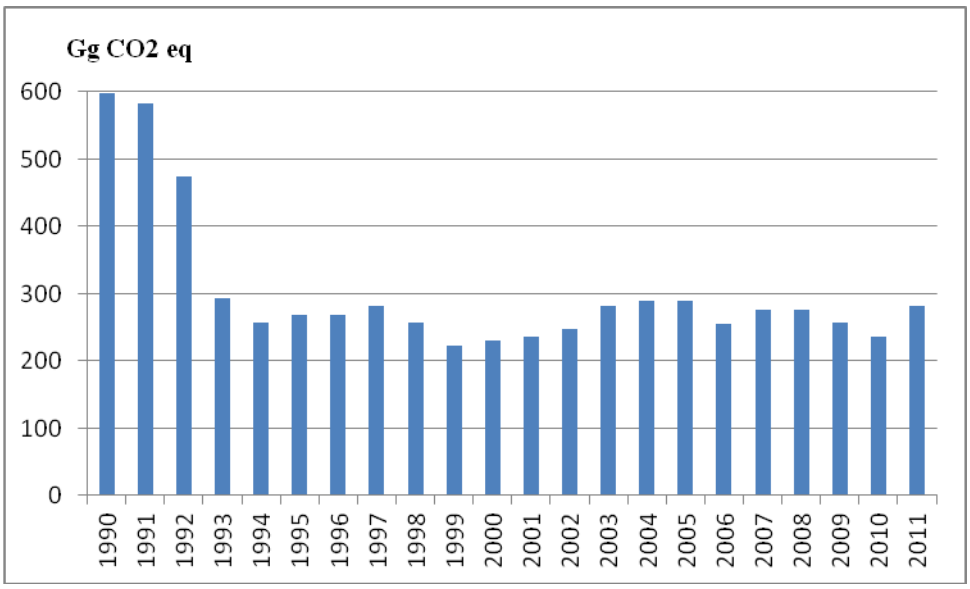


Figure 3.25 Development of GHG emissions in railway (Gg CO_2 eq)

3.2.6.4.2 Methodological issues

Methods

When calculating emissions from railway, IPCC 1996 Tier 1 method has been applied.

Activity data

The data about diesel oil consumption in railway are derived from the CSB. Development of diesel oil consumption is presented in Figure 3.26 and Table 3.32.

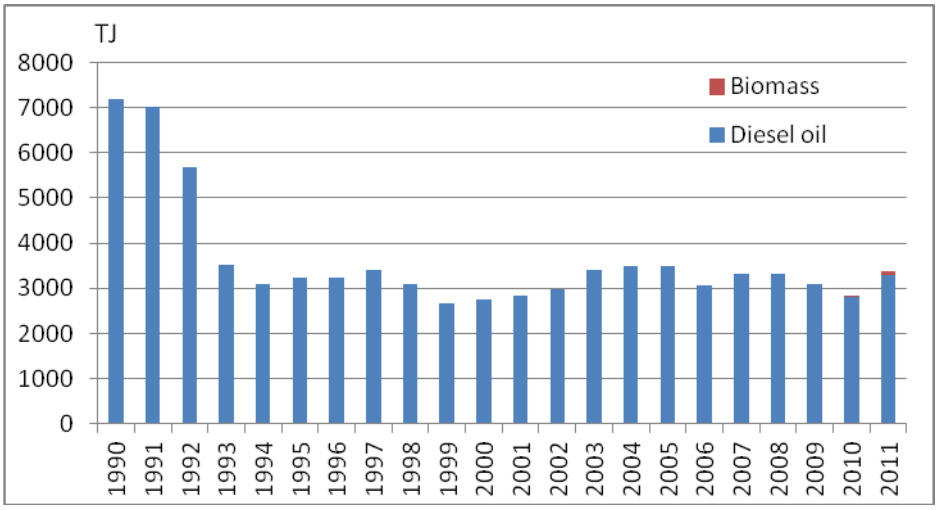


Figure 3.26 Development of fuel consumption in railway (TJ)

Table 3.32 Fuel consumption in railway (TJ)

	Diesel oil	Biodiesel
1990	7181	-
1991	7011	-
1992	5694	-
1993	3527	-
1994	3102	-
1995	3229	-
1996	3229	-
1997	3399	-
1998	3102	-
1999	2677	-

	Diesel oil	Biodiesel
2000	2762	-
2001	2847	-
2002	2974	-
2003	3399	-
2004	3484	-
2005	3484	-
2006	3059	-
2007	3314	-
2008	3314	-
2009	3102	-
2010	2804	35
2011	3144	91

Emission factors

Default EFs for railway is used (EMEP/Corinair 2009, Table 3.33).

Table 3.33 Emission factors used in the calculation of emissions from railway

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	Gg/PJ	**Gg/PJ**	**Gg/PJ**	**Gg/PJ**	**Gg/PJ**	**Gg/PJ**	**Gg/PJ**
Diesel oil	74	0.00423	0.02918	0.93198	0.251823	0.10943	0,02353 (2003-2004) 0,09414 (1990-2007) 0.04707 (2008-2011)

3.2.6.5 Navigation (CRF 1.A.3.d)

3.2.6.5.1 Source category description

In 2011, fuel consumption in navigation was responsible for 0.57 % of GHG emissions from total GHG emissions in transport.

Although Latvia has several ports, local navigation that providing transport of freight or passengers among local ports is not developed. Major activities in ports deal with international freight transport. In navigation, the emissions are calculated for miscellaneous vessels, recreational crafts and personal boats (Figure 3.27).

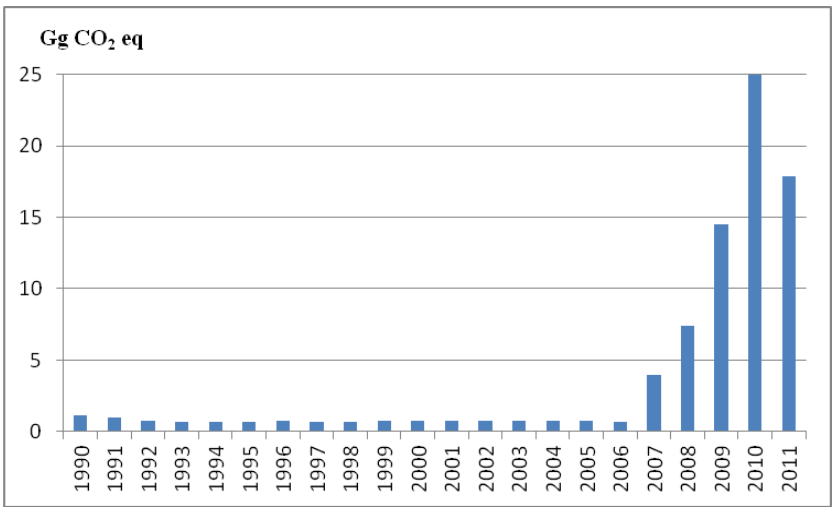


Figure 3.27 GHG emission development in navigation (Gg CO_2 eq)

3.2.6.5.2 Methodological issues

Methods

When calculating emissions from navigation, IPCC 1996 Tier 1 method has been applied.

Activity data

The data about diesel oil consumption in navigation are derived from the CSB. CSB have started to collect data from year 2006. For the time period 1990 – 2005 and for gasoline consumption it is used data evaluation method from the study ("Evaluation of fuel consumption for domestic aviation and navigation", FEI, 2004). Development of fuel consumption in navigation is presented in Figure 3.28 and Table 3.34.

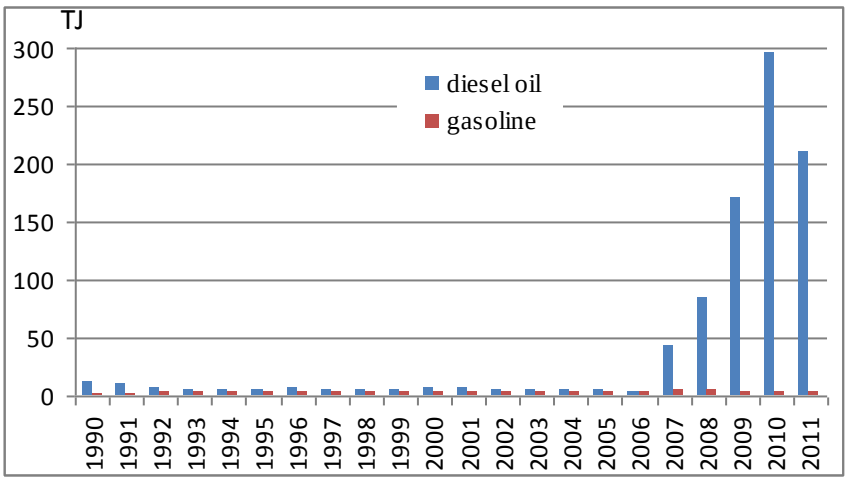


Figure 3.28 Development of gasoline and diesel oil fuel consumption in domestic navigation

Table 3.34 Fuel consumption in domestic navigation (TJ)

	Diesel oil	Gasoline
1990	11	2
1991	10	3
1992	7	3
1993	5	3
1994	6	3
1995	6	3
1996	6	3
1997	6	3
1998	6	3
1999	6	3
2000	6	3
2001	6	3
2002	6	4
2003	6	4
2004	6	4
2005	5	4
2006	4	4
2007	43	5
2008	70	5
2009	161	4
2010	297	3
2011	211	4

Emission factors

Default EFs for navigation is used (Revised IPCC Guidelines (1996) and EMEP/Corinair 2009, Table 3.35).

Table 3.35 Emission factors used in the calculation of emissions from navigation

	CO_2, t/TJ	CH4, t/TJ	N_2O, t/TJ
Gasoline	72.7	0.0473	0.000296
Diesel oil	74.0	0.004	0.003

3.2.6.6 Source - specific recalculations

The following recalculations and improvements of the emission inventories have been made in the transport sector since the emission reporting in 2010. (Table 3.36)

Table 3.36 Recalculations for Sub-category CRF 1.A.3 Transport

Sub-category	Recalculation	Improvements
Road transport (CRF A.3.b)	All emissions for year 2009-2010 have been recalculated	Recalculations have been done due to improvement of activity data. Improvements comprise more precise split of passenger cars, LDV and HDV by subgroups (depending on engine volume) and layers (EURO classes).It is recalculated emissions of road transport for year 2009 and 2010. Recalculation affected direct and non direct emissions
Road transport (CRF A.3.b)	CO2 emissions for gasoline year 2009-2010 have been recalculated	Recalculations have been done due to an updated specific CO2 EF. Instead 68.6 kg/GJ now 71.18 kg/GJ is implemented. CO2 emissions increased by 3.7% compared to the previous calculation.
Railway (CRF A.3.d)	SOx for time period 2008 - 2010	During the implementation of internal OA/QC procedure it was found that a new national Regulation determines using of diesel oil in railway with 0,1% sulphur content from year 2008. Recalculated emissions are 2 times less than declared in the previous submission.
Road transport (CRF A.3.b)	CO2, CH4 and N2O emissions of lubricants for time period 1990-2010	Recalculations have been done due to improvement in activity data estimation. Consumption of lubricants in road transport have been calculated based on EMEP Emission inventory Guidebook 2009; updated 2012. (Road transport pp 43)

3.2.6.7 Source – specific planned improvements

Considering potential contribution in calculation improvement of GHG emissions and available resources for their effective implementation, the following advancement is planned in the transport sector (Table 3.37).

Table 3.37 Planned improvements for Sub-category A.3. Transport

Sub-category	Planned improvements
Railway (CRF 1.A.3.C)	To carry out study to prepare activity data of railway for implementation of Tier 2 method in year 2013.

3.2.6.8 Uncertainties and time series consistency

Uncertainty in activity data of fuel consumption in transport is ±2% in 2011. CSB gives approximately 2% statistical sample error for statistical data. 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 10%. CH_4 and N_2O emission factor used in estimation of emissions was taken from EMEP/CORINAIR (2009) so uncertainty was assigned 50 %.

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.

3.2.6.9 Source-specific QA/QC and verification

Quality control procedures according to the IPCC GPG 2000 Tier 1 method for Energy sector were performed. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers. All findings were documented by using check-lists and introduced in GHG inventory. All corrections are archived.

3.2.6.9.1 General QA/QC checks for 1.A.3 sector

For transport emission's calculation following QA/QC checks are performed for all parts of national inventory.

1. Activity data checked at the institution responsible for the emission estimation and reporting:
    - During the activity data input in emission estimation database done by sectoral expert all the data changes are compared to previous inventory and agreed with CSB. The reasons of data changes are explained.
    - Before the data is processed in emission estimation model activity data is a verified using diagram that is the best way to reflect all the illogical data fluctuations.

Estimated emissions verification:

1. 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.
2. Emissions are checked using time series consistency check for the IEF estimated in CRF Reported. For road transport a checking is done on less aggregated level than CRF Reported. IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

Quality control procedures according to the IPCC GPG 2000 Tier 1 method for Energy sector were performed. All findings were documented by using check-lists and introduced in GHG inventory. All corrections are archived.

3.2.6.9.2 Additional QA/QC checks for Tier2 methodology

For emission calculation in road transport additional QA/QC check approach has implemented. QC activities are realised 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 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.

3.2.7 Other sources (CRF 1.A.4)

3.2.7.1 Source category description

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 as it is stated that emissions have to be reported in sector they are created.

Table 3.38 Emissions from 1.A.4 Other Sectors in 1990–2011 (Gg)

	CO_2	CH_4	N_2O	Aggregate GHGs (CO_2, CH_4, N_2O, HFCs, PFCs, SF6)	NOx	CO	NMVOC	SO_2
	Gg			Gg CO_2 equivalent	Gg			
1990	5503.71	11.20	0.164	5789.75	10.59	223.02	52.76	38.67
1991	5634.46	12.71	0.179	5956.87	10.75	199.13	31.78	36.08
1992	3992.90	11.50	0.167	4286.05	8.54	182.49	29.87	29.12
1993	3316.73	12.15	0.168	3624.07	7.70	191.50	31.55	23.36
1994	2298.12	12.04	0.160	2600.51	6.26	191.70	31.36	17.85
1995	1539.28	12.56	0.170	1855.56	5.67	189.78	32.07	9.47
1996	1556.85	12.92	0.175	1882.39	5.79	200.30	33.52	10.20
1997	1312.38	12.22	0.165	1620.27	5.30	188.91	31.72	7.59
1998	1138.14	11.36	0.156	1424.97	4.77	179.44	30.34	5.56
1999	1119.22	11.15	0.153	1400.91	4.74	174.72	29.39	4.07
2000	1037.04	10.47	0.144	1301.48	4.37	177.34	28.62	2.95
2001	1186.35	11.55	0.156	1477.33	4.80	192.85	30.64	3.39
2002	1156.63	11.31	0.154	1441.71	4.73	187.33	30.06	2.69
2003	1265.41	11.87	0.162	1564.75	5.00	197.52	32.15	2.11
2004	1318.95	12.22	0.169	1628.10	5.23	200.15	32.49	1.87
2005	1295.79	12.25	0.172	1606.42	5.17	208.17	32.89	1.74
2006	1356.59	11.89	0.165	1657.37	5.16	205.52	31.99	1.47
2007	1364.90	11.89	0.166	1666.14	5.23	202.79	31.40	1.19
2008	1286.81	10.99	0.155	1565.75	4.70	195.35	29.98	0.97
2009	1275.25	12.09	0.170	1581.87	4.95	213.94	33.22	0.81
2010	1438.26	11.33	0.160	1725.57	4.95	199.95	30.69	1.21
2011	1379.21	9.69	0.138	1625.44	4.44	178.85	28.05	1.35

Total GHG emissions from 1.A.4 Other Sectors increased in 2000 – 2011 by 24.89%. It can be explained with development of 1.A.4.a Commercial / Institutional sector. However, in year 2011 there is a decrease of GHG emissions by 5.80% which is explained with warm winter, therefore the amount of biomass and natural gas used for heating decreased. 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. At the same time there can be seen a trend that residential households replace central heating system (especially in years 2006-2007) with individual combustion facilities thereby the emissions in 1.A.4.b Residential sector increased.

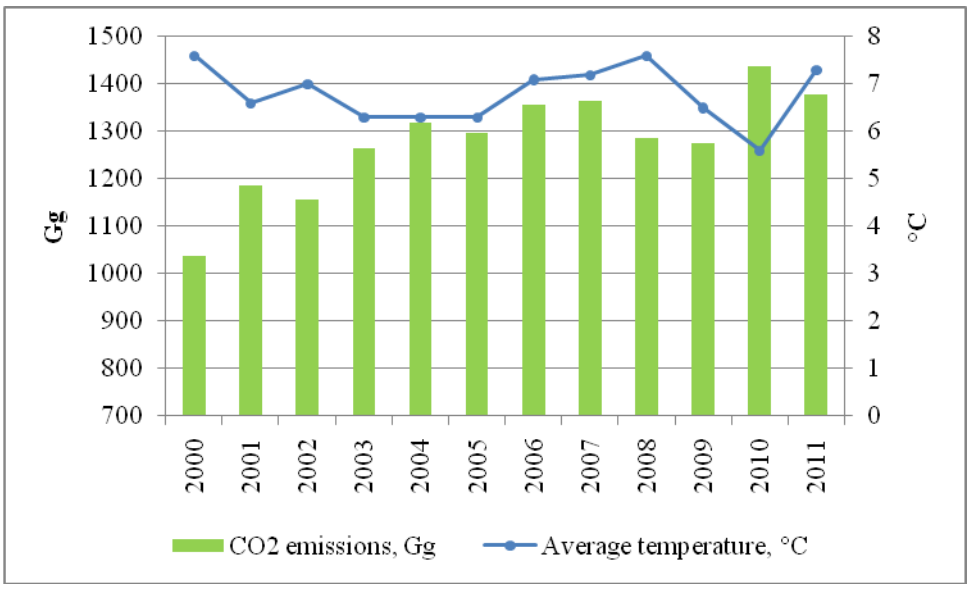


Figure 3.29 CO_2 emissions in 1.A.4 Other Sectors and average temperature in years 2000-2011

Decrease of CO_2 emissions from 1.A.4 Other Sectors in 1991-2000 can be observed and it is explained with changes and redistribution of structure of national economy (Table 3.38). Increase of CO_2 emissions in 2000–2007 is explained with development of national economy and well-being of population. CO_2 emissions are also affected by increase of individual heating supply consumers in 1.A.4.b Residential sector. Starting from year 2008 the emissions fluctuate which can mainly be explained with average temperatures and global crisis.

There can be seen also a decrease in CH_4 and N_2O emissions in 2011 by 14.45% and 13.55% respectively. It can be explained with a warm winter and there were no necessity for extra fuel to heat the households.

Also indirect GHG emissions from Other Sectors were estimated. SO_2 had biggest decrease by 96.51% in 1990–2011. It is explained with fuel switching to natural gas and biomass from which sulphur dioxide emissions aren't emitted.

3.2.7.2 Methodological issues

Methods

IPCC 1996 Tier1 Sectoral approach was used to calculate GHG emissions from the 1.A.4 sector. IPCC GPG 2000 Tier2 method was used to estimate CO_2 emissions from natural gas and landfill gas combustion as country specific parameters were used to estimate CO_2 emission factor of natural gas and plants specific emission parameters were used to calculate CO_2 emission factors for landfill gas combustion.

Calculation of all emissions from fuel combustion is done with Excel databases developed by experts from LEGMC. CRF Reporter software developed by experts from UNFCCC was used to report emission data.

The general method for preparing inventory data was used:

$$\boxed{Em = EF \times B_q}$$

where:
Em – total emissions (Gg)
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 1996;
- IPCC 2006;
- EMEP/EEA 2009.

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 1.A.4 Other sectors are estimated with the same equations and using same method as for 1.A.1 Energy industries sector with the exception for landfill gas CO_2 emission factor that is estimated with the same equation as sludge gas CO_2 emission factor but using other parameters.

In 2008-2011 straws also are combusted in the sector. CO_2 emission factor from IPCC 2006 – 100 Gg/PJ (as for other solid biomass) is used for emission estimation as no data is available to calculate country specific emission factor.

Landfill gas

There are four landfills in Latvia that are collecting biogas from landfills – one landfill is collecting and combusting biogas since 2002, second from 2003, third from 2004, but fourth landfill started to combust biogas with energy recovery only in 2008. As these landfills are quite large and have modern measurement equipment NCVs for biogas collected in landfills are known.

As landfills were not able to provide the information of carbon content percentage in working mass of fuel that's why constant methane value was used estimated basing on moll mass of components. Following equation 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 same equation as for natural gas was used (Table 3.39).

Table 3.39 Characteristics of methane obtained from landfil gas and estimated CO2 emission factors

Carbon content in working mass of landfil gas (C^d) %	NCV of landfil gas (Q_z^d) TJ/1000m^3	Amount of methane in landfil gas (%)	Default carbon content in working mass of methane (C^d) %	NCV of methane (Q_z^d) TJ/1000m^3	Oxidation factor (p)	Natural gas density (ρ) t/1000m^3	Emission factor with oxidation factor (EF CO_2) kg/GJ
41.92582%	22.0	56.00%	74.867543%	35.88	0.995	0.6687	50.870474

SO_2 emissions factors

SO_2 emissions factors were calculated by formula taken from IPCC Guidelines 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 2).

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, N_2O, NO_x, CO, NMVOC emission factors used in estimation of emission were taken from IPCC 1996 and EMEP/EEA 2009 (Table 3.40). Emission factors for sludge gas were equalled to natural gas emission factors due to unavailability of particular emission factors for sludge gas.

Gasoline emission factors given in Table 3.40 below are used for emission estimation from off-roads.

Table 3.40 CO_2, CH_4, N_2O, NO_x, CO, NMVOC emission factors (Gg/PJ)

Sectors	CH_4	N_2O	NO_x	CO	NMVOC
1.A.4.a Commercial/Institutional					
Gasoline	0.05	0.002	0.21	1	27.0
Diesel oil	0.01	0.0006	0.1	0.0	0.04
RFO	0.01	0.0006	0.1	0.01	0.04
LPG	0.01	0.0006	0.1	0.01	0.04
Jet fuel	0.01	0.0006	0.1	0.01	0.04
Other kerosene	0.01	0.0006	0.1	0.01	0.04
Other liquid	0.01	0.0006	0.1	0.01	0.04
Shale oil	0.01	0.0006	0.1	0.01	0.04
Coal	0.01	0.0014	0.173	0.0888	0.931
Coke	0.01	0.0014	0.173	0.1	0.931
Peat briquettes	0.3	0.004	0.1	0.6	5
Peat	0.3	0.004	0.1	0.6	5
Natural gas	0.005	0.0001	0.07	0.0025	0.025
Wood	0.3	0.004	0.15	0.146	1.6
Biogas	0.001	0.0001	0.05	0.0	0.05
Straws	0.3	0.004	0.1	0.05	0.02
1.A.4.b Residential and Agriculture/Forestry/Fishery					
Gasoline	0.05	0.002	0.21	1.0	27.0
Diesel oil	0.01	0.0006	0.068	0.0155	0.046
RFO	0.01	0.0006	0.068	0.0155	0.046
LPG	0.01	0.0006	0.068	0.0155	0.046
Jet fuel	0.01	0.0006	0.068	0.0155	0.046
Other kerosene	0.01	0.0006	0.068	0.0155	0.046
Other liquid	0.01	0.0006	0.068	0.0155	0.046
Shale oil	0.01	0.0006	0.1	0.005	0.02
Coal	0.3	0.0014	0.11	0.5	4.6

Sectors	CH_4	N_2O	NO_x	CO	NMVOC
Coke	0.3	0.0014	0.11	0.484	4.6
Peat briquettes	0.3	0.004	0.1	0.6	5
Peat	0.3	0.004	0.1	0.6	5
Natural gas	0.005	0.0001	0.057	0.0105	0.031
Wood	0.3	0.004	0.0745	0.9	5.3

SO_2 emission factors for fuel combustion are presented in Annex 3.1.

Activity data

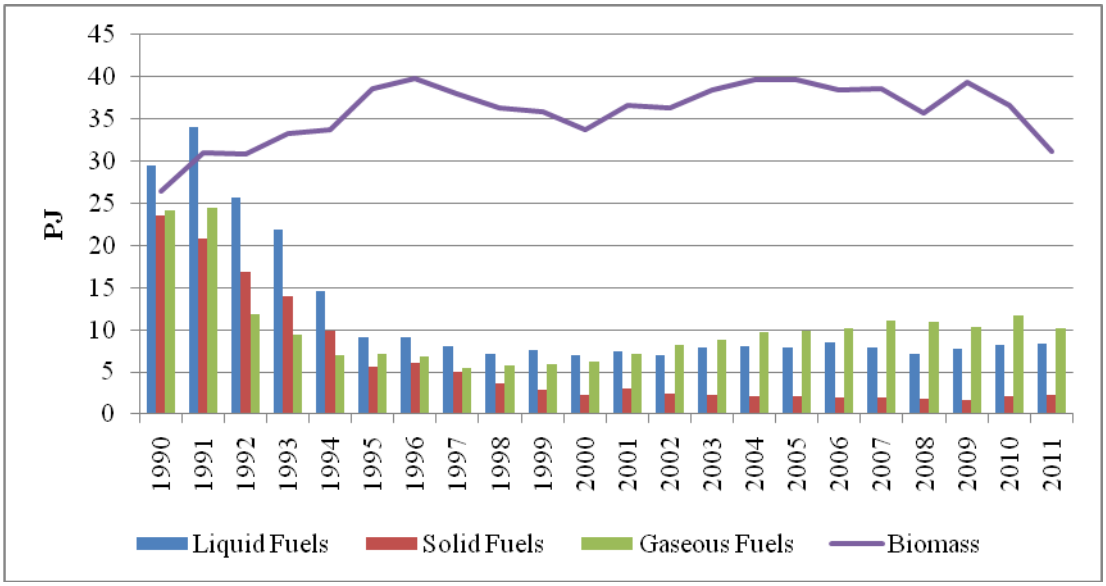


Figure 3.30 Fuel consumption in 1.A.4 Other sectors in in 1990–2011 (PJ)

Emissions from 1.A.4 sector are calculated using fuel consumption data from the CSB prepared within Annual questionnaires for 1990-2011 sent to EUROSTAT. The data collection system for 1.A.4 sector is the same as for 1.A.1 and 1.A.2 sectors (Table 3.41).

Autoproducers data prepared by CSB are taken into account into the calculation of the emissions from 1.A.4 sector according to IPCC 1996.

Only gasoline combustion is reported as off-roads in 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.

Table 3.41 Fuel consumption in 1.A.4 Other sectors in 1990–2011 (PJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.4 Other Sectors											
Liquid Fuels	29.452	34.043	25.645	21.848	14.536	9.139	9.082	8.001	7.148	7.553	6.968
Solid Fuels	23.526	20.774	16.882	13.965	9.879	5.570	6.028	4.997	3.596	2.884	2.204
Gaseous Fuels	24.144	24.475	11.806	9.396	7.032	7.180	6.825	5.513	5.755	5.951	6.269
Biomass	26.448	31.060	30.873	33.210	33.737	38.643	39.743	37.983	36.257	35.902	33.809
1.A.4.a. Commercial/Institutional											
Liquid Fuels	15.077	18.184	13.331	11.085	5.835	3.210	3.080	2.612	2.217	2.460	1.795
Gasoline	0.044	0.044	0.044	0.044	0.220	NO	0.088	0.088	0.044	0.088	0.088
Diesel oil	8.116	11.515	7.436	7.478	1.530	1.190	1.147	0.552	0.340	0.935	1.020
RFO	6.577	6.496	5.765	3.207	3.776	1.583	1.665	1.746	1.380	1.218	0.609
LPG	0.046	NO	NO	0.182	0.137	0.091	0.137	0.182	0.410	0.091	NO
Other kerosene	0.043	0.130	0.086	0.173	0.173	0.346	0.043	0.043	0.043	0.086	NO
Other	0.251	NO	NO	NO	NO	NO	NO	NO	NO	0.042	NO

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
liquid											
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.079
Solid Fuels	15.585	11.930	11.492	8.143	4.623	3.015	3.523	2.895	2.490	2.065	1.596
Coal	14.913	11.412	10.872	7.855	4.297	2.903	3.273	2.732	2.419	2.049	1.565
Peat briquettes	0.511	0.356	0.449	0.248	0.155	0.062	0.139	0.093	0.031	0.015	0.031
Peat	0.161	0.161	0.171	0.040	0.171	0.050	0.111	0.070	0.040	NO	NO
Natural gas	6.101	6.411	5.521	3.635	1.932	2.356	2.319	1.849	2.222	2.589	3.098
Biomass	5.218	5.162	5.282	5.508	5.630	8.282	8.029	7.636	5.615	6.179	4.991
Wood	5.218	5.162	5.282	5.508	5.630	8.282	8.029	7.636	5.615	6.179	4.991
Landfil gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other Liquid Biofuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.4.b. Residential											
Liquid Fuels	4.908	5.672	5.003	4.011	2.848	1.403	1.272	1.363	1.454	1.406	1.444
Gasoline	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.132
Diesel oil	1.912	2.762	2.592	1.827	0.892	0.127	0.042	0.042	0.042	0.085	0.127
RFO	0.041	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	2.869	2.823	2.368	2.140	1.913	1.275	1.230	1.321	1.412	1.321	1.184
Other kerosene	0.086	0.086	0.043	0.043	0.043	NO	NO	NO	NO	NO	NO
Solid Fuels	6.828	7.874	4.818	5.295	4.555	2.074	2.205	1.887	0.992	0.734	0.522
Coal	6.404	7.542	4.440	5.037	4.411	1.821	1.964	1.708	0.797	0.683	0.512
Peat briquettes	0.294	0.201	0.248	0.248	0.124	0.232	0.201	0.139	0.155	0.031	NO
Peat	0.131	0.131	0.131	0.010	0.020	0.020	0.040	0.040	0.040	0.020	0.010
Natural gas	3.970	4.238	4.905	5.090	4.361	4.182	3.799	3.093	2.927	2.857	2.665
Wood (including charcoal)	20.010	24.669	24.320	26.396	26.800	30.003	31.349	29.730	29.994	29.058	28.228
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.4.c. Agriculture/Forestry/Fisheries											
Liquid Fuels	9.468	10.187	7.311	6.753	5.853	4.527	4.730	4.026	3.476	3.687	3.729
Gasoline	1.628	0.132	0.132	0.132	0.132	0.088	0.088	0.088	0.044	0.044	0.044
Diesel oil	6.161	8.583	6.161	5.269	4.419	3.952	3.909	3.654	3.229	3.399	3.442
RFO	1.421	1.340	0.974	1.218	1.259	0.487	0.690	0.284	0.203	0.244	0.244
LPG	0.046	0.046	NO	0.091	NO	NO	NO	NO	NO	NO	NO
Other kerosene	0.086	0.086	0.043	0.043	0.043	NO	0.043	NO	NO	NO	NO
Other liquid	0.126	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid Fuels	1.112	0.970	0.572	0.527	0.700	0.481	0.300	0.215	0.114	0.085	0.085
Coal	1.081	0.939	0.541	0.455	0.655	0.455	0.285	0.199	0.114	0.085	0.085
Peat briquettes	0.031	0.031	0.031	0.031	0.015	0.015	0.015	0.015	NO	NO	NO
Peat	NO	NO	NO	0.040	0.030	0.010	NO	NO	NO	NO	NO
Natural gas	14.073	13.825	1.380	0.671	0.739	0.641	0.706	0.572	0.606	0.505	0.506
Biomass	1.220	1.229	1.271	1.306	1.307	0.358	0.365	0.617	0.648	0.665	0.590
Wood	1.220	1.229	1.271	1.306	1.307	0.358	0.365	0.617	0.648	0.665	0.590
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid biofuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Continuation of Table 3.41

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.A.4 Other Sectors											
Liquid Fuels	7.483	7.003	7.945	8.050	7.837	8.471	7.894	7.123	7.769	8.220	8.313
Solid Fuels	3.004	2.391	2.213	2.150	2.065	2.007	2.002	1.814	1.589	2.120	2.286
Gaseous Fuels	7.080	8.118	8.803	9.748	9.795	10.150	11.064	10.989	10.263	11.701	10.239
Biomass	36.562	36.350	38.400	39.685	39.693	38.521	38.527	35.685	39.418	36.602	31.206
1.A.4.a. Commercial/Institutional											
Liquid Fuels	2.049	1.903	2.266	2.281	1.889	2.304	1.908	1.605	1.578	1.521	1.343
Gasoline	0.088	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.088
Diesel oil	1.190	1.317	1.530	1.657	1.275	1.700	1.657	1.360	1.402	1.333	1.202
RFO	0.609	0.325	0.284	0.284	0.365	0.365	0.041	0.081	0.041	0.045	NO
LPG	0.091	0.046	0.182	0.137	0.137	0.137	0.137	0.091	0.091	0.099	0.053
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	0.071	0.171	0.226	0.159	0.029	0.058	0.029	0.029	NO	NO	NO
Shale oil	NO	NO	NO	NO	0.039	NO	NO	NO	NO	NO	NO
Solid Fuels	1.552	1.423	1.347	1.285	1.069	1.141	1.136	0.949	0.750	1.025	1.155
Coal	1.537	1.423	1.337	1.285	1.049	1.101	1.075	0.918	0.734	1.023	1.154
Peat briquettes	0.015	NO	NO	NO	NO	NO	0.001	0.001	0.006	0.002	0.001
Peat	NO	NO	0.010	NO	0.020	0.040	0.060	0.030	0.010	NO	NO
Natural gas	3.359	4.117	4.286	4.768	4.754	5.010	5.704	5.701	5.428	5.542	4.983
Biomass	5.497	5.764	6.044	7.005	6.907	6.792	7.381	5.193	5.029	5.289	4.604
Wood	5.497	5.663	5.803	6.652	6.485	6.381	6.966	4.691	4.482	4.679	3.997
Landfil gas	NO	0.101	0.241	0.353	0.421	0.400	0.410	0.488	0.518	0.549	0.537
Straws	NO	NO	NO	NO	NO	0.011	0.005	0.014	0.029	0.057	0.043
Other Liquid Biofuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.004	0.028
1.A.4.b. Residential											
Liquid Fuels	1.440	1.440	1.398	1.443	1.577	1.621	1.439	1.393	2.024	2.237	2.237
Gasoline	0.132	0.132	0.132	0.132	0.220	0.264	0.264	0.264	0.264	0.264	0.264
Diesel oil	0.170	0.170	0.127	0.127	0.127	0.127	0.127	0.127	0.850	1.062	1.062
RFO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	1.139	1.139	1.139	1.184	1.230	1.230	1.047	1.002	0.911	0.911	0.911
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid Fuels	1.338	0.854	0.787	0.787	0.944	0.813	0.813	0.813	0.813	1.069	1.105
Coal	1.338	0.854	0.787	0.787	0.944	0.813	0.813	0.813	0.813	1.049	1.075
Peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.020	0.030
Natural gas	3.007	3.298	3.667	3.964	4.199	4.333	4.595	4.700	4.313	5.216	4.478
Biomass	30.519	30.078	31.850	32.073	32.234	31.195	30.433	30.168	33.667	30.744	26.144
Wood (including charcoal)	30.519	30.078	31.850	32.043	32.174	31.165	30.388	30.108	33.607	30.682	26.084
Straws	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.060	NO
1.A.4.c. Agriculture/Forestry/Fisheries											
Liquid Fuels	3.994	3.660	4.282	4.326	4.370	4.546	4.548	4.125	4.167	4.461	4.733
Gasoline	0.011	0.017	0.044	0.044	0.044	0.044	0.044	NO	NO	NO	0.099
Diesel oil	3.739	3.399	3.994	4.079	4.164	4.461	4.504	4.079	4.122	4.461	4.589
RFO	0.244	0.244	0.244	0.203	0.162	0.041	NO	NO	NO	NO	NO
LPG	NO	NO	NO	NO	NO	NO	NO	0.046	0.046	NO	0.046
Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
kerosene											
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Solid Fuels	0.114	0.114	0.079	0.079	0.052	0.052	0.052	0.052	0.026	0.026	0.026
Coal	0.114	0.114	0.079	0.079	0.052	0.052	0.052	0.052	0.026	0.026	0.026
Peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Natural gas	0.713	0.703	0.850	1.016	0.842	0.807	0.765	0.588	0.522	0.943	0.778
Biomass	0.546	0.508	0.506	0.607	0.552	0.534	0.713	0.324	0.722	0.569	0.458
Wood	0.546	0.508	0.506	0.607	0.552	0.534	0.713	0.324	0.722	0.568	0.361
Other biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.097
Other liquid biofuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.001	NO

The biggest decrease in 1990-2011 was for solid fuel consumption – 90.28%, and liquid fuels consumption – 71.77% (Table 3.41). 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 as a fuel dominates in Other Sectors. 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 substantially by 17.99% in 1990–2011 in Other Sectors.

Since 1997, gaseous fuel consumption is constantly increasing until 2007. These are types of fuels with lower costs to whom liquid and solid fuels were switched. Fuel consumption increase in Other Sectors is strongly linked to fuel consumption decrease in Energy industries when central heating supply consumers switched to individual heating supply. In the latest years fluctuations of gaseous fuel are observed. The consumption of gaseous fuel decreased by 12.49% in 2011 comparing to 2010.

3.2.7.3 Uncertainties and time series consistency

Uncertainty in activity data of fuel combustion in 1.A.4 sector is ±2% in 2011. CSB gives approximately 2% statistical sample error for statistical data. 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 15% because biomass activity data were collected by CSB with questionnaires sent by enterprises consumed biomass. Uncertainty of biogas stationary combusted in enterprises covered by 1.A.4.a Commercial / Institutional 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 approximate by the wastewater treatment plant that's why final uncertainty of combusted sludge gas is assumed as 20%. Taking into account uncertainties of solid biomass and biogas consumption total biomass fuel consumption uncertainty is assumed as 20%.
As fuel consumption in 1.A.4.b Residential sector is obtained only every 5 years using questionnaire the uncertainty of all fuel consumption in residential is assumed 50%

CO_2 emission factor was estimated according physical characterization of used fuels in country basing on average NCV reported by fuel consumers and determined carbon content so uncertainty was assigned as quite low about 10%. For combustion of solid fuels uncertainty of CO_2 emission factor was assigned higher to 15% because CO_2 emission factor of peat briquettes was taken from GHG inventories of Finland. As well as 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 factor for landfill gas was assigned as 10% because constant carbon content was used in emission estimation but plant specific NCV value is used. CO_2 emission factor for biomass is assigned as 50% because emission factor is estimated by using default net calorific values still activity data is estimated by using net calorific values for specific wood products, wood types and moisture content of fuel wood.

Taking into account uncertainties of solid biomass and biogas emission factors total biomass emission factor uncertainty is assumed as 50%.

CH_4 and N_2O emission factor used in estimation of emissions was taken from IPCC 1996 so uncertainty was assigned as very high about 50% according IPCC GPG 2000.

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 Source-specific QA/QC and verification

Quality control procedures according to the IPCC GPG 2000 Tier 1 method for Energy sector were performed. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers. All findings were documented by using check-lists and introduced in GHG inventory. All corrections are archived.

3.2.7.4.1 General QA/QC checks for 1.A.4 sector

For stationary fuel combustion following QA/QC checks are performed for all parts of national inventory.

There are several steps for activity data verification:

1. Activity data check at the data providing institution:
    - CSB has the internal QA/QC procedures based on mathematical model and analysis to avoid logic mistakes.
2. Activity data checked at the institution responsible for the emission estimation and reporting:
    - During the activity data input in emission estimation database done by sectoral expert all the data changes are compared to previous inventory and agreed with CSB. The reasons of data changes are explained.
    - After the data is input in emission estimation database activity data is verified using diagrams that is the best way to reflect all the illogical data fluctuations.
    - 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. Still the data reporting requirements of IPCC 1996 make difficult the activity data comparison as autoproducers have to be excluded from Energy industries sector and included in relevant sectors.
3. Activity data used in Sectoral Approach estimation methodology is compared to the activity data used in Reference Approach estimations. 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.

Estimated emissions verification:

1. 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.

2. Emissions are checked using time series consistency check for the IEF estimated in CRF Reported and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

3.2.7.4.2 Additional QA/QC checks for Tier 2 methodology

Country specific CO_2 emission factors

Mainly Tier1 methodology is reported as used in the CO_2 emission estimation but according to IPCC 2006 it would be Tier2 methodology as country or plant specific emission factors are used. Country specific emission factors are estimated using NCV values reported by CSB. CSB collects these data from fuel combustion enterprises and reports annual average number in Annual Questionnaire tables. Carbon content values of the fuels are determined in local expert's research. Detailed CO_2 emission factors estimation data is used and CO_2 emission factor is estimated to the last decimal place. Estimated CO_2 emission factors are within IPCC range. Even if the estimated CO_2 EFs are almost equal to IPCC default EFs or don't differ at all the EFs are reported as country specific.

Plant specific CO_2 emission factors and Tier2 CO_2 emission estimation methodology

Tier2 methodology is used for CO_2 emission from natural gas and landfill gas combustion estimation as plant specific NCVs are used in CO_2 EF estimation. The parameters are reported to LEGMC by only natural gas supplier "Latvijas Gāze" and 3 landfills and the companies confirm that the data is reasonable and useful.

Natural gas supplying company measures NCV every day and reports the average annual number to LEGMC and CSB. All the measuring equipments are checked and verified.

The parameters also are verified by CSB comparing the data natural gas supplier and landfill gas collecting plants has reported within annual Energy balance surveys.

Also CO_2 emission estimation methodology differs from IPCC default because only methane obtained from sludge gas only is taken into account.

3.2.7.5 Source-specific recalculations

There were fuel consumption in 1.A.4.a sector updated because of updated activity data by CSB and incorrectnesses found in the database, especially natural gas, straws and wood consumption.

CO_2 emissions for gasoline year 2009-2010 have been recalculated. Recalculations have been done due to an updated specific CO_2 EF. Instead 68.6 kg/GJ now 71.18 kg/GJ is implemented.

3.2.7.6 Source-specific planned improvements

The summarized necessary improvements are:

- Implement the country specific emission factors obtained in research of CH_4 emissions from solid biomass combustion in the Submission 2014.
- Update NCVs for solid fuels in the next inventory (Submission 2014).
- Researches of possibility to use plant specific data from national database "2-AIR" where facilities that perform any of pollution activities have to report all emissions they create.

3.2.8 Other sources (CRF 1.A.5.b)

3.2.8.1 Source 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 1995 (Table 3.42).

Table 3.42 Emissions from 1.A.5 Other sources in 1995–2011 (Gg)

	CO_2	CH_4	N_2O	GHGs (CO_2 eq)	NO_x	CO	NMVOC	SO_2
1990	NO	NO	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO	NO	NO
1995	6.1223	0.0000	0.0002	6.1768	0.0259	0.0086	0.0043	0.0020
1996	3.2525	0.0000	0.0001	3.2815	0.0132	0.0787	0.0033	0.0011
1997	12.3403	0.0001	0.0003	12.4501	0.0520	0.0545	0.0092	0.0040
1998	3.2525	0.0000	0.0001	3.2815	0.0132	0.0787	0.0033	0.0011
1999	9.3347	0.0001	0.0003	9.4178	0.0391	0.0718	0.0074	0.0030
2000	0.1358	0.0000	0.0000	0.1370	0.0002	0.0528	0.0008	0.0000
2001	0.1667	0.0000	0.0000	0.1682	0.0002	0.0648	0.0010	0.0001
2002	6.7579	0.0004	0.0001	6.7907	0.1430	0.0147	0.0058	0.0019
2003	6.3312	0.0003	0.0001	6.3639	0.1248	0.1450	0.0072	0.0018
2004	11.4722	0.0006	0.0002	11.5335	0.2182	0.1016	0.0107	0.0033
2005	7.5973	0.0004	0.0001	7.6366	0.1500	0.0807	0.0073	0.0022
2006	8.8744	0.0004	0.0001	8.9265	0.1486	0.1731	0.0094	0.0026
2007	2.8250	0.0001	0.0001	2.8449	0.0337	0.0313	0.0026	0.0009
2008	3.3928	0.0001	0.0001	3.4154	0.0449	0.1533	0.0047	0.0010
2009	5.3177	0.0003	0.0001	5.3470	0.0975	0.0414	0.0049	0.0015
2010	7.8462	0.0004	0.0001	7.8841	0.1662	0.0232	0.0068	0.0022
2011	7.1998	0.0004	0.0001	7.2343	0.1536	0.0158	0.0062	0.0020

Emissions from this sector aren't 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 previous two years – 2010 and 2011 – there has been an increase of fuel consumption, according to data given by CSB.

3.2.8.2 Methodological issues

Methods

IPCC 1996 Tier1 Sectoral approach was used to calculate GHG emissions from the 1.A.5.b Other Mobile source. Calculation of all emissions from fuel combustion is done with Excel databases developed by experts from LEGMC. CRF Reporter software developed by experts from UNFCCC was used to report emission data.

The general method for preparing inventory data was used:

$$\boxed{Em = EF \times B_q}$$

where:
Em – total emissions (Gg)
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 IPCC 1996 (Table 3.43). Indirect GHGs emission factors of aviation gasoline and diesel oil were taken from EMEP/EEA 2009, emission factors of jet fuel were taken from IPCC 1996.

Table 3.43 Emission factors for the calculation of emissions from 1.A.5 Other sources (Gg/PJ)

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
aviation gasoline	70.2	0.0005	0.002	0.091	27.291	0.432	0.023
diesel oil	74	0.005	0.0006	1.847	0.174	0.066	0.02
jet fuel	70.86	0.0005	0.002	0.30	0.10	0.05	0.023

SO_2 emissions factors were calculated by formula taken from IPCC Guidelines and were calculated by national expert considering physical characterizations of types of fuels used in Latvia and national and international legislation (Chapter 3.2.6.2). SO_2 emission factors for fuel combustion are presented in Annex 3.1.

Activity data

Emissions from 1.A.2 sector are calculated using fuel consumption data from the CSB prepared within Annual questionnaires for 1990-2011 sent to EUROSTAT. The data collection system for 1.A.2 sector is the same as for 1.A.1 sector (Table 3.44).

Table 3.44 Fuel consumption in 1.A.5 Other sources in 1995−2011 (TJ)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.A.5.b Other mobile sources																	
aviation gasoline	NO	2.73	1.36	2.73	2.15	1.93	2.37	NO	4.84	2.86	2.37	5.72	0.97	5.41	1.12	0.22	NO
diesel oil	NO	NO	NO	NO	NO	NO	NO	74.57	64.54	110.94	77.12	73.13	14.28	20.65	49.03	86.68	80.26
jet fuel	86.40	43.20	172.80	43.20	129.60	NO	NO	17.50	17.15	43.21	24.33	43.21	24.00	20.96	22.73	19.98	17.79

3.2.8.3 Uncertainties and time series consistency

Uncertainty in activity data of fuel combustion in sectors CRF 1.A.5.b is ±2% in 2011 because official statistical information from CSB is used. Still for some years there are gaps in activity data time series obtained by CSB and these data has to be précised.

Emission factors used emission estimation were taken from IPCC Guidelines so uncertainty was assigned as very high about 50% according IPCC GPG 2000.

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 Source-specific QA/QC and verification

Quality control procedures according to the IPCC GPG 2000 Tier 1 method for Energy sector were performed. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers. All findings were documented by using check-lists and introduced in GHG inventory. All corrections are archived.

3.2.8.4.1 General QA/QC checks for 1.A.5 sector

For stationary fuel combustion following QA/QC checks are performed for all parts of national inventory.

There are several steps for activity data verification:

1. Activity data check at the data providing institution:
    - CSB has the internal QA/QC procedures based on mathematical model and analysis to avoid logic mistakes.
2. Activity data checked at the institution responsible for the emission estimation and reporting:

- During the activity data input in emission estimation database done by sectoral expert all the data changes are compared to previous inventory and agreed with CSB. The reasons of data changes are explained.
- After the data is input in emission estimation database activity data is verified using diagrams that is the best way to reflect all the illogical data fluctuations.
- 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. Still the data reporting requirements of IPCC 1996 make difficult the activity data comparison as autoproducers have to be excluded from Energy industries sector and included in relevant sectors.

- Activity data used in Sectoral Approach estimation methodology is compared to the activity data used in Reference Approach estimations. 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.

Estimated emissions verification:

1. 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.
2. Emissions are checked using time series consistency check for the IEF estimated in CRF Reported and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

3.2.8.4.2 Additional QA/QC checks for Tier2 methodology

Country specific CO_2 emission factors

Mainly Tier1 methodology is reported as used in the CO_2 emission estimation but according to IPCC 2006 it would be Tier2 methodology as country or plant specific emission factors are used. Country specific emission factors are estimated using NCV values reported by CSB. CSB collects these data from fuel combustion enterprises and reports annual average number in Annual Questionnaire tables. Carbon content values of the fuels are determined in local expert's research. Detailed CO_2 emission factors estimation data is used and CO_2 emission factor is estimated to the last decimal place. Estimated CO_2 emission factors are within IPCC range. Even if the estimated CO_2 EFs are almost equal to IPCC default EFs or don't differ at all the EFs are reported as country specific.

3.2.8.5 Source-specific recalculations

According to updated activity data given by CSB for years 2009-2010 there have been changed activity data of each fuel and the amount of emissions recalculated has increased significantly.

3.2.8.6 Source-specific planned improvements

Improving of activity data:

- To receive the data from CSB including data smaller than EUROSTAT Annual Questionnaire's thresholds of 1kt;
- To receive precise data up to last decimal place instead of rounded values.

3.3 FUGITIVE EMISSIONS FROM SOLID FUELS AND OIL AND NATURAL GAS (CRF 1.B)

Under the 1.B Fugitive emissions category CH_4, NO_x and CO emissions (for several years) from operations with natural gas and NMVOC emissions from operations with light liquid fuels are reported.

Table 3.45 Reported emissions from fuel combustion in Latvia in 2011

Source	Emissions						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1.B.1 Solid Fuels							
1.B.1.a Coal Mining and Handling	NO	NO	NO	NO	NO	NO	NO
1.B.1.b Solid Fuels Transformation	NO	NO	NO	NO	NO	NO	NO
1.B.1.c Others	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas							
1.B.a Oil	NO	NO	NO	NO	NO	√	NO
1.B.2.b Natural Gas	√	√	NA	NO	NO	NO	NO
1.B.2.c Venting and Flaring	NO	NO	NO	NO	NO	NO	NO
1.B.2.d Other	NO	√	NO	NO	NO	NO	NO

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. It would be possible to estimate CH_4 emissions from peat bog manufacturing but according to IPCC these emissions have to be reported in LULUCF sector.

There are no coal mines in Latvia and therefore no fugitive emissions from mining processes.

3.3.1 Fugitive emission from oil (CRF 1.B.2.A)

3.3.1.1 Source category description

CRF sector 1.B.2 Oil and Natural Gas includes NMVOC emissions from refined oil products storage and distribution.

There are no oil refineries in Latvia; therefore NMVOC emissions from gasoline distribution (Table 3.46) were only calculated for 1990–2001. For 1990–1999 it was impossible to acquire precise data on fuel storage technologies, therefore experts' opinion was taken into consideration. Experts concluded that most of the fuel was stored incorrectly until 2000, when most fuel storage facilities had fuel vapour storage, but not vapour filters and pumps.

Table 3.46 Fugitive NMVOC emissions from oil products 1990–2011 (Gg)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2.979	2.533	2.411	2.342	2.239	2.019	1.994	1.833	1.715	1.656	1.324

2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.387	1.351	1.324	1.407	0.861	0.642	0.629	0.499	0.643	0.738	1.079

For 2002–2011 fugitive NMVOC emission from oil products storage and distribution in oil terminals and pump stations was taken from statistical database "2-AIR" where operators have to report fugitive NMVOC emissions from activities with oil products.

Decrease of NMVOC emissions in 2004-2005 by 39% is explained with the strong legislation rules set in the country for operation with liquid fuels. Fugitive NMVOC emissions increased by 15.1% in 2010 comparing with 2009, and by 46.5% in 2011.

3.3.1.2 Methodological issues

Methods

EMEP/CORINAIR methodology is used to estimate fugitive NMVOC emissions from operations with gasoline in 1990–2001. For time period 2002–2011 NMVOC emission data are taken from operator's reported in database "2-AIR" so this is bottom-up reporting.

Emission factors

NMVOC emission factor for emission from gasoline transportation and storage estimation in 1990–2000 were taken from the local expert research and is based on the expert's judgment. Emission factor for 2000-2001 is taken from EMEP/CORINAIR as default emission factor for gasoline distribution (Table 3.47).

Table 3.47 NMVOC emission factors (g/kg)

1990-1999	2000-2001
4.9	3.93

Activity data

Activity data for NMVOC emission calculation was used from CSB Energy Balance. (Table 3.48) Activity data for 2002–2011 isn't obtained because final emission data was taken from operator's reports to database "2-AIR". This emission data is reported by the petrol stations and oil terminals and verified by Regional Environmental Boards. Mostly these emissions are obtained by using measurement or estimated using mass balance method.

Table 3.48 Activity data used for NMVOC emission calculation in 1990–2001 (PJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gasoline	26.75	22.75	21.65	21.03	20.11	18.13	17.91	16.46	15.40	14.87	14.83	15.53

3.3.1.3 Uncertainties and time series consistency

Activity data for fugitive emissions for 1990–2001 from operations with gasoline were taken from CSB and uncertainty was assumed as very low for about 2% as statistical frame mistake. Reported NMVOC emissions for 2002-2011 from operations with oil products are assumed as 50% because emission data are taken from database "2-AIR" where enterprises report their emission data. Operators mostly estimate NMVOC emissions by using mass balance method or emissions are measured. Environment State Bureau checks and verifies all reports.

Time series of the NMVOC emissions are consistent for 1990–2001 where emissions are estimated by using emission factor method that is top-down method as well as NMVOC emissions from oil terminals aren't taken into account. For 2002-2011 NMVOC emissions data are taken from enterprises – petrol stations and oil terminals that is bottom-up method.

Emissions from all sectors are estimated or reported as not occurring / not applicable therefore there are no "not estimated" sectors.

3.3.1.4 Source-specific QA/QC and verification

Quality control procedures according to the IPCC GPG 2000 Tier 1 method for Energy sector were performed. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers. All findings were documented by using check-lists and introduced in GHG inventory. All corrections are archived.

NMVOC emissions reported for 2002-2011 are taken from national database "2-Air". The data input by companies' is verified and approved by Regional Environmental Boards.

3.3.1.5 Source-specific recalculations

No recalculations have been done for the specific sector.

3.3.1.6 Source-specific planned improvements

No improvements have been planned for the specific sector.

3.3.2 Fugitive emissions from natural gas (CRF 1.B.2.B, CRF 1.B.2.D)

3.3.2.1 Source category description

CH_4 emissions from operations with natural gas are reported in following sub-sectors of 1.B.2 Oil and Natural gas sector:

- 1.B.2.b.3 Transmission;
- 1.B.2.b.4 Distribution;
- 1.B.2.b.5 Other leakage – including leakage at industrial plants and power stations and leakage at residential and commercial sectors;
- 1.B.2.d Other – including leakage at underground natural gas storage facility.

Table 3.49 Fugitive CH_4 emissions from natural gas 1990-2011 (Gg)

Year	CH_4 emissions, Gg
1990	13.5915
1991	13.2215
1992	12.8478
1993	12.5009
1994	12.3078
1995	11.9378
1996	11.5578
1997	11.1926
1998	10.8196
1999	10.5076
2000	10.0673
2001	9.9284
2002	9.9284
2003	8.1124
2004	7.7214
2005	7.4471
2006	6.5291
2007	6.5432
2008	6.1947
2009	6.3569
2010	6.3039
2011	4.2769

Fugitive CH_4 emissions are decreasing constantly until year 2009 when it starts to fluctuate (Table 3.49). The general reasons were modernization of gas transport system, expansion process of distribution system, increase of infiltration and consumption of gas amount from underground storage. In Transmission sector CH_4 emissions have a tendency to increase because of an increasing pipeline length which is directly linked to the emissions since they have calculated after Tier1 method instead of Tier2.

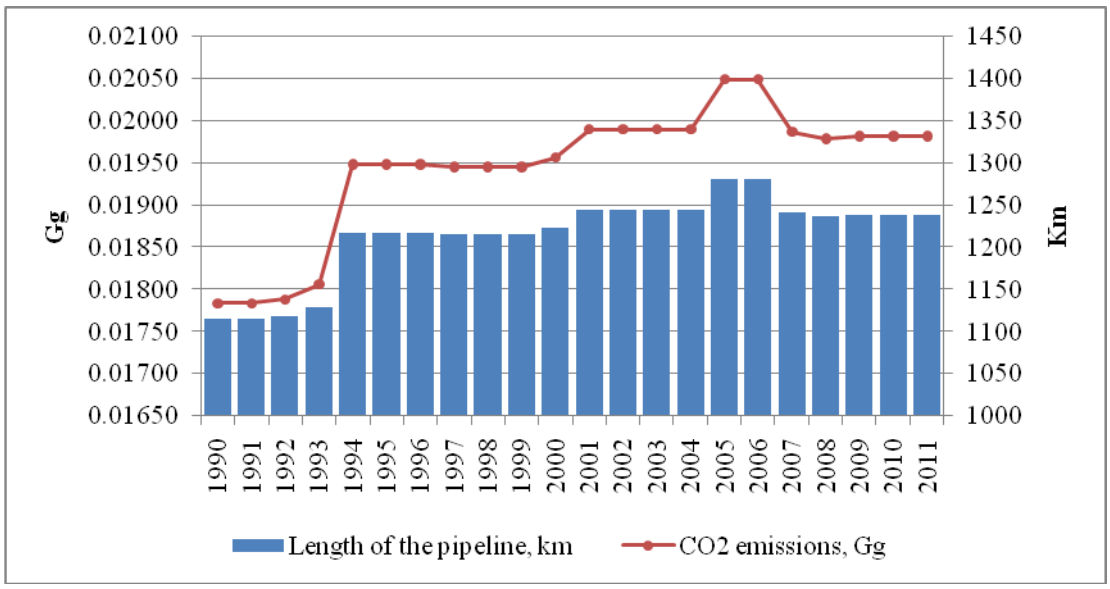


Figure 3.31 Fugitive CO_2 emission from natural gas in 1990-2011 (Gg).

In 2012 a resubmission had been done and fugitive CO_2 emissions calculated. However, these emissions do not exceed 0.0205 Gg (20.5 tonnes per year), therefore their amount is not considered as a key category. In years 2005 and 2006 there is an increase of emissions because a certain amount of pipelines had been handed over from distribution to transmission system. In year 2007 there had been 39 km carried from transmission system to distribution system, therefore the emissions in 1.B.2.b.3 Transmission sector the next years decreased.

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 1990–2011. Consequently company "Latvijas Gāze" calculates emissions by itself.

LEGMC has methodological material, which describes how these emissions are calculated, but due to lack of financial resources it is not possible to translate them. Brief essences of the methods are given below.

CH_4 leaks were calculated from:

- End user internal gas provision systems;
- Distribution systems;
- Gas transport pipeline systems;
- Underground gas storage facility (in Inčukalns);

Below more detailed information on these systems is provided.

<u>End user internal gas provision systems</u>

Natural gas leaks from the imperfections in the internal provision systems in residential buildings with gas stoves are calculated, the following equation being applied:

$$\boxed{Q_{gas} = q \times N \times n}$$

where:
Q_{gas} – leaks from the imperfections in the internal provision systems in residential buildings with gas stoves (m^3);
N – number of days;
n – number of apartments;

q – daily leakage from the imperfections in the internal gas provision systems in residential buildings with gas stoves; q = 0.044 m^3 per day per apartment

Additional natural gas leaks in gas heaters and/or hot water preparation devices are calculated, the following equation being applied:

$$Q_{gas} = 0.7 \times q \times N \times n$$

where:
Q_{gas} – additional natural gas leaks in gas heaters and/or hot water preparation devices, (m^3);
0.7 – coefficient that takes into account the condition of the devices;
N – number of days;
n – number of devices;
q – amount of leakage in the gas heaters and/or hot water preparation devices; q = 0.556 m^3 per day.

Gas distribution systems and gas transport pipeline systems

Natural gas leaks are classified as follows:

- Leaks of unburned gas;
- Amounts of burned gas;
- Gas leaks from the system's imperfections;
- Leaks without emission to atmosphere;
- Leaks from emergencies.

Emission factors and other parameters

CH_4 emission calculation from natural gas is described above.

Activity data

CH_4 emissions are obtained from the holding company "Latvijas Gāze" and activity data for this sector is confidential according to national legislation as "Latvijas Gāze" is only natural gas supplier and distributor in Latvia.

Considering the ERT objection, it is decided that Latvia calculates CH_4 emissions for Transmission sector by Tier 1 method, and the lowest emission factor from 2000 IPCC good practice guidance, Table 2.16 is used (0.0021 Gg per year and per km), because due to short distances (if compared to larger countries) there are no compressors in the transmission system, based on the information given by a representative of "Latvijas Gāze".

The formula to calculate the fugitive CO_2 emissions is as follows:

$$Fugitive\ CH_4\ emissions = Length\ of\ the\ pipeline \times EF,$$

where
Length of the pipeline, km – according to enterprise "Latvijas Gāze" information;
EF, Gg per year and per km of transmission pipeline – 2.1E-03, according to 2000 IPCC GPG Table 2.16: Gas transmission and storage – Transmission – Fugitives – CH_4.

3.3.2.3 Uncertainties and time series consistency

Uncertainty of methane emission from natural gas consumption is assigned as quite low – 10%, as emissions were measured and estimated by only enterprise operated with natural gas in Latvia – "Latvijas Gāze" by methodology developed for enterprise. The emission factor uncertainty is estimated as 30%.

Emissions from all sectors are estimated or reported as not occurring / not applicable therefore there are no "not estimated" sectors.

3.3.2.4 Source-specific QA/QC and verification

"Latvijas Gāze", that reports fugitive CH_4 emissions from the operations with natural gas, estimates CH_4 emissions according to methodology prepared especially of the organization that is internationally verified and approved by the Environment State Bureau and Ministry of

Environment. Underground storage "Inčukalns" from what CH_4 emissions are reported in CRF 1.B.2.D has ISO standard and all the information obtaining procedures are controlled and verified.

The length of transmission gas pipes are available online for years 2001-2011 (see the reference chapter), and approved by a representative of the company. Also the data obtained by years 1990-2001 are given by the representative of "Latvijas Gāze".

3.3.2.5 Source-specific recalculations

There have been calculated CO_2 emissions in all time series in 1.B.2.b iii – Transmission sector after Centralised review 2012 and experts' recommendations.

There have been recalculated all time series in 1.B.2.b iii – Transmission sector after ERT recommendations to use Tier1 methodology for CH_4 emissions.

3.3.2.6 Source-specific planned improvements

It is planned to obtain activity data from "Latvijas Gāze" to ensure transparency of reporting.

CHAPTER 4: INDUSTRIAL PROCESSES (CRF 2)

4.1 OVERVIEW OF SECTOR

4.1.1 Quantitative overview

Sources of emissions from Industrial Processes are (Table 4.1):

- Mineral products (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) – CRF 2.A.2;
  - limestone and dolomite use – CRF 2.A.3
    - in glass production,
    - in steel production,
    - in lime production.
    - in sugar production;
  - soda ash use in glass production – CRF 2.A.4,
  - asphalt roofing – CRF 2.A.5;
  - road paving with asphalt – CRF 2.A.6;
  - other – use of mineral products in glass and ceramics production – CRF 2.A.7:
    - raw materials use in glass production – potash, fluorspar and whiterite;
    - NMVOCs and indirect CO_2 from glass fibre production,
    - use of raw materials in bricks production,
    - use of raw materials in tiles production;
- Metal production (CRF 2.C):
  - CO_2 emissions from use of crude iron as raw material,
  - CH_4 and indirect GHG emissions from total iron and steel production;
- Other production (CRF 2.D):
  - NMVOC emissions from food and drink production,
  - SO_2 emissions from Pulp and Paper production for time period 1990 – 1996;
- Actual emissions from consumption of HFCs halocarbons and SF_6 (CRF 2.F):
  - refrigerators and air conditioners,
  - foam blowing,
  - fire extinguishers,
  - medical aerosols,
  - electric equipment,
  - other – HFC-134a from shoes;
- Potential emissions from consumption of HFCs halocarbons and SF_6 (CRF 2.F.P).

Emissions from the Chemical Industry (CRF 2.B), Production of Halocarbons and SF_6 (CRF 2.E) and Other (CRF 2.G) sectors are not occurring in Latvia.

Table 4.1 Reported emissions from Industrial Processes in Latvia in 2011

Source	Emissions												
	CO_2	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
2.A Mineral Products													
1. Cement Production	√									√		√	√
2. Lime Production	√												
3. Limestone and Dolomite Use	√												
4. Soda Ash Production and	NO												

Source	Emissions												
	CO_2	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
Use													
5. Asphalt Roofing	√										√	√	
6. Road Paving with Asphalt	√									NE	NE	√	NE
7. Other													
Production of Glass (Use of fluorspar)	√	NE	NE							NE	NE	NE	NE
Production of Glass (Use of potash)	NO	NO	NO							NO	NO	NO	NO
Production of Glass (Use of whiterite)	NO	NO	NO							NO	NO	NO	NO
Production of Glass Fibre	√	NE	NE							NE	NE	√	NE
Production of Bricks	√	NE/NO	NE/NO							NE/NO	NE/NO	NE/NO	NE/NO
Production of Tiles	√	NE	NE							NE	NE	NE	NE
B. Chemical Industry													
1. Ammonia Production	NO	NO	NO							NO	NO	NO	NO
2. Nitric Acid Production			NO							NO			
3. Adipic Acid Production	NO		NO							NO	NO	NO	
4. Carbide Production	NO	NO								NO	NO	NO	NO
5. Other													
Carbon Black		NO											
Ethylene	NO	NO	NO										
Dichloroethylene		NO											
Styrene		NO											
Methanol		NO											
C. Metal Production													
1. Iron and Steel Production	√	NO	NA							√	√	√	√
2. Ferroalloys Production	NO	NO	NO							NO	NO	NO	NO
3. Aluminium Production	NO	NO	NO				NO			NO	NO	NO	NO
4. SF_6 Used in Aluminium and Magnesium Foundries									NO				
5. Other													
Other non-specified	NO	NO	NO							NO	NO	NO	NO
D. Other Production													
1. Pulp and Paper										NO	NO	NO	NO
2. Food and Drink[(2)]	NA											√	
E. Production of Halocarbons and SF_6													
1. By-product Emissions													
Production of HCFC-22					NO								
Other					NO		NO		NO				
2. Fugitive Emissions					NO		NO		NO				
3. Other													
Other non-specified					NO		NO		NO				
F. Consumption of Halocarbons and SF_6													
1 Refrigeration and Air Conditioning Equipment				√	√	NO	NO	NO	NO				
2. Foam Blowing				√	√	NO	NO	NO	NO				
3. Fire Extinguishers				√	√	NO	NO	NO	NO				
4. Aerosols/ Metered Dose Inhalers				√	√	NO	NO	NO	NO				
5. Solvents				NO	NO	NO	NO	NO	NO				
6. Other applications using ODS[(3)] substitutes				NO	NO	NO	NO	NO	NO				
7. Semiconductor Manufacture				NO	NO	NO	NO	NO	NO				
8. Electrical Equipment				NO	NO	NO	NO	√	√				
9. Other *(as specified in table 2(II)*													

Source	Emissions												
	CO_2	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
Production of shoes				√	√	NO	NO	NO	NO				
G. Other													
Other non-specified	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

4.1.2 Description

Industrial processes GHG emissions contribute 6.43% of the total anthropogenic GHG emissions in Latvia in 2011. The most important emission source of the Industrial Processes in 2011 is CO_2 emissions from Mineral products and HFCs emissions from Consumption of halocarbons an SF6.

Table 4.2 Greenhouse gas emission trend in 1990–2011 (Gg CO2 eq)

	TOTAL	2.A Mineral Products	2.C Metal Production		HFCs		2.F.P HFCs	SF_6	
		CO_2	CO_2	CH_4	Actual	Potential		Actual	Potential
1990	598.81	585.98	12.83	0.0028	IE,NA,NE,NO	NE,NO	NE,NO	NA,NE,NO	NE,NO
1991	536.03	527.32	8.71	0.0019	IE,NA,NE,NO	NE,NO	NE,NO	NA,NE,NO	NE,NO
1992	256.62	250.88	5.73	0.0012	IE,NA,NE,NO	NE,NO	NE,NO	NA,NE,NO	NE,NO
1993	83.64	76.63	7.01	0.0015	IE,NA,NE,NO	NE,NO	NE,NO	NA,NE,NO	NE,NO
1994	146.69	140.14	6.55	0.0017	IE,NA,NE,NO	NE,NO	NE,NO	NA,NE,NO	NE,NO
1995	159.29	154.86	4.43	0.0014	0.641	0.473	NE,NO	0.2512	0.6335794
1996	175.11	171.63	3.49	0.0015	0.837	0.498	NE,NO	0.2873	0.6697354
1997	180.64	172.64	8	0.0023	1.928	0.558	NE,NO	0.5081	0.890514
1998	181.24	172.74	8.5	0.0024	2.861	0.948	NE,NO	0.7097	1.0921
1999	218.45	210.74	7.71	0.0024	3.276	1.287	NE,NO	0.9772	1.3596
2000	172.95	164.52	8.43	0.0025	5.120	2.32	NE,NO	1.2751	1.6575
2001	197.67	189.63	8.04	0.0025	7.589	32.199	NE,NO	1.9768	2.3592
2002	210.4	202.8	7.6	0.0025	9.866	32.77	NE,NO	3.3819	3.7643
2003	227.09	214.92	12.16	0.0027	15.722	65.51	NE,NO	4.4135	4.7959
2004	366.32	353.4	12.92	0.0028	18.098	125.3	125.3	5.3696	5.7520
2005	250.23	237.87	12.36	0.0028	28.391	132.945	132.945	7.5302	7.9126
2006	278.23	265.66	12.57	0.0028	62.641	161.714	161.714	7.1239	7.5953
2007	296.79	282.22	14.57	0.0028	98.657	131.955	131.955	8.5963	9.0618
2008	288.75	280.01	8.73	0.0027	72.960	194.094	194.094	10.0764	10.6010
2009	251.57	242	9.56	0.0022	74.485	199.867	199.867	13.5293	14.0772
2010	519.83	508.55	11.28	0.0027	72.315	321.454	321.454	13.1286	12.7805
2011	632.25	631.77	0.48	0.0008	82.973	178.452	178.452	12.4543	12.9740

Data on emissions in the Industrial Processes sector are linked with the economic situation of the country as well as availability of statistical data. The largest decrease in emissions occurred between 1990 and 1993 (Figure 4.1, Table 4.2), when industry was going through a crisis.

It has to be noted that in the beginning of 90ties during the countrywide change in government system and national economy statistics was not well kept. Therefore there is lack of statistical data regarding industry during this time period or they are vague. The data extrapolation was carried out for the sectors where possible although the extrapolation is almost impossible to do due to different circumstances – changes and total restructuring of national economy when industrial development wasn't predictable and explainable.

Since year 2000 and after the crisis in national economy of Russian Federation in 1999-2000 with whom Latvia has strength economic relations, GHG emissions from Industrial Processes sector have increased by 131.73% in 2000-2007. It is explained with sharp development of Latvian industry when construction activities increased and industrial production of building materials also increased.

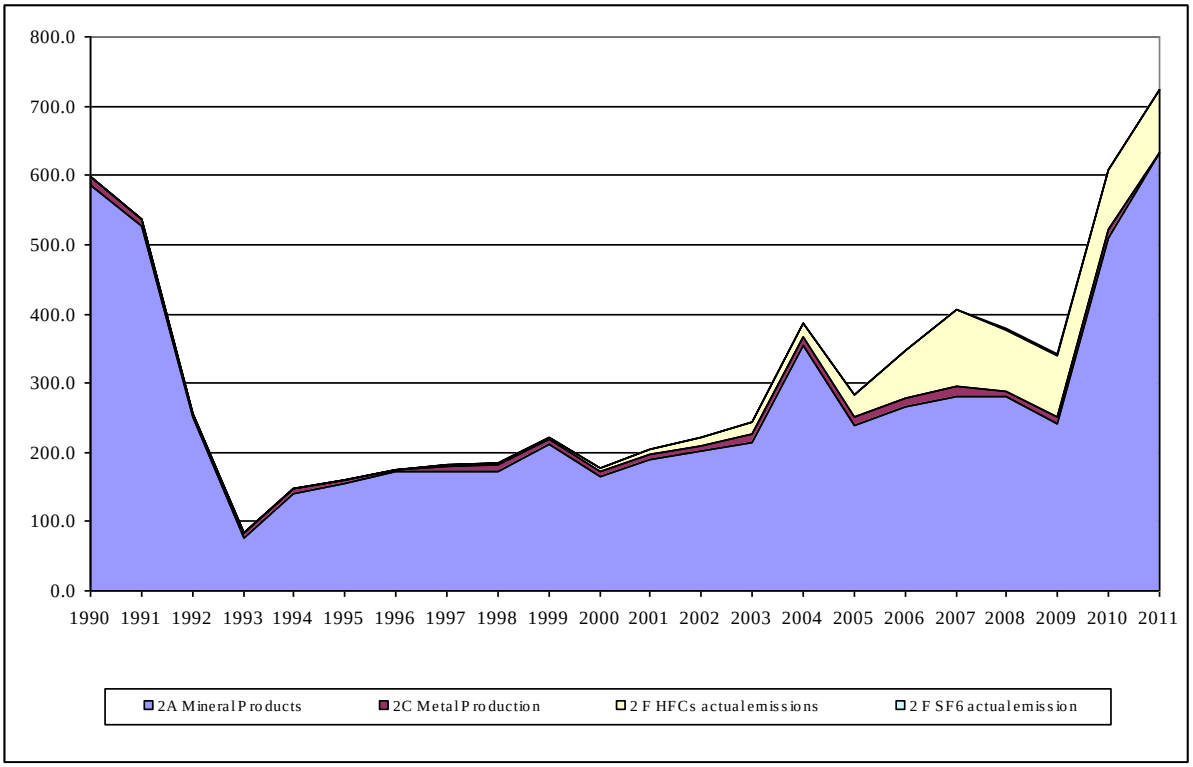


Figure 4.1 GHG emissions from Industrial Processes in 1990–2011 (Gg CO_2 eq.)

Still at the end of 2008 and in 2009 the global financial crisis caused a crisis in Latvia's national economy when the industrial production has decreased quite significantly. The decrease mainly is explained with the decrease of population welfare when lot of people lost their jobs, benefits and pensions were decreased and taxes were increased therefore the purchase capacity of population decreased remarkably. Due to that the building and construction sector development decreased as well as companies also were charged with higher taxes. In 2011 there is an overall increase of activity and emissions from Industrial production.

Only HFCs and SF_6 emissions increased in latest years as biggest F-gases sectors – commercial refrigerators and mobile air conditioning equipment, are not directly linked with development of national economy. Refrigerating equipments are used in manufacturing industry and trading that are developing even during economical crisis. Mobile air conditioning equipments are installed in all newer cars and need to be refilled.

Key categories

Key categories reported in the Table 4.3 are estimated without taking into account LULUCF sector by using Tier1 estimation level.

CO_2 emission from 2.A.1 Cement production sector is key source category with respect to Level assessment without LULUCF sector with 4.860%. CO_2 emissions from 2.A.6 Road Paving with Asphalt are key source according to Trend assessment with 2.904%.

HFCs emissions from 2.F(a).1 Refrigeration and Air Conditioning Equipment are a key source category in 2011 according to Level and Trend assessments – 0.646% and 5.077% respectively (Table 4.3).

Table 4.3 Key categories of Industrial Processes sector in 2011 (%)

IPCC GHG Source and Sink Categories (LUCF not included)	Gas	% Level Assessment	% Trend Assessment
2.A.1 Cement Production	CO2	4.860%	2.873%
2.A.3 Limestone and Dolomite Use	CO2	0.043%	1.826%

IPCC GHG Source and Sink Categories (LUCF not included)	Gas	% Level Assessment	% Trend Assessment
2.A.6 Road Paving with Asphalt	CO2	0.544%	2.904%
2.F(a).1 Refrigeration and Air Conditioning Equipment	HFCs	0.646%	5.077%
2 F(a).9 Other	HFCs	0.045%	0.355%

4.2 MINERAL PRODUCTS (CRF 2.A)

4.2.1 Source category description

2.A Mineral Products sector is main source of GHG emissions in Industrial Processes sector. At the moment the most important for non-energy CO_2 emission sources from Industrial Processes sector are cement, road paving with asphalt process, limestone use in glass and metal production and lime production.

CO_2 emissions are strongly influenced by economic situation in country. Emission curve reflects economic crisis in time period 1991–1993 after changes in national economy in country when significant amount of industrial producers stop their activities and large former Soviet Union market broke down (Table 4.4). Also radical decrease of CO_2 emissions from 1999 to 2000 are influenced by economical crisis in neighbourhood Russian Federation whom Latvia had strong foreign trade linkage.

Table 4.4 Emissions from 2.A Mineral Products in 1990–2011 (Gg)

	CO_2								NOx	CO	NMVOC	SO_2
	2.A	2.A.1	2.A.2	2.A.3	2.A.4	2.A.5	2.A.6	2.A.7				
1990	585.9846	366.1233	8.2048	141.0046	-	0.0001	1.4633	69.1885	0.9025	0.0001	0.6543	3.4094
1991	527.3158	327.1361	8.2048	111.3693	-	0.0000	0.4728	80.1328	0.8338	0.0000	0.3052	3.1498
1992	250.8836	149.1772	8.2048	55.3052	-	0.0000	0.0788	38.1176	0.3753	0.0000	0.0919	1.4178
1993	76.6322	16.7364	8.2048	39.2057	0.4821	0.0002	2.2110	9.7919	0.0415	0.0001	0.7635	0.1568
1994	140.1369	81.1090	8.2048	37.0545	0.9147	0.0004	4.7135	8.1399	0.2025	0.0003	1.6439	0.7650
1995	154.8558	95.4179	8.2048	35.2116	0.6428	0.0003	4.3895	10.9887	0.2372	0.0002	1.5396	0.8960
1996	171.6285	107.7005	9.4012	34.3735	0.9680	0.0006	8.0598	11.1249	0.2673	0.0004	2.7989	1.0099
1997	172.6399	109.5535	12.1691	29.9104	1.0027	0.0007	8.4421	11.5615	0.2723	0.0004	2.9327	1.0286
1998	172.7394	106.5023	10.9649	31.3259	0.9926	0.0007	8.4621	14.4909	0.2641	0.0005	2.9393	0.9978
1999	210.7407	140.5379	11.3487	29.6332	0.9401	0.0010	12.5623	15.7174	0.3550	0.0007	4.3491	1.3412
2000	164.5212	89.5780	10.5316	30.3861	1.7431	0.0006	17.8823	14.3995	0.2257	0.0004	6.1419	0.8526
2001	189.6333	110.9633	11.2553	29.7188	1.4978	0.0007	20.9239	15.2734	0.2743	0.0005	7.1910	1.0364
2002	202.8007	119.1347	11.0128	30.6009	2.0230	0.0008	23.5715	16.4570	0.2984	0.0006	8.0987	1.1273
2003	214.9234	131.5304	11.2153	29.3229	1.7489	0.0009	26.4102	14.6948	0.3255	0.0006	9.0711	1.2296
2004	353.4023	139.0343	14.3200	28.9946	1.5148	0.0054	154.1518	15.3814	0.3510	0.0037	52.6569	1.3260
2005	237.8681	134.9512	13.4209	27.7580	1.5535	0.0017	49.1761	11.0065	0.3583	0.0012	16.8492	1.3535
2006	265.5073	169.5322	9.2300	28.0651	0.4656	0.0016	47.1366	11.2262	0.4464	0.0011	16.1617	1.6863
2007	281.6851	171.8114	10.1572	24.4078	0.0374	0.0022	63.0002	12.8042	0.4567	0.0015	21.5839	1.7254
2008	280.0140	167.7947	11.6513	20.7647	-	0.0023	64.8635	14.9377	0.4515	0.0015	22.2177	1.7058
2009	242.0048	178.8549	6.9483	17.4219	-	0.0012	35.3914	3.3870	0.7033	0.0008	12.1136	1.7390
2010	509.9933	431.1965	12.8149	20.2085	-	0.0014	39.5589	4.7719	0.4829	0.0010	13.5182	0.0705
2011	631.7763	558.6567	0.0014	4.9395	-	0.0022	62.5343	5.6422	0.9341	0.0015	21.3604	0.3737
Share of total 2011 emissions[22]	**4.22%**	**3.57%**	**0.11%**	**0.17%**	**-**	**0.00%**	**0.34%**	**0.04%**	**0.02%**	**0.00%**	**0.12%**	**0.04%**

Due to Latvia's economical 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 from 2.A.1 Cement production increased as cement production plant switched the production technology and installations and increased its capacity by approximately 2.4 times. In 2011 there is increased production capacity about 1.2 times.

The NMVOC emissions from road paving and asphalt roofing are included as well as NMVOC emissions from glass fibre production. The SO_2 emissions from cement production are reported. NO_x and NMVOC emissions from cement production are reported in 2.A.7 Other sector due to structure of CRF Reporter software when it is not possible to report NO_x and NMVOC emissions in 2.A.1 Cement Production sector.

Indirect CO_2 emissions were estimated from NMVOC emissions in 2.A.5, 2.A.6 sectors and from glass fibre production.

4.2.2 Cement Production (CRF 2.A.1)

4.2.2.1 Source category description

CO_2, NOx, NMVOC and SO_2 emissions are estimated for Cement production sector. The emission curve represent the total situation in national economy when the big decrease happened in the beginning of the 90ties due to changes in national economy, domestic market and production demand. CO_2 emissions had decreased by 95.43% in 1990-1993. Increase of emissions in 2000-2007 represents the development of construction sector and development of external market. Still in 2009 new production plant with dry process kiln production technology was erected and the old one where the wet process kiln technology was used was closed in the middle of the year. And as the old production plant was set to closing no active cement kiln dust recovery occurred and all cement kiln dust was collected and transported to landfill for storage. Therefore amount of cement kiln dust and CKD/clinker ratio increased sharply in 2008-2009 that affected CO_2 emissions (Figure 4.2).

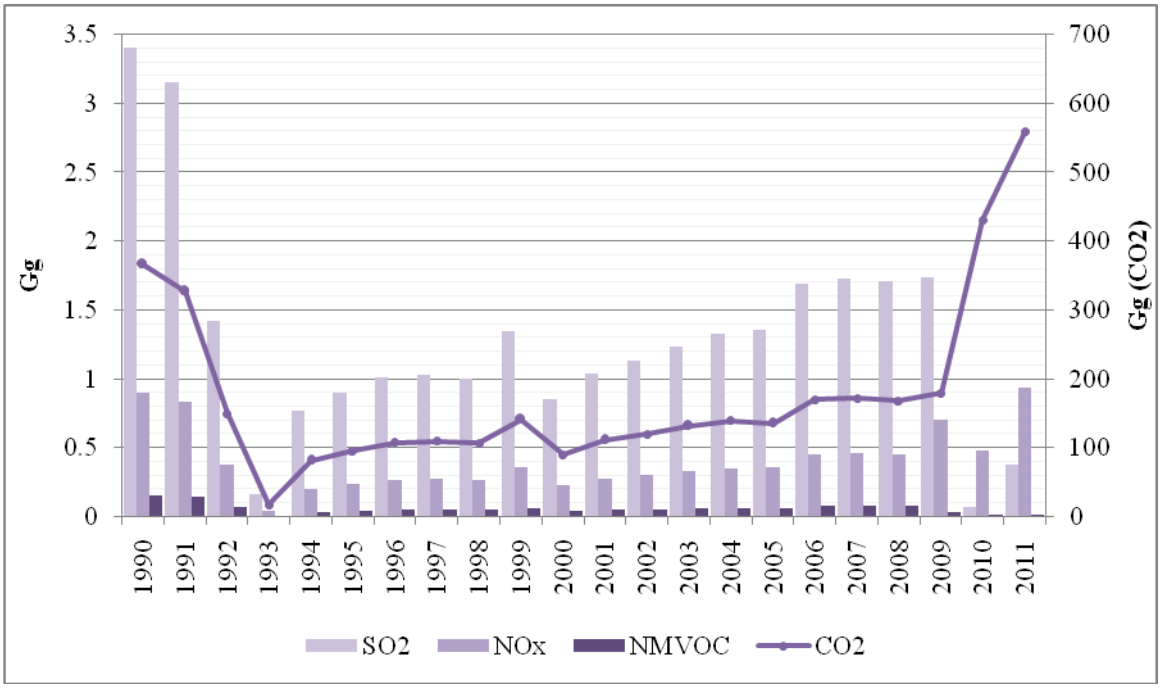


Figure 4.2 Emissions from Cement production in 1990–2011 (Gg) (SOx, NOx and NMVOC emissions on secondary axis)

All emissions except NMVOC increased in 2008-2009 when CO_2 increased by 6.59%, SO_2 – by 1.95%. NOx emissions increased quite sharp by 55.76% that is explained with the emission factor of NOx for new production plant using dry process kiln is 181.48% higher than in old production plant. NMVOC emissions increased by 61.22% that is also explained with the emission factor for new production plant that is 95.65% lower than for the old production plant's wet kiln process technology.

Starting from 2010 fully dry process kiln is used in cement production. For 2009 both kiln process 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 data for cement

clinker in 2010 there are obviously decreased amount of SO_x emissions. From year 2009 to 2010 SO_x emissions are decreased about 95.95% due to changing technology of cement clinker production from wet to dry process kiln. As resources there are used tyres and lube oil which consists sulphur compounds, all necessary for producing clinker. NO_x are decreased about 31.34% but these data are not representative due to new technology started to work with full capacity only in July on 2nd half of year 2010 and fully in 2011. In 2011 there are increased emissions from 2.A.1 sector due to increasing of used activity data about 31.17% in cement production.

4.2.2.2 Methodological issues

Methods

Tier1 method from IPCC GPG 2000 was used to estimate clinker production data from final cement production amount when clinker / cement ratio for different types of cement is known. For CO_2 emission factor as well as emission estimations IPCC GPG 2000 Tier2 method is used.

CO_2 emissions from clinker production are estimated using following equation from IPCC GPG 2000:[15]

$$Em = EF \times AD_{\text{clinker}} \times CKD_{CF}$$

where:
Em – CO_2 emissions from clinker production (Gg)
EF – clinker production EF (Gg/Gg)
$AD_{clinker}$ – clinker production activity data (Gg)
CKD_{CF} – cement kiln dust correction factor

Tier2 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 kilns and technology based EFs.

Emission factors

<u>CO_2 emission factor</u>

CO_2 emission factor is calculated for all years in time series 1990–2011 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 even if it is not accredited and certified as requested in EU ETS MRG so CaO content in limestone is available to estimate CO_2 emission factor for clinker. These emission factors will correspond to Tier2 emission factor estimations from IPCC GPG 2000 as CO_2 emissions from Cement Production sector.

CO_2 emission factor is calculated using equation from IPCC GPG 2000:[16]

$$EF = 0.785 \times CaO_{content}$$

where:
EF – clinker production EF (Gg/Gg)
0.785 – molecular weight ration of CO_2 to CaO in the raw material ($CaCO_3$)
CaO – CaO content (weight fraction) in produced clinker (%)

[15] http://www.ipcc-nggip.iges.or.jp/public/gp/english/3_Industry.pdf, p3.10
[16] http://www.ipcc-nggip.iges.or.jp/public/gp/english/3_Industry.pdf, p3.12

Table 4.5 Average CaO content in clinker (%) and average CO_2 emission factor in 1990–2011 (t CO_2 / t clinker)

	Average CaO content (%)	CO_2 EF without CKD factor	CKD correction factor	CO_2 EF with CKD factor
1990	64.6	0.507	1.08	0.548
1991	64.65	0.508	1.04	0.53
1992	63.77	0.501	1.07	0.537
1993	64.19	0.504	1.08	0.544
1994	63.78	0.501	1.08	0.541
1995	64.06	0.503	1.08	0.543
1996	64.41	0.506	1.08	0.544
1997	64.41	0.506	1.07	0.543
1998	64.41	0.506	1.08	0.544
1999	64.41	0.506	1.06	0.534
2000	64.41	0.506	1.06	0.536
2001	64.41	0.506	1.08	0.546
2002	64.41	0.506	1.07	0.539
2003	64.41	0.506	1.08	0.546
2004	64.41	0.506	1.06	0.535
2005	64.41	0.506	1.01	0.508
2006	64.75	0.508	1.01	0.513
2007	64.06	0.503	1.01	0.508
2008	63.72	0.502	1.00	0.502
2009	65.27	0.512	1.02	0.525
2010	65.24	0.512	1.01	0.516
2011	64.34	0.505	1.01	0.510

For year 1996–2005 average CaO content data of years 1995 and 2006 was used in emissions calculation since data for average CaO content in produced clinker for years 1996–2003 was not available in cement production plant. Also information from plant that average CaO content of years where data is available could be used was received.

For Submission 2013 the CaO content data for 2011 was requested to cement production plant. CO_2 emission factor for 2011 was used according to information on CaO content in produced clinker provided by plant.

Indirect GHG emission factors

As the EFs for NOx, NMVOC and SO_2 are not available in EMEP/EEA 2009[17] (marked as "Not Estimated") the EFs from EMEP/CORINAIR 2007[18] were used as these emissions are emitted in the production according to cement production plant. For submission 2013 the EFs were divided for dry process kiln used (Table 4.6).

Table 4.6 EFs for cement clinker production emission estimation (Gg/Gg)

	NOx	**NMVOC**	**SO_2**
wet process kiln	0.00135	0.00023	0.0051
dry process kiln	0.00245	0.00001	0.0051

Activity data

The produced clinker is not weighted in cement production plant but clinker production is estimated from final cement type by multiplying it with cement/clinker ration according to cement producer GHG report.

[17] http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009/part-b-sectoral-guidance-chapters/2-industrial-processes/2-a-mineral-industry/2-a-1-cement-production.pdf (pages 12-13)

[18] http://www.eea.europa.eu/publications/EMEPCORINAIR5/B3311vs2.4.pdf (pages 12-13)

According to IPCC GPG 2000 it is not a good practice to estimate CO_2 emissions from final cement production data. According to IPCC GPG 2000 alternative of activity data if clinker production data is not available is to use cement clinker data and the estimate this 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 particular types of cement produced. The clinker production data is unknown as clinker is not weighted in cement production plant but directly used to produce different types of cement. CaO content is measured in the cement production companies and CO_2 EF for produced clinker is estimated according to IPCC GPG 2000 Chapter 3 equation 3.3[19]. As it 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.

Due to changing of technology there are produced 2.4 and 1.3 times more clinker in 2010 and 2011 as in previous years. It is explained with new dry process kiln technology and increasing of activity produced by clinker production plant. Full capacity of dry process cement clinker production has caused the increase of CO_2 from Industrial processes in 2010 and 2011. Cement clinker are produced for internal use but mainly for export.

Table 4.7 CKD correction factor in 1990–2011

	Produced clinker (Gg)	Produced cement kiln dust (Gg)	CKD / clinker ratio (%)	Corrected CKD / clinker ratio (%)
1990	668.50	175.49	26.25	8.00
1991	617.60	27.00	4.37	4.37
1992	278.00	20.0	7.19	7.19
1993	30.754	5.00	16.26	8.00
1994	150.00	15.00	10.00	8.00
1995	175.70	15.00	8.54	8.00
1996	198.00	15.00	7.57	7.57
1997	201.70	15.00	7.44	7.44
1998	195.70	15.00	7.67	7.67
1999	263.00	15.00	5.70	5.70
2000	167.20	10.00	5.98	5.98
2001	203.20	18.18	8.94	8.00
2002	221.00	14.60	6.61	6.61
2003	241.10	19.05	7.90	7..90
2004	260.00	15.00	5.77	5.77
2005	265.40	1.527	0.58	0.58
2006	330.60	2.888	0.87	0.87
2007	338.30	3.349	0.99	0.99
2008	334.50	0.99	0.30	0.30
2009	341.00	8.084	2.37	2.37
2010	834.94	7.020	0.84	0.84
2011	1095.23	10.875	0.99	0.99

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 (0.296%). Still to ensure comparability, as required by the IPCC GPG 2000 and also reflect the national circumstances of Latvia, Latvia uses the maximum permissible good practice guidance limit of CKD – 6-8% where the plant specific data exceeds 8% for the calculation of CO2 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.

[19] http://www.ipcc-nggip.iges.or.jp/public/gp/english/3_Industry.pdf page 3.12

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 through LEGMC ETR web page (only in Latvian), internal verification documentation is confidential. The cement clinker is produced only from limestone and CKD amount changes due to production technology. For the last years CKD has decreased due to improvement of used technology.

4.2.2.3 Uncertainties and time series consistency

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 weighed 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 in time series. 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 true. 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.

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.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level. No specific issues were found.

4.2.2.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers.

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 Reporter and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

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.

Plant specific CO_2 emission factors and Tier 2 CO_2 emission estimation methodology

Tier2 methodology is used to estimate CO_2 emissions from cement production using plant specific data of CaO content in used limestone and Tier2 methodology from IPCC GPG 2000.

Cement, cement kiln dust production data and estimated clinker production data is taken from plant's annual GHG reports within EU ETS. According to legislation the GHG reports are verified by accredited verifiers and then checked and approved by Regional Environmental Boards. The data reported in CRF tables and in NIR is also verified by CSB.

CaO content data is reported to LEGMC by cement production plant and is determined in plant's laboratory according to plant's internal procedures.

CO_2 emission is estimated according to IPCC GPG 2000 and the Tier2 methodology was verified by ERT during two in-country reviews in 2007 and 2009 and accepted as correct.

4.2.2.5 Source-specific recalculations

No recalculation has been done for the sector.

4.2.2.6 Source-specific planned improvements

It is important to revise CO_2 emission estimations for the sector as plant specific parameters and values are used in emission estimation. There are involved external auditor for QA/QC as this is a key source category.

4.2.3 Lime Production (CRF 2.A.2)

4.2.3.1 Source 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.

In iron & steel production facility lime necessary for steel smelting in open heart furnaces is produced only from limestone in vertical shaft kiln. The plant is reporting their non-marketed quicklime production data for 2005-2010 within ETS so the estimated emissions as well as used activity data and emission factor are taken from plant's annual GHG report within GHG (Table 4.8).

Table 4.8 CO_2 emission from lime production in steel production in 2005–2011 (Gg)

2005	13.421
2006	9.229
2007	10.157
2008	11.651
2009	6.948
2010	12.815
2011	0.0014

As for most of Latvia's economy sectors the emissions in 2008-2009 have decreased significantly due to the economical crisis. In 2010, emissions have increased due to increasing activity data of produced lime that are used for glass and metal production. There are increased emissions from lime production due to overall increasing of activity data in Industrial processes. In 2011, emissions of produced lime that are used for metal production are decreased due to changing technology of metal production.

4.2.3.2 Methodological issues

Methods

CO_2 emissions from lime production in steel production plant are estimated with Tier1 method based on total produced quicklime data and default emission factor.

$$EM = EF \times AD$$

where:
EM – CO_2 emissions from quicklime production (Gg)
EF – default EF according to IPCC GPG 2000 (tCO_2/t lime) and MRG
AD – quicklime production data (Gg)

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[20]. Lime in the particular plant is produced only from limestone.

Activity data

Activity data of produced lime in steel production company is taken from plant's GHG reports within ETS (Table 4.9).

Table 4.9 Amount of produced lime in steel production in 2005–2011 (Gg)

	Produced lime
2005	6.326
2006	12.025
2007	9.017
2008	5.378
2009	8.472
2010	4.147
2011	0.002

For years 1995-2004 the iron production plant reported their activity data additionally after the information request letter. Due to lack of official data it was decided to use year's 1995 activity data for emission estimation for 1990-1995.

4.2.3.3 Uncertainties and time series consistency

Although according to IPCC GPG the uncertainty of non-marketed lime production data could reach 100% and more[21] it is assumed that the uncertainty of activity data for non-marketed lime production data is 2.A.2 sector is assumed as 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 MRG are used 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 changes and attention was paid to changes that increased 10% level. There are no specific issues.

4.2.3.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers.

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

[20] http://www.ipcc-nggip.iges.or.jp/public/gp/english/3_Industry.pdf (page 3.20)
[21] http://www.ipcc-nggip.iges.or.jp/public/gp/english/3_Industry.pdf (page 3.23)

requirements from the legislation. Steel production facility certifies that all additional information for CO_2 emission estimation is true. 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 that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

Each expert reviewer has to check and fill in QC form for each category taking into account criteria given in QA/QC plan approved in national legislation. Form then is archived by each sector expert.

4.2.3.5 Source-specific recalculations

No recalculation has been done for the sector.

4.2.3.6 Source-specific planned improvements

No improvements are planned for the sector.

4.2.4 Limestone, Dolomite and Soda Ash Use (CRF 2.A.3, 2.A.4)

4.2.4.1 Source category description

Limestone, dolomite and soda ash are used in glass production plants, steel production plant and lime production plants. All these plants are participants of EU ETS so the detailed information of used technologies, raw materials as well as emission factors are available as plants report their annual GHG reports to LEGMC. This IEF are taken from annual report and it is suggest as accurate one by verificator. This EF are elected according to changes in operator GHG permission.

Under CRF 2.A.3 and CRF 2.A.4 sectors following CO_2 emission sources are reported:

- limestone and dolomite use in two glass production plants and one glass fibre production plant;
- limestone and dolomite use in one iron & steel production plant;
- limestone use in one lime production plant;
- dolomite use in one lime production plant;
- limestone use in sugar production processes;
- soda ash use in one glass production plant.

It's feasible that the emissions in early 90ties are higher because iron & steel production plant is active since 19th century. The storage of data in production plants wasn't effective (the information after particular period was transferred to local archive and wasn't stored in plants) and during the changes in national economy, social and political structure biggest part of the data was lost. Therefore the data of use of raw materials in steel production plant is not available for the time period 1990-1993. For more precision of the inventory the data of year 1994 was used for the years in 1990-1993.

As it can be seen in Figure 4.3 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 90ties due to recession of overall national economy.

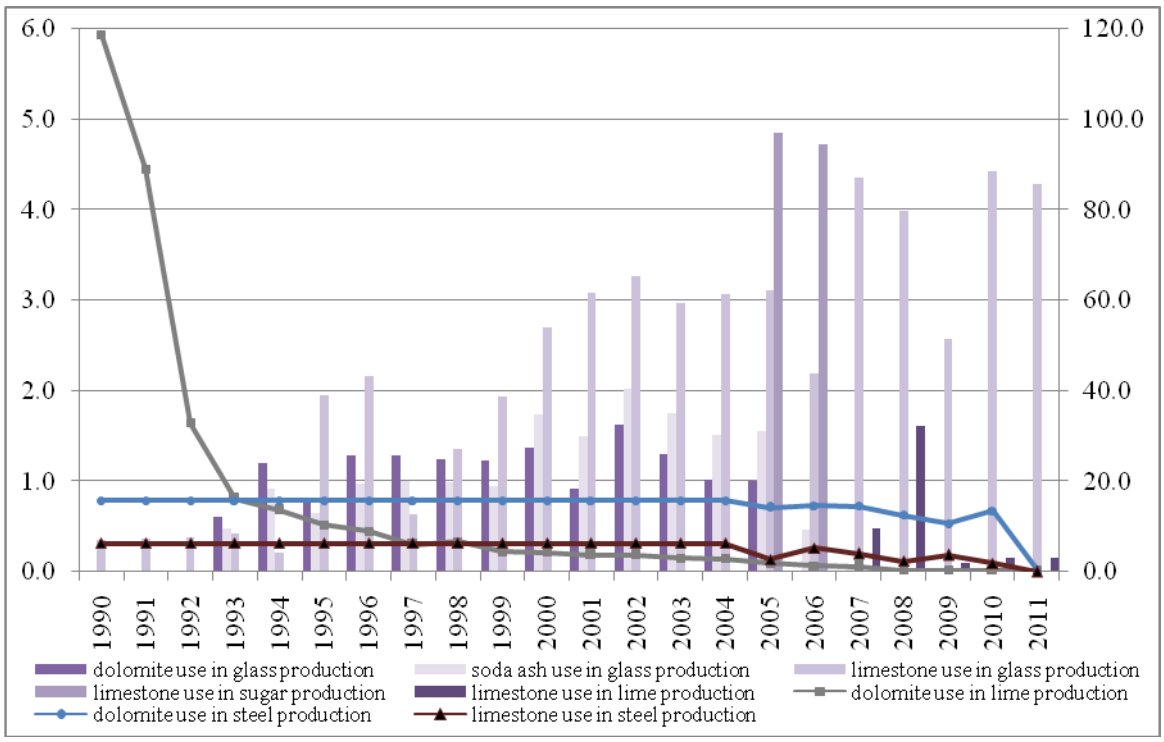


Figure 4.3 CO_2 emission from limestone, dolomite and soda ash use in 1990–2011 (Gg)[22]

The sharp decrease of limestone use in glass production plant in 1997 and accordingly the CO_2 emissions is explained with changes in plant's structure as since 1997 the plant is Joint Stock Company and overall changes in production technology (Figure 4.3).

The economical crisis is obviously reflecting in CO_2 emissions from limestone, dolomite and soda ash use in mineral productions. Also the increase of taxes influences the ability of industrial producers to invest in future development. In 2010 there are increased CO_2 emissions from limestone, dolomite and soda ash use due to increasing activity in all industrial sector. It is explained with fact that Latvia is almost over economical crisis. In 2011 there are sharply decrease of CO_2 emissions in limestone and dolomite use in steel production due to changing technology of metal production.

4.2.4.2 Methodological issues

Methods

CO_2 emissions from Limestone and Dolomite Use in Glass and Metal industry, limestone use in sugar production and Soda Ash Use in Glass Production are estimated with Tier2 method basing on plant specific activity data and default IPCC 1996 emission factors.

CO_2 emissions from Lime production in two direct lime production plants are calculated basing 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 calculation. CO_2 emissions from limestone use in lime production processes are estimated with Tier2 method based on plant specific activity data and default IPCC 1996 emission factors. Tier3 method is used in CO_2 emission from dolomite use in lime production processes estimation as plant specific activity data as well as plant specific CO_2 emission factors are used in estimation.

Emission factors

Emission factors of limestone and dolomite use in production of glass and steel as well soda ash use in glass production are default ones taken from IPCC 1996. CO_2 emission factor for

[22] dolomite use (steel production), limestone use (steel production), dolomite use (lime production), limestone use (sugar production) on secondary axis

limestone use in lime production and sugar production also is taken from IPCC 1996 (Table 4.10).

Table 4.10 CO_2 emission factors for limestone, dolomite and soda ash use (t CO_2/t raw material)

	1990–2011
Limestone use in glass, steel, lime and sugar production	0.440
Dolomite use in glass and steel production	0.477
Soda use in glass production	0.415

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 only lime producer 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 CO2 in lime is 16.99%;
- average content of dolomite (dry) is 94.76% or 947.6 $_{\text{kg dolomite}}$.

947.6 $_{\text{kg dolomite}}$ contains:
491.14 $_{\text{kg CaCO3}}$ (51.86%)
386.62 $_{\text{kg MgCO3}}$ (40.80%)
55.72 $_{\text{kg SiO2; Fe2O3; Al2O3}}$ (5.88%)
14.12 $_{\text{kg Others}}$ (1.49%)
947.6 $_{\text{kg dolomite}}$ complete decomposes and pullulates:
491.14 $_{\text{kg CaCO3}}$ × 0.440 (emission factor) = 216.10 $_{\text{kg CO2}}$
386.62 $_{\text{kg MgCO3}}$ × 0.522 (emission factor) = 201.82 $_{\text{kg CO2}}$.

Oxides capture:
491.14 $_{\text{kg CaCO3}}$ × 0.560 (emission factor) = 275.04 $_{\text{kg CaO}}$
(or 491.14 $_{\text{kg CaCO3}}$ – 216.10 $_{\text{kg CO2}}$ = 275.04 $_{\text{kg CaO}}$)
386.62 $_{\text{kg MgCO3}}$ × 0.478 (emission factor) = 184.80 $_{\text{kg MgO}}$
(or 386.62 $_{\text{kg MgCO3}}$ – 201.82 $_{\text{kg CO2}}$ = 184.80 $_{\text{kg MgO}}$)
216.10 $_{\text{kg CO2}}$ + 201.82 $_{\text{kg CO2}}$ + 275.04 $_{\text{kg CaO}}$ + 184.80 $_{\text{kg MgO}}$ = 877.76 $_{\text{kg}}$
947.6 $_{\text{kg}}$ – 877.76 $_{\text{kg}}$ = 69.84 $_{\text{kg ballast}}$

Lime is made (theoretical):
275.04 $_{\text{kg CaO}}$ + 184.80 $_{\text{kg MgO}}$ + 69.84 $_{\text{kg ballast}}$ = 529.69 $_{\text{kg lime}}$
CO_2 content in lime is 16.99% (practical):
529.69 $_{\text{kg lime}}$ – 83.01%

Lime is made (practical):
638.09 $_{\text{kg lime + CO2}}$ – 100%
CO_2 content in lime is:
638.09 $_{\text{kg lime + CO2}}$ – 529.69 $_{\text{kg lime}}$ = 108.41 $_{\text{kg CO2}}$

CO_2 emissions (1 tonne complete decomposition) pullulate:

$$216.10_{\ kg\ CO2} + 201.82_{\ kg\ CO2} - 108.41_{\ kg\ MgO} = 309.51_{\ kg\ CO2}$$

$0.3095_{\ t\ CO2}$ 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:

$CO_2\ EF_{\ dolomite\ use\ in\ lime\ production} = 309.51_{\ kg\ CO2} \times 94.76\% = 0.29329167$ t CO_2 / t dolomite.

Activity data

Latvia has simpler situation in activity data of this sector because there are two facilities of lime production, two facilities of glass production (one plant after 2005, one plant is not active late 2008) and one plant of steel production (Table 4.11).

Activity data were taken from industrial production plants. Industrial producers are participants of the ETS the GHG reports of these enterprises have to be freely available according to EU ETS regulations. The GHG reports of 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).

Dolomite and limestone use in glass and metal production are reported in 2.A.3 Limestone and Dolomite use according to recommendations of Expert Review Team. Data on dolomite and soda use are available only from 2000 as new enterprise went into a business. Data of soda ash use in glass production are reported under 2.A.4 Soda Ash Production and Use sub-sector.

Unfortunately activity data is not complete for 1990-1993 due to lack of data from glass and steel production plants. Changes of national economy and whole data exchange system in early 90ties were the reason why many data is lost even in production plants. Still to improve CO_2 emission estimation 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.

Table 4.11 Limestone, dolomite and soda ash use activity data (t CO_2/t raw material)

	Limestone and Dolomite Use (total)	Dolomite use (glass production)	Limestone use (glass production)	Dolomite use (steel production)	Limestone use (steel production)	Dolomite use (lime production)	Limestone use (lime production)	Limestone use (sugar production)	**Soda ash use (glass production)**
1990	452.542	-	0.800	33.000	14.300	404.442	-	-	**-**
1991	351.482	-	0.833	33.000	14.300	303.349	-	-	**-**
1992	160.309	-	0.870	33.000	14.300	112.139	-	-	**-**
1993	104.575	1.273	0.958	33.000	14.300	55.045	-	-	**1.162**
1994	96.700	2.523	0.472	33.000	14.300	46.405	-	-	**2.204**
1995	88.957	1.697	4.425	33.000	14.300	35.535	-	-	**1.549**
1996	85.235	2.694	4.904	33.000	14.300	30.338	-	-	**2.333**
1997	71.746	2.706	1.433	33.000	14.300	20.307	-	-	**2.416**
1998	75.794	2.621	3.096	33.000	14.300	22.777	-	-	**2.392**
1999	69.402	2.563	4.410	33.000	14.300	15.129	-	-	**2.265**
2000	70.912	2.875	6.133	33.000	14.300	14.604	-	-	**4.200**
2001	68.794	1.917	7.017	33.000	14.300	12.560	-	-	**3.609**
2002	70.653	3.414	7.439	33.000	14.300	12.500	-	-	**4.875**
2003	67.069	2.730	6.748	33.000	14.300	10.291	-	-	**4.214**
2004	66.212	2.140	6.964	33.000	14.300	9.808	-	-	**3.650**
2005	51.493	2.088	7.070	29.707	6.326	6.303	-	11.021	**3.743**
2006	51.958	-	4.991	30.491	12.025	4.452	-	10.746	**1.122**
2007	53.096	-	9.899	30.405	9.017	3.776	1.078	-	**0.090**

	Limestone and Dolomite Use (total)	Dolomite use (glass production)	Limestone use (glass production)	Dolomite use (steel production)	Limestone use (steel production)	Dolomite use (lime production)	Limestone use (lime production)	Limestone use (sugar production)	**Soda ash use (glass production)**
2008	41.649	-	9.073	26.245	5.378	0.954	3.654	-	**-**
2009	37.866	-	5.853	22.393	8.472	1.149	0.229	-	**-**
2010	43.656	-	10.072	28.115	4.147	1.323	0.349	-	**-**
2011	11.297	-	9.726	0.246	0.002	1.323	0.350	-	**-**

Activity data fluctuates in whole time series. Biggest decrease occurs in the beginning of 1990ties as a consequence of changes in structure of country's national economy. Dolomite use in glass production ended in 2005 as glass production plant stopped its activity. The total amount of raw material used was affected by the closing of glass and sugar production plant, suspending of activity of another glass production plant. In 2010 activity data are increased by 23.03% due to overall increasing of activity in all industrial sector. Exception is limestone use in steel production. This activity data are still decreasing due to changes of steel production GHG permit. In 2011, there is overall decreasing of total emissions from 2.A.3 subsector about 74.12 % due to changes of steel production technology.

4.2.4.3 Uncertainties and time series consistency

The uncertainty of activity data for 2.A.3 and 2.A.4 sectors is assumed as 2%. The activity data reported in production plants' annual GHG reports within ETS is verified by accredited verifiers and Latvia's Regional Environment Boards so the activity data is adequately verified.

As default emission factors for limestone, dolomite and soda ash use are used (with except of dolomite use in lime production) the uncertainty is assumed 50% for 2.A.3 and 2.A.4 sectors. The average uncertainty of CO_2 emission factor for lime production from dolomite is assumed as 5% as plant specific emission factor is estimated according to laboratory measurements of used dolomite.

As default emission factors for lime production from MRG are used the uncertainty is assumed 50%.

Time series of the estimated emissions are consistent and complete because the same methodology, emission factors and data sources are used for sector 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 changes and attention was paid to changes that increased 10% level. There are no specific issues.

4.2.4.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers.

Activity data, CO_2 emission factors and estimated emissions from glass and steel production plants as well as lime 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 approve 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 that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

Each expert reviewer has to check and fill in QC form for each category taking into account criteria given in QA/QC plan approved in national legislation. Form then is sent to National Inventory Compiler and archived.

Tier3 methodology is used for CO_2 emission estimation from dolomite use in lime production as CO_2 emission factor for dolomite use is estimated based on dolomite characteristics determined in plant's laboratory according to laboratory measurements. CO_2 emission factor estimation methodology is verified by accredited verifiers and approved in LEGMC. All information of CO_2 emission factor estimation is given in NIR.

4.2.4.5 Source-specific recalculations

No recalculation has been done for the sector.

4.2.4.6 Source-specific planned improvements

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.

4.2.5 Asphalt Roofing and Road Paving with Asphalt (CRF 2.A.5, 2.A.6)

4.2.5.1 Source category description

In this sector emissions from construction materials production as well as road paving activities are reported.

According to CSB information the biggest part of NMVOC and CO_2 occurs during road paving with asphalt. Just small part of all bitumen mixtures are used in asphalt roofing sector.

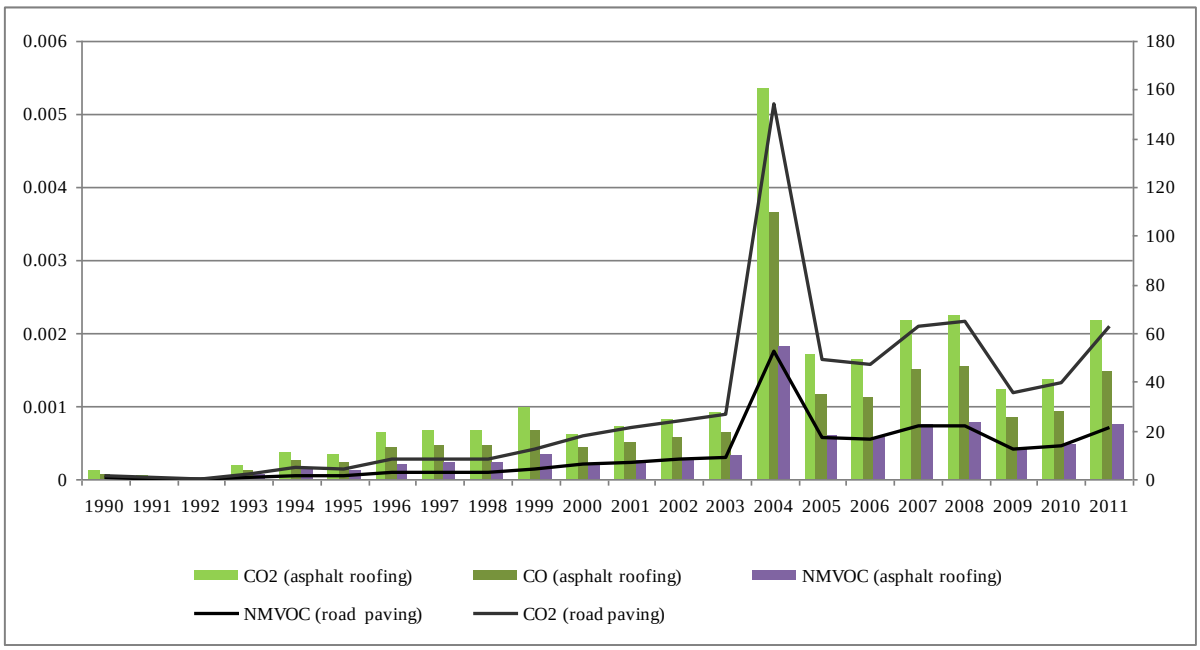


Figure 4.4 Emissions from asphalt roofing and road paving in 1990–2011 (Gg)[23]

The emissions from these two particular sectors are constantly increasing since the beginning of 90ties. Slight emission decrease in 1999-2000 is 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 is explained with Latvia's accession to EU in the May of 2004 before and after what the road paving works were very active. As it is explained previous there are tend to increase CO2 emissions from road paving and asphalt roofing activity in 2010. In

[23] Emissions from road paving with asphalt on secondary axis

2011 there are increased amount of activity data used for road paving and asphalt roofing about 58.08% (Figure 4.4).

4.2.5.2 Methodological issues

Methods

EMEP/EEA 2009 Tier1 was used to estimate NMVOC emissions from the 2.A.5. Road Paving with Asphalt and 2.A.6 Road Paving with Asphalt. According to CSB the biggest part of bitumen mixtures amount is used for road paving. Only small part is used for roofing activities (Table 4.12).

NMVOC emissions are estimated using simpler default methodology:

$$E_{NMVOC} = AD_{bitumen} \times EF_{NMVOC}$$

where:
E_{NMVOC} – NMVOC emissions (Gg)
$AD_{bitumen}$ – bitumen and bitumen mixtures used in CRF 2.A.5 and 2.A.6 activities (Gg)
EF_{NMVOC} –NMVOC emission factor (Gg/Gg)

For Submission 2013 indirect CO_2 emissions from asphalt roofing and road paving with asphalt activities were estimated according to IPCC 2006 provided methodology 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 (Gg)
EF_{CO2} – estimated CO_2 emission factor
NMVOC – NMVOC emissions (Gg)

Emission factors

For CO_2 emission estimation 80% of carbon content conversion factor. According to IPCC 2006[24], indirect emissions of CO_2 from atmospheric oxidation of emitted NMVOC are to be included in the national emission inventory. The average amount of carbon in NMVOC is assumed to be 80%[25]. The default carbon content conversion factor of IPCC 2006 that is 60% was assumed as too low.

So the CO_2 emission factor was estimated using following equation:

$$EF_{CO_2} = 80\% \times 44.0098/12.011$$

where
EF_{CO2} – CO_2 emission factor (Gg/Gg)
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 2009.[26,27] Due to lack of the technology use information Tier1 EFs were used (Table 4.12).

[24] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_7_Ch7_Precursors_Indirect.pdf (page 7.6)
[25] Basing of the most often used average carbon conversion factor
[26] http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009/part-b-sectoral-guidance-chapters/2-industrial-processes/2-a-mineral-industry/2-a-5-asphalt-roofing.pdf (page 7)

Table 4.12 Emission factors for asphalt roofing and road paving in 1990–2011

	CO_2 (t CO_2/t NMVOC)	CO (Gg/Gg)	NMVOC (Gg/Gg)
Asphalt Roofing	2.93	0.00001	0.000005
Road Paving with Asphalt	2.93		0.016

Activity data

The activity data to calculate NMVOC emissions from road paving and asphalt roofing are taken from the CSB (Table 4.12). For submission 2013 the amount of bitumen mixtures was used as activity data. According to CSB the bitumen mixtures includes:

- Asphalt bitumen that usually consists of 60% or more of bitumen and solvent. Used for highway paving;
- Emulsion – or a solid asphalt, bitumen, pitch, tar suspensions in water that are used especially in highway paving;
- Asphalt mastic and other bitumen resins, and similar bituminous mixtures that include minerals such as sand or asbestos.
- Products that are sintered in blocks and that are repeatedly melted before use.

According to information from CSB the biggest part of bitumen mixtures is used for road paving. According to IPCC 2006 typically 80-90% of bitumen is used for road paving materials.[28] Still as Latvia before the beginning of 90ties was part of former USSR and was going through the economical transitions phase, it was assumed that 80% is used for road paving and remaining is used for asphalt roofing till 2000. After that the 90% amount was used to road paving.

Table 4.13 Activity data for road paving with asphalt and asphalt roofing production

	amount of bitumen mixtures used (Gg)	% of asphalt used for road paving	% of asphalt used for roofing	Road Paving With asphalt (Gg)	Asphalt roofing (Gg)
1990	39.0	80%	20%	31.20	7.80
1991	12.6	80%	20%	10.08	2.52
1992	2.1	80%	20%	1.68	0.42
1993	58.9280	80%	20%	47.1424	11.7856
1994	125.6250	80%	20%	100.5000	25.1250
1995	116.9900	80%	20%	93.5920	23.3980
1996	214.8110	80%	20%	171.8488	42.9622
1997	224.9990	80%	20%	179.9992	44.9998
1998	225.5330	80%	20%	180.4264	45.1066
1999	334.8106	80%	20%	267.8485	66.9621
2000	423.6426	90%	10%	381.2783	42.3643
2001	495.7003	90%	10%	446.1303	49.5700
2002	558.4238	90%	10%	502.5814	55.8424
2003	625.6749	90%	10%	563.1074	62.5675
2004	3651.9587	90%	10%	3286.7628	365.1959
2005	1165.0154	90%	10%	1048.5139	116.5015
2006	1116.6968	90%	10%	1005.0271	111.6697

[27] http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009/part-b-sectoral-guidance-chapters/2-industrial-processes/2-a-mineral-industry/2-a-6-road-paving-with-asphalt.pdf (page 9)

[28] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_5_Ch5_Non_Energy_Products.pdf (page 5.14)

	amount of bitumen mixtures used (Gg)	% of asphalt used for road paving	% of asphalt used for roofing	Road Paving With asphalt (Gg)	Asphalt roofing (Gg)
2007	1492.5170	90%	10%	1343.2653	149.2517
2008	1536.6588	90%	10%	1382.9929	153.6659
2009	838.4465	90%	10%	754.6019	83.8447
2010	937.1768	90%	10%	843.4591	93.7177
2011	1481.4804	90%	10%	1333.3324	148.1480

As mentioned before in 2004 the sharp increase of bitumen mixtures use was observed that is explained with large amount of road paving works before Latvia's accession to EU and after that when EU financial instruments became available (Table 4.13).

4.2.5.3 Uncertainties and time series consistency

Uncertainty of activity data for estimations of CO_2 emissions from 2.A.5 Asphalt roofing sector and 2.A.6 Road Paving with Asphalt sector is assumed rather low as CSB data of used bitumen mixtures are used and the percentage of IPCC 2006 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 as at least 20%.

The CO_2 emission factors for 2.A.5 and 2.A.6 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 2009 As Tier1 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 changes and attention was paid to changes that increased 10% level. There are no such issues.

4.2.5.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers.

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.

Emissions are checked using time series consistency check for the IEF estimated in CRF. Reported and all IEF changes that are higher than 10% in time series are double-checked.

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.

4.2.5.5 Source-specific recalculations

No recalculation has been done for the sector.

4.2.5.6 Source-specific planned improvements

No improvements are planned for the sector.

4.2.6 Glass Production (CRF 2.A.7)

4.2.6.1 Source category description

In this sector CO_2 emissions from use of additional raw materials used in glass production plants – fluorspar, potash and whiterite (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 CO2 emission factors and activity data to CO_2 emissions directly.

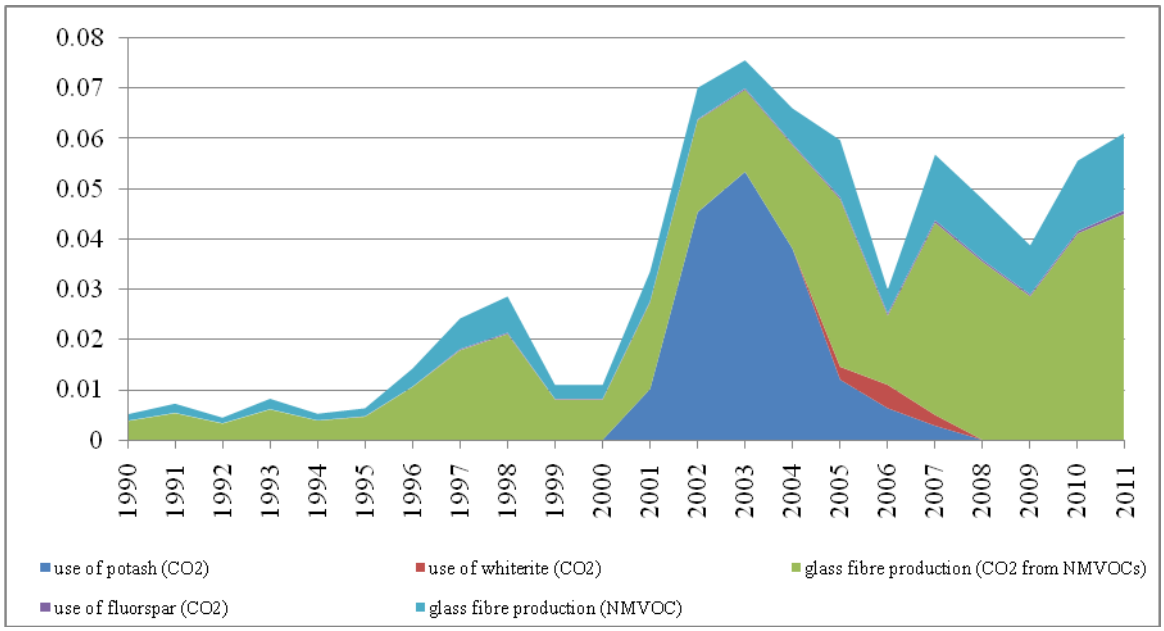


Figure 4.5 Emissions from raw materials use in glass production 1990-2011 (Gg)[29]

Use of potash as well as NMVOC emissions from glass production stopped in 2005 when the glass production plant ended its activity although the use of raw materials in last years of this glass production plant increased sharply. Use of whiterite is occurring only in 2005-2007 in glass production manufacturing plant but as 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 4.5).

NMVOC emissions for time period 1997-2011 were taken from national database "2-AIR" where glass fibre production plant reported its emissions divided by NMVOC sub-type (Table 4.14). For time period 1990-1996 only butylacetate data is available from glass fibre production company's application for GHG permit within EU ETS. For year 2005, also glass production company had reported its NMVOC emissions (these emissions are reported together under Glass fibre production sector in CRF Reporter) but since then glass production

[29] Emissions from use of potash on primary axis

is not operating therefore NMVOC emissions from glass production are reported only for 2005.

Table 4.14 NMVOC emissions from glass fibre and glass production in 1990–2011 (Gg)

	Acetone	Butylacetate	Acetic acid	Formaldehyde	Isopropanol (isopropyl)	Methanol (methyl alcohol)	Methane	Kerosene	Propan (propyl alcohol)	Formic acid	**total NMVOC in glass fibre production**	**total NMVOC in glass production**	**total NMVOC (Gg)**
1990	-	0.0013	-	-	-	-	-	-	-	-	**0.00128**	-	**0.00128**
1991	-	0.0018	-	-	-	-	-	-	-	-	**0.00182**	-	**0.00182**
1992	-	0.0011	-	-	-	-	-	-	-	-	**0.00111**	-	**0.00111**
1993	-	0.0021	-	-	-	-	-	-	-	-	**0.00207**	-	**0.00207**
1994	-	0.0013	-	-	-	-	-	-	-	-	**0.00131**	-	**0.00131**
1995	-	0.0016	-	-	-	-	-	-	-	-	**0.00158**	-	**0.00158**
1996	-	0.0036	-	-	-	-	-	-	-	-	**0.0036**	-	**0.00360**
1997	1.570	3.8040	0.5380	0.1820	-	-	-	-	-	-	**0.00609**	-	**0.00609**
1998	1.360	3.7510	0.3000	0.0840	-	-	-	1.7100	-	-	**0.00721**	-	**0.00721**
1999	1.121	0.3790	0.2280	0.0810	-	-	-	0.9420	-	-	**0.00275**	-	**0.00275**
2000	0.140	0.6640	0.2940	0.0660	-	-	-	1.5700	-	-	**0.00273**	-	**0.00273**
2001	1.187	1.3670	0.5221	0.0698	0.0991	0.0098	-	2.6013	-	0.0396	**0.0059**	-	**0.00590**
2002	-	0.6561	0.6483	0.1082	0.1908	0.0263	-	4.4906	-	0.1235	**0.00624**	-	**0.00624**
2003	-	0.4852	1.1747	0.1073	0.2585	0.0708	-	3.2663	-	0.2071	**0.00557**	-	**0.00557**
2004	-	0.7470	1.2473	0.1532	0.3566	0.1070	0.0378	4.0271	-	0.3568	**0.00703**	-	**0.00703**
2005	-	1.4932	0.9089	0.1067	0.2757	0.0835	-	0.6586	1.2000	0.2331	**0.00496**	**0.00642**	**0.01138**
2006	-	1.4859	0.9603	0.1010	0.3600	0.2316	-	0.0940	1.2737	0.1878	**0.00469**	-	**0.00469**
2007	-	1.3145	1.7041	-	1.7221	2.4136	-	-	5.9203	-	**0.01307**	-	**0.01307**
2008	-	0.9678	1.5477	-	1.5986	2.1726	-	-	5.8104	-	**0.0121**	-	**0.01210**
2009	-	1.1724	0.4018	-	1.0712	0.4009	-	-	6.7152	-	**0.00976**	-	**0.00976**
2010	-	1.6839	1.6732	-	1.3547	2.6126	-	-	6.7115	-	**0.01404**	-	**0.01404**
2011	-	1.6220	1.9080	-	2.3510	2.8730	-	-	6.6400	-	**0.01539**	-	**0.01539**

4.2.6.2 Methodological issues

Methods

Default methodology was used to estimate emissions when activity data is multiplied with emission factor. CO_2 emission factors used to estimate emissions from raw materials use in glass production are plant specific and taken from plants' annual GHG reports within ETS (Table 4.15). NMVOC emissions for time period 1997-2011 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.

For Submission 2013, indirect CO_2 emissions from glass fibre production processes were estimated according to IPCC 2006 provided methodology and explanation of indirect CO_2 emission estimation basing on carbon conversion factor and average default carbon content amount. CO_2 emission factors are not provided in emission estimation methodology and it wouldn't be possible to obtain activity data for direct CO2 emission estimation.

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 (Gg)
EF_{CO2} – estimated CO_2 emission factor
NMVOC – NMVOC emissions (Gg)

Emission factors

CO_2 emission factors for emission from additional raw materials use in glass production processes were taken from reports of glass production plants submitted within EU ETS implementation and from applications to GHG permits. These are plant specific emission factors.

Table 4.15 Emission factors for materials use in glass production (t emissions / t product or raw material)

	1990 – 2011
Fluorspar use	0.0017
Potash use	0.32
Barium carbonate (whiterite) use	0.223
Butylacetate use (NMVOC)[30]	1.0

For CO_2 emission from glass fibre production estimation 80% of carbon content conversion factor. According to IPCC 2006[31], indirect emissions of CO_2 from atmospheric oxidation of emitted NMVOC are to be included in the national emission inventory. The average amount of carbon in NMVOC is assumed to be 80%[32]. The default carbon content conversion factor of IPCC 2006 that is 60% was assumed as too low.

The CO_2 emission factor was estimated using following equation:

$$EF_{CO_2} = 80\% \times 44.0098/12.011$$

where

EF_{CO2} – CO_2 emission factor (Gg/Gg)

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 as 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 1990-2011 (Gg)

	Use of potash (Gg)	Use of fluorspar (Gg)	Use of barium carbonate (Gg)	Use of butylacetate (Gg)
1990	-	-	-	0.0013

[30] For emission estimation only for year 1990-1996, since 1997 the plant reported data from national database "2-AIR" is used
[31] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_7_Ch7_Precursors_Indirect.pdf (page 7.6)
[32] Basing of the most often used average carbon conversion factor

	Use of potash (Gg)	Use of fluorspar (Gg)	Use of barium carbonate (Gg)	Use of butylacetate (Gg)
1991	-	-	-	0.0018
1992	-	-	-	0.0011
1993	-	0.0217	-	0.0021
1994	-	0.0100	-	0.0013
1995	-	0.1158	-	0.0016
1996	-	0.1181	-	0.0036
1997	-	0.0328	-	-
1998	-	0.0743	-	-
1999	-	0.1074	-	-
2000	-	0.0840	-	-
2001	0.0318	0.1520	-	-
2002	0.1420	0.1580	-	-
2003	0.1671	0.2160	-	-
2004	0.1191	0.2460	-	-
2005	0.0376	0.2652	0.0115	-
2006	0.0198	0.2221	0.0209	-
2007	0.0088	0.2013	0.0096	-
2008	-	0.2552	-	-
2009	-	0.4084	-	-
2010	-	0.6222	-	-
2011	-	0.5912	-	-

In 2008-2011, 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.

4.2.6.3 Uncertainties and time series consistency

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 ETS so the activity data is adequately verified.

CO_2 emission factor 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%.

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 changes and attention was paid to changes that increased 10% level. There are no such issues.

4.2.6.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers.

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.

Emissions are checked using time series consistency check for the IEF estimated in CRF Reported and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

4.2.6.5 Source-specific recalculations

No recalculation has been done for the sector.

4.2.6.6 Source-specific planned improvements

No improvements are planned.

4.2.7 Bricks Production (CRF 2.A.7)

4.2.7.1 Source category description

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.

For now it is known that only plants 1 and 5 were operating in time period 1990-1993 so the indicator IE is used for both these plants in time period 1990-1993. As it was not possible to obtain the data for raw materials use in Bricks production companies No 1 and 5, there wasn't possible to estimate the emissions using the same methodology as for 1993-2008 and 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.

4.2.7.2 Methodological issues

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.

<u>CO_2 emission estimation for 1990-1992</u>

For year 1990-1992 no plant specific data is available from bricks production plants so 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.

Then is final amount of produced bricks is know it is possible to determine approximate clay consumption (Table 4.17). In CO_2 emission estimation emission factor 0.047 tCO_2/t used clay is used.

Table 4.17 Data and assumptions used for CO_2 emission estimation for 1990-1992

	1990	**1991**	**1992**
produced bricks (piece)	471800000	546423000	259918000
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 (Gg)	**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 (Gg)	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 last years due to availability of necessary activity data and laboratory measures of used raw materials.

4.2.7.2.1 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 CO2 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 tCO_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 2008-2009 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[33].

According to bricks production plant's reported information the following equation to estimate CO_2 emissions was used:

$$\boxed{CO_2 = \sum \left(\left(AD_{raw} \times AD_{CaO,MgO} \right) \times EF \times CF \right)}$$

where:
CO_2 – total CO_2 emissions from bricks production (Gg)
AD_{raw} – activity data of used raw materials – clay (Gg)
$AD_{CaO,MgO}$ – CaO and MgO content in used raw materials (%)
EF – CO_2 emission factor of CaO and MgO (Gg/Gg)
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[34] (Table 4.18).

Activity data

As MgO and CaO content data was not available for years 1993-2004 so the data reported in bricks production plant's GHG report for 2005 was used: MgO content – 4.9%, CaO content – 11.6%.

[33] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF (page 80)
[34] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF (page 81)

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 2008-2009: MgO content – 2.9%, CaO content – 10.23%.

Table 4.18 Data and assumptions used for CO_2 emission estimation from 1st bricks production plant

	use of clay (Gg)	MgO content (%)	CaO content (%)	MgO amount (Gg)	CaO amount (Gg)	MgO CO_2 EF (tCO2/t oxide)	CaO CO_2 EF (tCO2/t oxide)	**CO_2 emissions (Gg)**	Average CO_2 EF (tCO_2/t oxides)
1993	2.000	4.90%	11.60%	0.098	0.232	1.092	0.785	**0.29**	0.876
1994	2.400	4.90%	11.60%	0.118	0.278	1.092	0.785	**0.35**	0.876
1995	2.700	4.90%	11.60%	0.132	0.313	1.092	0.785	**0.39**	0.876
1996	3.000	4.90%	11.60%	0.147	0.348	1.092	0.785	**0.43**	0.876
1997	3.600	4.90%	11.60%	0.176	0.418	1.092	0.785	**0.52**	0.876
1998	4.000	4.90%	11.60%	0.196	0.464	1.092	0.785	**0.58**	0.876
1999	4.400	4.90%	11.60%	0.216	0.510	1.092	0.785	**0.64**	0.876
2000	4.800	4.90%	11.60%	0.235	0.557	1.092	0.785	**0.69**	0.876
2001	4.800	4.90%	11.60%	0.235	0.557	1.092	0.785	**0.69**	0.876
2002	4.800	4.90%	11.60%	0.235	0.557	1.092	0.785	**0.69**	0.876
2003	6.500	4.90%	11.60%	0.319	0.754	1.092	0.785	**0.94**	0.876
2004	6.500	4.90%	11.60%	0.319	0.754	1.092	0.785	**0.940**	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

4.2.7.2.2 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[35] is used in plant's emission estimation for its application for GHG permit as well for reporting of annual CO_2 emission:

$$CO_2 = \left(AD_{raw} \times AD_{CaCO_3} \times EF_{CaCO_3}\right) + \left(AD_{raw} \times AD_{MgCO_3} \times EF_{MgCO_3}\right)$$

where:
CO_2 – CO_2 emissions from 3rd bricks production plant (Gg)
AD_{raw} – activity data of used clay (Gg)
AD_{CaCO3} – $CaCO_3$ content in used clay (%)
EF_{CaCO3} – $CaCO_3$ emission factor (Gg/Gg)
AD_{MgCO3} – $MgCO_3$ content in used clay (%)
EF_{MgCO3} – $MgCO_3$ emission factor (Gg/Gg)

Emission factors

[35] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF (page 79)

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 4.19).

Table 4.19 Data and assumptions used for CO_2 emission estimation from 2nd bricks production plant

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Use of clay (Gg)	11.750	16.370	17.637	20.610	23.055	21.648	22.983	28.559	37.203	13.975
$MgCO_3$ content (%)	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	10.98%	9.56%	9.52%	9.50%
$CaCO_3$ content (%)	9.00%	9.00%	9.00%	9.00%	9.00%	9.00%	13.06%	13.15%	13.10%	13.10%
$MgCO_3$ amount (Gg)	0.588	0.819	0.882	1.031	1.153	1.082	2.523	2.729	3.542	1.328
$CaCO_3$ amount (Gg)	1.058	1.473	1.587	1.855	2.075	1.948	3.002	3.756	4.874	1.831
$MgCO_3$ CO_2 EF (tCO2/t oxide)	0.522	0.522	0.522	0.522	0.522	0.522	0.522	0.522	0.522	0.522
$CaCO_3$ CO_2 EF (tCO2/t oxide)	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440
CO_2 emissions (Gg)	0.772	1.076	1.159	1.354	1.515	1.422	2.638	3.077	3.993	1.50
Average CO_2 EF (tCO2/t oxides)	0.469	0.469	0.469	0.469	0.469	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.

4.2.7.2.3 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 IPCC Guidelines. Still in the application the plant had reported the MgO and CaO content data in used dry clay so 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[36] – 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:

$$CO_2 = \sum \left(\left(AD_{raw} \times AD_{CaO,MgO} \right) \times EF \times CF \right)$$

[36] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF (page 80)

where:
CO_2 – total CO_2 emissions from bricks production (Gg)
AD_{raw} – activity data of used raw materials – clay (Gg)
$AD_{CaO,MgO}$ – CaO and MgO content in used raw materials (%)
EF – CO_2 emission factor of CaO and MgO (Gg/Gg)
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 so the data was recalculated using the emission estimation method as for 2005-2007. Following equation from MRG is used to estimate emissions for 2005-2009:

$$CO_2 = \left(AD_{raw} \times AD_{CaCO_3} \times EF_{CaCO_3}\right) + \left(AD_{raw} \times AD_{MgCO_3} \times EF_{MgCO_3}\right)$$

where:
CO_2 – CO_2 emissions from 3rd bricks production plant (Gg)
AD_{raw} – activity data of used clay (Gg)
AD_{CaCO3} – $CaCO_3$ content in used clay (%)
EF_{CaCO3} – $CaCO_3$ emission factor (Gg/Gg)
AD_{MgCO3} – $MgCO_3$ content in used clay (%)
EF_{MgCO3} – $MgCO_3$ emission factor (Gg/Gg)

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[37] (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[38] to recalculate the emissions. (Table 4.20,Table 4.21).

Activity data

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 4.20, Table 4.21).

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 (Gg)
AD_{clay} – amount of used clay (Gg)
M – moisture content of clay in bricks pressing process (%)

For year 2005-2010 the activity data was estimated by using following equation from bricks production plant's GHG report:

$$AD_{raw} = \sum \left(AD_{bulk} \times M_{av}\right)$$

where:

[37] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF (page 81)
[38] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF (page 79)

AD_{raw} – activity data of used raw materials – clay (Gg)
AD_{bulk} – amount of dried bulk materials (pieces)
M_{av} – average mass with 0% moisture content (Gg)

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. So for year 2005-2011 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 4.20 Data and assumptions used for CO_2 emission estimation from 3rd bricks production plant

	1998	1999	2000	2001	2002	2003	2004
use of clay (Gg)	7.47	9.656	10.250	10.375	11.237	10.963	11.600
moisture content (%)	17.00%	17.00%	17.00%	17.00%	17.00%	17.00%	17.00%
used raw materials - dry clay (Gg)	6.20	8.01	8.51	8.61	9.33	9.10	9.63
MgO content (%)	8.03%	8.03%	8.03%	8.03%	8.03%	8.03%	8.03%
CaO content (%)	3.02%	3.02%	3.02%	3.02%	3.02%	3.02%	3.02%
MgO amount (Gg)	0.498	0.644	0.683	0.691	0.749	0.731	0.773
CaO amount (Gg)	0.187	0.242	0.257	0.260	0.282	0.275	0.291
MgO CO_2 EF (tCO2/t oxide)	1.092	1.092	1.092	1.092	1.092	1.092	1.092
CaO CO_2 EF (tCO2/t oxide)	0.785	0.785	0.785	0.785	0.785	0.785	0.785
CO_2 emissions (Gg)	**0.6907**	**0.89**	**0.95**	**0.96**	**1.04**	**1.01**	**1.07**
Average CO_2 EF (tCO_2/t oxides)	1.008	1.008	1.008	1.008	1.008	1.008	1.008

Table 4.21 Data and assumptions used for CO_2 emission estimation from 3rd bricks production plant (continuation)

	2005	2006	2007	2008	2009	2010	2011
use of clay (Gg)	29.891	22.316	23.854	77.687	19.814	32.513	38.914
$MgCO_3$ content (%)	10.75%	10.75%	10.75%	10.75%	10.75%	10.75%	10.75%
$CaCO_3$ content (%)	12.79%	12.79%	12.79%	12.79%	12.79%	12.79%	12.79%
$MgCO_3$ amount (Gg)	3.213	2.399	2.564	8.351	2.130	3.495	4.183
$CaCO_3$ amount (Gg)	3.823	2.854	3.051	9.936	2.534	4.158	4.977
$MgCO_3$ CO2 EF (tCO2/t oxide)	0.522	0.522	0.522	0.522	0.522	0.522	0.522
$CaCO_3$ CO2 EF (tCO2/t oxide)	0.440	0.440	0.440	0.440	0.440	0.440	0.440
CO_2 emissions (Gg)	**3.359**	**2.508**	**2.681**	**8.73**	**2.23**	**3.65**	**4.37**
Average CO_2 EF (tCO_2/t oxides)	0.477	0.477	0.477	0.477	0.477	0.477	0.477

4.2.7.2.4 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 tCO_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.

So to make emission estimation more consistent 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 4.22).

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[39].

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 (Gg)
AD_{clay} – activity data of used clay (Gg)
AD_{CaCO3} – $CaCO_3$ content in used clay (%)
EF_{CaCO3} – $CaCO_3$ emission factor (Gg/Gg)
AD_{MgCO3} – $MgCO_3$ content in used clay (%)
EF_{MgCO3} – $MgCO_3$ emission factor (Gg/Gg)

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 MRG[40] to recalculate the emissions.

Activity data

[39] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF (pages 78,79)
[40] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF (page 79)

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 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 so the percentage amount of carbonates of year 2007 was used. (Table 4.22)

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 (Gg)
AD_{bulk} – amount of dried bulk materials (pieces)
M_{av} – average mass (Gg)
M_{bulk} – mass of dried bulk materials loaded in furnace
moisture/100 – average moisture content of clay (%)
$M_{chippings}$ – mass of dried scobs (Gg)
$M_{tenisite}$ – mass of tenisite (granulated burnt defectives of ceramics) (Gg)

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 4.22 Data and assumptions used for CO_2 emission estimation from 4th bricks production plant

	2000	2001	2002	2003	2004	2005	2006	2007	2008
use of clay (Gg)	9.000	11.742	24.090	25.234	22.983	25.246	29.826	34.166	27.329
$MgCO_3$ content (%)	1.80%	1.80%	1.80%	1.80%	1.80%	6.47%	6.47%	6.67%	6.67%
$CaCO_3$ content (%)	11.48%	11.48%	11.48%	11.48%	11.48%	14.62%	14.62%	13.71%	13.71%
$MgCO_3$ amount (Gg)	0.162	0.211	0.434	0.454	0.414	1.634	1.929	2.280	1.824
$CaCO_3$ amount (Gg)	1.033	1.348	2.766	2.897	2.638	3.691	4.361	4.684	3.747
$MgCO_3$ CO_2 EF (tCO2/t oxide)	0.522	0.522	0.522	0.522	0.522	0.522	0.522	0.522	0.522
$CaCO_3$ CO_2 EF (tCO2/t oxide)	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440	0.440
CO_2 emissions (Gg)	**0.539**	**0.703**	**1.443**	**1.512**	**1.377**	**2.477**	**2.926**	**3.251**	**2.601**
Average CO_2 EF (tCO_2/t oxides)	0.451	0.451	0.451	0.451	0.451	0.465	0.465	0.467	0.467

In year 2009 the bricks production plant is not operating due to economical 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.

4.2.7.2.5 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 so 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[41]. 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.

$$CO_2 = \sum \left(AD_{raw} \times AD_{CaO,MgO} / 100 \right) \times EF \times CF$$

where:
CO_2 – total CO_2 emissions from bricks production (Gg)
AD_{raw} – activity data of used raw materials – clay (Gg)
$AD_{CaO,MgO}$% / 100 – CaO and/or MgO content in used raw materials (%)
EF – CO_2 emission factor of CaO and/or MgO (Gg/Gg)
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 (Gg)
AD_{raw} – activity data of used raw materials – clay (Gg)
$AD_{additive}$% / 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 (Gg/Gg)
CF – conversion factor

In latest years 2008-2009 the CO_2 emissions were estimated for different bulks of used clay so CaO and MgO content data for these bulks differs. Therefore the CO_2 emissions were estimated separately (Table 4.2.19 continuation).

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[42]. In plant's application to GHG permit unknown source emission factor was used so 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:

$$AD_{raw} = \sum \left(AD_{bulk} \times M_{av} - M_{bulk} \times moisture / 100 \right)$$

where:
AD_{raw} – activity data of used raw materials – clay (Gg)
AD_{bulk} – amount of dried bulk materials (pieces)
M_{av} – average mass (Gg)
M_{bulk} – mass of dried bulk materials
moisture/100 – content of moisture (%)

[41] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF (page 80)
[42] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF (page 81)

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 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 (Table 4.23, Table 4.24).

Table 4.23 Activity data, emission factors and other parameters used for CO_2 emission estimation in 5th bricks production plant

	Use of clay (Gg)	MgO content (%)	CaO content (%)	MgO amount (Gg)	CaO amount (Gg)	MgO CO_2 EF (tCO_2/t oxide)	CaO CO_2 EF (tCO_2/t oxide)	**CO_2 emissions (Gg)**	Average CO_2 EF (tCO_2/t oxides)	$CaCO_3$ (additive) (Gg)	CaO (estimated from $CaCO_3$)	**CO_2 emissions (Gg)**	**Total CO_2 emissions (Gg)**
1993	97.765	1.43%	10.39%	1.398	10.153	1.092	0.785	**9.50**	0.822	-	-	-	**9.497**
1994	80.186	1.43%	10.39%	1.147	8.327	1.092	0.785	**7.79**	0.822	-	-	-	**7.789**
1995	107.382	1.43%	10.39%	1.536	11.152	1.092	0.785	**10.43**	0.822	-	-	-	**10.431**
1996	107.991	1.43%	10.39%	1.544	11.215	1.092	0.785	**10.49**	0.822	-	-	-	**10.490**
1997	111.065	1.43%	10.39%	1.588	11.534	1.092	0.785	**10.79**	0.822	-	-	-	**10.789**
1998	133.373	1.43%	10.39%	1.907	13.851	1.092	0.785	**12.96**	0.822	-	-	-	**12.956**
1999	135.801	1.43%	10.39%	1.942	14.103	1.092	0.785	**13.19**	0.822	-	-	-	**13.191**
2000	112.495	1.43%	10.39%	1.609	11.683	1.092	0.785	**10.93**	0.822	-	-	-	**10.928**
2001	117.412	1.43%	10.39%	1.679	12.193	1.092	0.785	**11.41**	0.822	-	-	-	**11.405**
2002	118.883	1.43%	10.39%	1.700	12.346	1.092	0.785	**11.55**	0.822	-	-	-	**11.548**
2003	95.357	1.43%	10.39%	1.364	9.903	1.092	0.785	**9.26**	0.822	-	-	-	**9.263**
2004	105.546	1.43%	10.39%	1.509	10.961	1.092	0.785	**10.25**	0.822	-	-	-	**10.253**
2005	88.293	0.39%	1.75%	0.344	1.545	1.092	0.785	**1.5889**	0.841	-	-	-	**1.5889**
2006	94.435	0.39%	1.75%	0.368	1.653	1.092	0.785	**1.6995**	0.841	0.342	0.191	**0.1499**	**1.8494**
2007	80.895	0.36%	1.47%	0.291	1.189	1.092	0.785	**1.2515**	0.845	1.218	0.682	**0.5354**	**1.7869**

Table 4.24 Activity data, emission factors and other parameters used for CO_2 emission estimation in 5th bricks production plant (continuation)

	2008				**2009**				**2010**			
use of clay (Gg)	26.322	28.326	28.820	13.205	1.049	21.015	22.050	1.194	0,823	21,053	21,154	20,796
MgO content (%)	1.23%	1.35%	1.26%	1.09%	1.09%	1.07%	1.16%	1.12%	0,112%	0,123%	0,113%	0,116%
CaO content (%)	0.32%	0.41%	0.38%	0.25%	0.25%	0.27%	0.27%	0.23%	0,23%	0,26%	0,24%	0,28%
MgO amount (Gg)	0.324	0.382	0.363	0.144	0.011	0.225	0.256	0.013	0,001	0,026	0,024	0,024
CaO amount (Gg)	0.084	0.116	0.110	0.033	0.003	0.057	0.060	0.003	0,002	0,055	0,051	0,058
MgO CO_2 EF (tCO_2/t oxide)	1.092	1.092	1.092	1.092	1.092	1.092	1.092	1.092	1,092	1,092	1,092	1,092
CaO CO_2 EF (tCO_2/t oxide)	0.785	0.785	0.785	0.785	0.785	0.785	0.785	0.785	0,785	0,785	0,785	0,785
CO_2 emissions (Gg)	**0.4197**	**0.5087**	**0.4825**	**0.1831**	**0.0145**	**0.2901**	**0.3260**	**0.0168**	**0,0025**	**0,0712**	**0,0660**	**0,0721**
Total CO_2 emissions	**1.594**				**0.647**				**0.660**			

	2008	2009	2010
(Gg)			

Table 4.25 Activity data, emission factors and other parameters used for CO_2 emission estimation in 5th bricks production plant (continuation)

	2011			
Use of clay (Gg)	17.723	26.511	25.50	24.067
MgO content (%)	1.112%	0.123%	0.113%	0.116%
CaO content (%)	0.23%	0.26%	0.24%	0.28%
MgO amount (Gg)	0.020	0.033	0.028	0.028
CaO amount (Gg)	0.041	0.69	0.060	0.067
MgO CO_2 EF (tCO_2/t oxide)	1.092	1.092	1.092	1.092
CaO CO_2 EF (tCO_2/t oxide)	0.785	0.785	0.785	0.785
CO_2 emissions (Gg)	**0.0537**	**0.0897**	**0.0781**	**0.0834**
Total CO_2 emissions (Gg)	**0.753**			

4.2.7.3 Uncertainties and time series consistency

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 from Monitoring and Reporting Guidelines within ETS 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.

Only CO_2 emissions from bricks production are estimated. Other emissions are not estimated due to lack of official emission estimation methodology and emission factors.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level.

4.2.7.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers.

Emissions are checked using time series consistency check for the IEF estimated in CRF Reporter and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

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.

Plant specific CO_2 emission factors and Tier 2 CO_2 emission estimation methodology

Tier 2 methodology is used to estimate CO_2 emissions from bricks production using plant specific data of used clay characteristics – amount of carbonates, percentage division of carbonates and Tier2 methodology from IPCC GPG 2000.

Activity data is taken from plants reported annual GHG reports 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 checks the annual GHG reports and approves the report if everything reported is correct.

CO_2 emission factors are taken from MRG and are the default ones therefore there is no need to re-check correctness of emission factors.

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.

4.2.7.5 Source-specific recalculations

No recalculation has been done for the sector.

4.2.7.6 Source-specific planned improvements

No improvements are planned for this sector for nearest submissions.

4.2.8 Tiles Production (CRF 2.A.7)

4.2.8.1 Source category description

There is only one tiles production plant in Latvia and CO_2 emissions from use of clay in tile production process in 1995-2011 are reported in this sector. The tiles production plant is participant of ETS so the data from plant's annual GHG reports is available for inventory.

Table 4.26 CO_2 emissions from tile production in 1995-2011 (Gg)

	Use of clay in tile production (Gg)
1995	0.163
1996	0.190
1997	0.235
1998	0.245
1999	0.217
2000	0.208
2001	0.325
2002	0.315
2003	0.382
2004	0.258
2005	0.135
2006	0.140
2007	0.179
2008	0.042
2009	0.229
2010	0.200
2011	0.279

Emissions are decreasing since 2003 with some fluctuation due to decrease of activity of tiles production plant. (Table 4.26) Still in 2009 the CO_2 emissions have increased approximately 4 times as the building and construction sector was again become active. In 2010 activity of tile production is decreased for about 12.66%. In 2011 activity of tile production is increased for about 39.50%.

4.2.8.2 Methodological issues

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 MRG.[43]

Amount of used clay in tiles production is taken from only tiles production plant in Latvia (Table 4.27).

Table 4.27 Activity data for tile production in 1995-2011 (Gg)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Use of clay in tiles production (Gg)	2.034	2.380	2.932	3.065	2.711	2.594	4.065	3.935	4.776	3.231	1.685	1.748	2.242	0.525	2.861	2.497	3.484

4.2.8.3 Uncertainties and time series consistency

The uncertainty of activity data for this sector is assumed as 2%. The activity data reported in production plant's annual GHG reports within 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 ETS 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 production are estimated. Other emissions are not estimated due to lack of official emission estimation methodology and emission factors.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level. There are no such issues.

4.2.8.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers.

Activity data, CO_2 emission factor and estimated emissions are taken from the annual GHG reports that steel production plant submit within EU ETS. 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. Regional Environmental Boards also checks the annual GHG reports and approves the report if everything reported is correct.

CO_2 emission factors are taken from MRG and are the default ones therefore there is no need to re-check correctness of emission factors.

Emissions are checked using time series consistency check for the IEF estimated in CRF Reported and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

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.

[43] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:LV:PDF, page 80

4.2.8.5 Source-specific recalculations

No recalculation has been done for the sector.

4.2.8.6 Source-specific planned improvements

No improvements are planned for this sector for nearest submissions.

4.3 CHEMICAL PRODUCTS (CRF 2.B)

4.3.1 Source category description

Although there are strong traditions of the chemical industry in Latvia there are nonchemical industry production processes listed in IPCC GPG 2000 or EMEP/EEA 2009 that generate GHG emissions.

The biggest part of chemical industry is medicine production and then small part of paints and varnishes production.

4.4 METAL PRODUCTS (CRF 2.C)

4.4.1 Source category description

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 IPCC GPG 2000 excluding scrap metal use in crude steel production. The indirect GHG emission sources are also included under iron and steel production.

Table 4.28 Emissions from 2.C Metal Production in 1990–2011 (Gg)

	CO_2	CH_4	NOx	CO	NMVOC	SO_2
1990	12.8288	0.0028	2.8050	0.0006	0.2475	0.0880
1991	8.7118	0.0019	1.9048	0.0004	0.1681	0.0598
1992	5.7341	0.0012	1.2538	0.0002	0.1106	0.0393
1993	7.0067	0.0015	1.5320	0.0003	0.1352	0.0481
1994	6.5524	0.0017	1.6930	0.0003	0.1494	0.0531
1995	4.4328	0.0014	1.4246	0.0003	0.1257	0.0447
1996	3.4851	0.0015	1.4952	0.0003	0.1319	0.0469
1997	7.9966	0.0023	2.3691	0.0005	0.2090	0.0743
1998	8.5019	0.0024	2.4013	0.0005	0.2119	0.0753
1999	7.7112	0.0024	2.4671	0.0005	0.2177	0.0774
2000	8.4261	0.0025	2.5515	0.0005	0.2251	0.0800
2001	8.0419	0.0025	2.5616	0.0005	0.2260	0.0804
2002	7.6017	0.0025	2.5867	0.0005	0.2282	0.0812
2003	12.1641	0.0027	2.7915	0.0005	0.2463	0.0876
2004	12.9158	0.0028	2.8406	0.0006	0.2506	0.0891
2005	12.3577	0.0028	2.8272	0.0006	0.2495	0.0887
2006	12.5729	0.0028	2.8282	0.0006	0.2495	0.0887
2007	14.5726	0.0028	2.8466	0.0006	0.2512	0.0893
2008	8.7324	0.0027	2.7054	0.0005	0.2387	0.0849
2009	9.5606	0.0022	2.2463	0.0004	0.1982	0.0705
2010	11.2779	0.0027	2.7300	0.0005	0.2408	0.0856
2011	0.4755	0.0008	0.8548	0.0002	0.0754	0.0268
Share of total 2011 emissions[53]	**0.004%**	**0.00%**	**0.007%**	**0.000%**	**0.001%**	**0.000%**

Biggest decrease occurred in time period 1990–1992 due to changes in Latvia's national economy (Table 4.28). Decrease of CO_2 emissions in 1990–1996 also occurred due to decrease of used crude iron in open-hear 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 emission 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 only metal industry facility fluctuates in small range in latest years. After going through a crisis in 2008-2009, there are increased all emissions from Metal production in 2010. In 2011 there are sharply decrease of emissions due to changing technology of metal production, so also decreased amount of mass of steel produced in electric arc furnaces (EAF) (about 75.11%) and mass of steel produced in OHF (about 68.67 %). This is due to reconstruction of steel production plant with aim in future to switch on EAF only.

4.4.2 Methodological issues

IPCC 1996, IPCC GPG 2000 Tier2 and EMEP/CORINAIR are used to calculate direct and indirect GHG emissions from the 2.C Metal Production sector. There is only one Iron & Steel production plant in Latvia that produces crude steel by melting crude iron not only by melting scrap metals. The plant is participant of 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 Guidelines[44] within ETS didn't correspond to production technology used in plant.

Calculation of all emissions from processes is done with Excel databases developed by experts from LEGMC. CRF Reporter software developed by experts from UNFCCC was used to report emission data.

<u>CO_2 emission estimations from crude steel production</u>

Methods

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:

$$\begin{aligned} Emissions_{crude\ steel} = {} & (\text{Mass of Carbon in the Crude Iron used for Crude Steel Production -} \\ & \text{Mass of Carbon in the Crude Steel}) \times 44/12 + \\ & \text{Emission factor}_{EAF} \times \text{Mass of Steel Produced in EAF} \end{aligned}$$

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, 2010, and 3% for 2008;

[44] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:EN:PDF

- Average carbon content of produced steel is 0.1 – 0.4% for 1990-2006, 0.3% for 2007-2008 and 0.2% for 2009, 2010.

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

Default emission factor – 1.5 kg carbon per tonne of steel is used because plant reported emission factor – 6 kg carbon per tonne of steel, is considered as unreliable high. For 2008 plant reported 18 kg per tonne of steel as also was assumed as incredibly high.

Activity data

For year 1990-2006 the used amount of raw materials in different types of production installations – open-heart furnaces and electric arc furnaces was known as CSB reported the data to LEGMC even though the data could be confidential. Total produced amount of crude steel was known without division into particular production installations. So it was necessary to divide amount of crude steel produced in open-heart furnaces and in electric arc furnaces. These amounts are estimated by using amount of raw materials used in open-heart 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-heart furnaces and in electric arc furnaces is divided from total produced crude steel.

For years 2007-2008 the total produced crude steel amount divided by used production technologies was reported by plant but the plant couldn't report the used raw materials 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 heart furnaces;
- 95.52% of total used crude iron were used in open heart 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 in what production crude iron was involved. It is estimated by using crude iron / scrap metal ratio since amounts of used scrap metal in open-heart furnaces and used crude iron in the same furnaces are known. Then this ratio number is multiplied with amount of steel produced in open-heart furnaces to estimate amount of crude steel produced directly from crude iron.

Coke 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 is reported in 1.A.2.a Iron & Steel sector of Energy sector.

Data for CO_2 emission estimations are given in

Table 4.29 below.

Table 4.29 Data for estimation of CO_2 emissions from steel production (tonnes)

	Crude steel production	% mass of steel produced in OHF	**Mass of steel produced in OHF**	Used scrap metal in open heart furnaces in steel production	Crude iron used in open heart furnaces	Crude iron/scrap metal ratio	% mass of steel produced in EAF	**Mass of steel produced in EAF**	**Amount of crude steel in what production crude iron where involved**	C content in crude iron	C content in crude steel	EF for EAF (t/t)	Conversion factor
1990	**550000**	98.74%	**543074.4**	537227	107732	20.05%	1.26%	**6925.57**	**108904.7**	3.5%	0.25%	0.0015	3.664
1991	**373492**	98.74%	**368789**	364818	73158	20.05%	1.26%	**4702.99**	**73954.6**	3.5%	0.25%	0.0015	3.664
1992	**245834**	98.74%	**242738.5**	240125	48153	20.05%	1.26%	**3095.53**	**48677.2**	3.5%	0.25%	0.0015	3.664
1993	**300393**	98.74%	**296610.5**	293417	58840	20.05%	1.26%	**3782.53**	**59480.4**	3.5%	0.25%	0.0015	3.664
1994	**331955**	98.86%	**328163.6**	317658	55116	17.35%	1.14%	**3791.42**	**56938.8**	3.5%	0.25%	0.0015	3.664
1995	**279326**	98.72%	**275747.1**	285015	37086	13.01%	1.28%	**3578.85**	**35880.1**	3.5%	0.25%	0.0015	3.664
1996	**293167**	98.90%	**289954.5**	307261	29099	9.47%	1.10%	**3212.48**	**27460.0**	3.5%	0.25%	0.0015	3.664
1997	**464529**	99.45%	**461977.5**	469205	67039	14.29%	0.55%	**2551.52**	**66006.3**	3.5%	0.25%	0.0015	3.664
1998	**470835**	99.48%	**468374.9**	470302	71341	15.17%	0.52%	**2460.06**	**71048.7**	3.5%	0.25%	0.0015	3.664
1999	**483744**	99.54%	**481521.4**	490912	64631	13.17%	0.46%	**2222.65**	**63394.7**	3.5%	0.25%	0.0015	3.664
2000	**500292**	99.23%	**496433.9**	503123	70637	14.04%	0.77%	**3858.06**	**69697.9**	3.5%	0.25%	0.0015	3.664
2001	**502277**	99.21%	**498295.8**	511026	67352	13.18%	0.79%	**3981.18**	**65674.2**	3.5%	0.25%	0.0015	3.664
2002	**507194**	99.19%	**503079.2**	520425	63620	12.22%	0.81%	**4114.77**	**61499.5**	3.5%	0.25%	0.0015	3.664
2003	**547346**	99.62%	**545264.6**	524232	102437	19.54%	0.38%	**2081.40**	**106546.9**	3.5%	0.25%	0.0015	3.664
2004	**556974**	98.92%	**550969.7**	527155	108762	20.63%	1.08%	**6004.27**	**113675.4**	3.5%	0.25%	0.0015	3.664
2005	**554345**	98.94%	**548472.4**	527950	104010	19.70%	1.06%	**5872.56**	**108053.1**	3.50%	0.25%	0.0015	3.664
2006	**554546**	98.90%	**548419.1**	531026	105769	19.92%	1.10%	**6126.89**	**109233.3**	3.50%	0.25%	0.0015	3.664
2007	**558156**	99.76%	**556814**	463940	109248	23.55%	0.24%	**1342.00**	**131117.8**	4.00%	0.30%	0.0015	3.664
2008	**530462**	99.34%	**526964**	492450	88319	17.93%	0.66%	**3498.00**	**94508.9**	3.00%	0.30%	0.018	3.664
2009	**440458**	99.90%	**440016**	413058	68784	16.65%	0.10%	**442.00**	**73272.7**	4.00%	0.20%	0.00644	3.664
2010	**535301**	99.79%	**534168**	476868	81340	17.06%	0.21%	**1133.00**	**91113.7**	4.00%	0.20%	0.00644	3.644
2011	**167624**	99.83%	**167342**	187103	3389	1.81%	0.17%	**282.00**	**3031.1**	4.00%	0.20%	0.00644	3.644

<u>CH_4 and indirect GHG emission estimations from crude steel production</u>

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/CORNAIR methodology and emission factors.

Emission factors

Emission factors of methane and indirect GHG emissions are taken from EMEP/EEA 2009 (Table 4.30).

Table 4.30 Emission factors of metal production (t/t)

	CH_4	NO_x	CO	NMVOC	SO_2
1. Iron and Steel Production					
Steel	0.000005	0.0051	0.000001	0.00045	0.00016

Emission factors for NO_x, NMVOC and SO_2 emissions are taken from EMEP/CORINAIR Guidelines according to methodology for estimations of emissions from processes in open-heart furnaces, where 95% of total steel production is produced.

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.

4.4.3 Uncertainties and time series consistency

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 CORINAIR methodologies is assigned as 10% so it is apposite for open-heart furnaces – technology mainly used in facility operated in iron and steel industry in Latvia.

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.

4.4.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from 2000 IPCC GPG. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers.

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 Reporter and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

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.

Plant specific CO_2 emission factors and Tier2 CO_2 emission estimation methodology

Tier2 methodology is used to estimate CO_2 emissions from steel production using plant specific data and Tier2 methodology from IPCC GPG.

All the activity data required in CO_2 emission estimation IPCC GPG is reported by steel production plant to LEGMC within National Inventory System. The plant confirms that the data is reliable and useful. The data then is compared to the CSB data.

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.

CO_2 emission is estimated according to IPCC GPG 2000 and the Tier2 methodology was verified by ERT during two in-country reviews in 2007 and 2009 and accepted as correct.

4.4.5 Source-specific recalculations

No recalculations were done in the sector since last submission.

4.4.6 Source-specific planned improvements

It is important to revise CO_2 emission estimations for the sector as plant specific parameters and values are used in emission estimation. There are involved external auditor for QA/QC as this is a key source category.

4.5 OTHER PRODUCTION (CRF 2.D)

4.5.1 Source category description

Other Production sub-sector includes indirect emissions from:

- Pulp and Paper production;
- Food and Drink production.

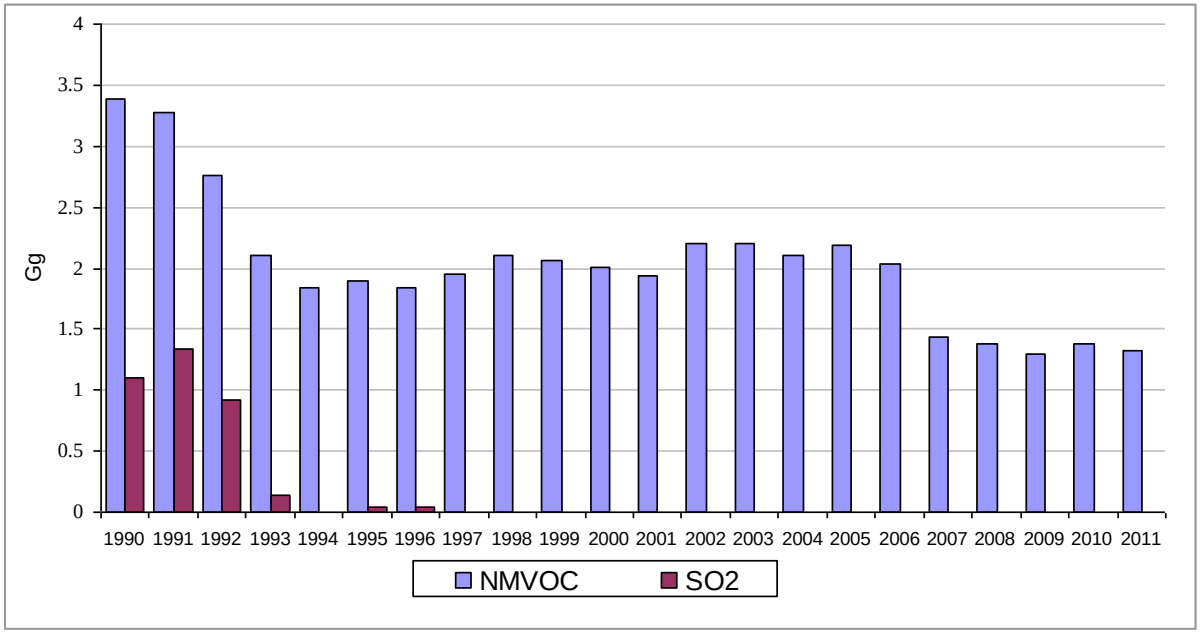


Figure 4.6 Total emissions from 2.D Other Production in 1990–2011 (Gg) [45]

Biggest fluctuations occurred in time period 1991–1993 due to changes in economical situation in country (Figure 4.6). Decrease of NMVOC emissions in time period 1999 – 2001 is explained with economical crisis in neighbourhood Russia with whom Latvia has stable economical relations. 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.

[45] SO_2 emissions on secondary axis

Since 2007 the total amount of food and drink production sector is decreasing that is explained with economical crisis in 2008-2009 as well as of purchasing capacity population and difference in prices of national production 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.

4.5.2 Methodological issues

Methods

Calculation of all emissions from processes is done with Excel databases developed by experts from LEGMC. CRF Reporter software developed by experts from UNFCCC was used to report emission data.

NMVOC emissions from the food and drink industry as well as SO_2 emissions from pulp and paper industry are calculated at the LEGMC. IPCC 1996 was used in estimations.

Emission factors

SO_2 emission factor 0.03 (t/t) is taken from IPCC 1996.

The NMVOC emission factors (Table 4.31) are taken from the IPCC 1996 with exception of NMVOC emission factor for spirits production. NMVOC emissions factor from EMEP/CORINAIR that corresponds to other spirits was used. Central Statistical Bureau 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 4.31 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

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 4.32). LEGMC has signed an agreement with CSB to get data of total production of products from sectors where data are confidential.

Still for the 2007-2011 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 last two years in time series.

Table 4.32 Activity data of 2.D Other Production sector

	1. Pulp and Paper	Wine	Beer	Spirits	Meat, fish, poultry	Sugar	Cakes, biscuits, breakfast cereals	Bread	Animal forage
	Gg	1000 hl	1000 hl	1000 hl	Gg	Gg	Gg	Gg	Gg
1990	36.6	19.9	87.4	324.5	569.3	31.0	54.8	314.0	200.0
1991	44.7	197.5	1295.3	330.0	490.4	35.0	39.2	293.0	200.0
1992	30.8	179.8	858.9	259.3	281.6	39.0	22.1	240.0	200.0
1993	4.7	87.7	545.9	217.4	154.0	26.0	15.8	177.4	245.4
1994	0.2	134.2	637.9	314.8	95.6	15.8	22.7	161.5	174.0

	1. Pulp and Paper	Wine	Beer	Spirits	Meat, fish, poultry	Sugar	Cakes, biscuits, breakfast cereals	Bread	Animal forage
	Gg	1000 hl	1000 hl	1000 hl	Gg	Gg	Gg	Gg	Gg
1995	1.5	159.2	652.8	341.5	82.8	29.3	24.4	145.4	214.4
1996	1.5	154.7	644.9	379.6	100.5	31.2	13.1	137.1	206.2
1997	NO	114.7	714.8	456.4	129.1	41.2	16.9	132.1	205.0
1998	NO	99.6	721.0	417.4	110.9	64.9	18.1	124.8	203.3
1999	NO	C	953.2	C	166.9	C	20.8	121.5	144.5
2000	NO	C	945.1	C	197.3	C	24.3	121.1	173.8
2001	NO	C	996.6	C	244.6	C	24.4	123.1	184.9
2002	NO	C	1199.2	C	262.9	C	29.0	122.6	201.3
2003	NO	C	1336.6	C	264.4	C	37.3	124.0	201.4
2004	NO	C	1313.1	C	262.5	C	43.6	119.3	211.8
2005	NO	C	1293.3	C	243.8	C	53.6	116.3	248.6
2006	NO	C	1383.0	C	288.4	C	45.0	107.3	244.2
2007	NO	C	1414.3	C	286.0	NO	46.5	102.3	336.8
2008	NO	C	1333.8	C	297.7	NO	38.5	100.7	307.3
2009	NO	C	1292.4	C	253.5	NO	33.3	95.9	299.3
2010	NO	C	1484.9	C	252.7	NO	38.0	90.0	409.8
2011	NO	C	1626.6	C	261.5	NO	39.7	88.6	360.9

4.5.3 Uncertainties and time series consistency

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 for wine production. SO_2 and NMVOC emission factors were assigned as 50% because default emission factors taken from the 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.

4.5.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers.

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 that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

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.

4.5.5 Source-specific recalculations

No recalculations were done in the sector since last submission.

4.5.6 Source-specific improvement

No improvements are planned for this sector for nearest submissions.

4.6 CONSUMPTION OF HALOCARBONS AND SF6 (CRF 2.F)

4.6.1 Source category description

Latvia has ratified *Convention for the Protection of the Ozone Layer* (Vienna, 1985) and it's *Protocol on Substances Depleting the Ozone Layer* (Montreal, 1987). These documents are aimed to take out the circulation of completely halogenated alkanes (CFC-11, CFC-12, CFC-113, and CFC-114), partly halogenated alkanes (CFC-22, CFC-21) and halons, and to substitute them with alternative substances like hydrofluorocarbons (HFC), perfluorocarbons (PFC) and sulphur hexafluoride (SF_6).

In the framework of the project first time in Latvia the pilot inventory of HFC, PFC and SF_6 emissions was carried out covering data for period from 1995 – 2003.[46] The identification of areas and users of HFC, PFC and SF_6 gases in Latvia was carried out; further, the sources of emissions (in accordance with IPCC methodology) and availability of activity and consumption data were assessed. Within the project questionnaires were sent to 120 enterprises operate with F – gases and response were extremely low about 28%. So experts from LEGMC had to find other ways to collect necessary data.

According to (EC) No 842/2006 Regulation of the European Parliament and of the Council on certain fluorinated greenhouse gases Latvia has accepted Regulations of ozone depleting substances and fluorinated greenhouse gases that are freezing agents with whom producers, importers, exporters and operators need to report their activities with the F–gases for previous year till next year 1st February. Starting submission 2007 these data are available for LEGMC to estimate actual emissions of F–gases. For submission 2011 more than 350 operators reported data of their operation with F-gases.

The calculation of emissions was carried out for F–gases, namely: SF_6, HFC–23, HFC–32, HFC–125, HFC–134a, HFC–143a, HFC–152 and HFC–227ea. The most used gas is HFC-134a (used in mobile air conditioners).

The emissions of F-gases are linearly increasing since 1995 – 0.64 (CO_2 eq. Gg) in 1995 to 96.54 (CO_2 eq. Gg) in 2011 (Table 4.33, Figure 4.7).

Table 4.33 Total emissions of HFCs in 1990–2011 (Gg CO_2 eq)

	2.F	2.F.1:	2.IIA.F.1.1	2.IIA.F.1.2	2.IIA.F.1.3	2.IIA.F.1.6	2.F.2	2.F.3	2.F.4	2.F.9
1995	0.641	0.277	0.0628	-	0.0150	0.0150	-	-	-	0.3640
1996	0.837	0.451	0.0871	-	0.0036	0.2278	-	-	-	0.3852
1997	1.928	1.522	0.0993	-	0.0075	1.0037	-	-	-	0.4066
1998	2.861	2.248	0.1116	0.0168	0.0270	1.3581	-	-	0.156	0.4564
1999	3.276	2.435	0.1364	0.0402	0.0181	1.5700	-	-	0.6331	0.2086
2000	5.120	3.289	0.1612	0.0572	0.0152	2.2843	-	-	1.124	0.7076
2001	7.589	4.601	0.1891	0.1322	0.0450	3.1611	-	0.0353	1.5751	1.3776
2002	9.866	6.190	0.2293	0.1889	0.0420	4.2775	-	0.0353	1.8483	1.7926
2003	15.722	8.452	0.2908	0.2560	0.0644	5.7462	3.2712	0.0882	1.7533	2.1578
2004	18.098	11.967	0.3603	0.3533	0.0707	8.1296	1.3537	0.1786	1.7357	2.8628
2005	28.391	17.379	0.4317	0.4094	0.1099	12.3118	5.6846	0.1150	1.9378	3.2739

[46] Project report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003", Riga 2004

2006	62.641	32.402	0.5122	2.5662	0.0697	18.1900	24.2162	0.1790	2.1704	3.6736
2007	98.657	49.550	0.5804	2.1453	NO	25.6088	41.8769	0.1108	2.5155	4.6038
2008	72.960	63.095	0.6433	3.5477	NO	29.9121	1.6516	0.1813	2.7099	5.3069
2009	74.485	66.711	0.6824	5.0364	NO	30.7130	0.0092	0.2517	2.548	4.9496
2010	72.315	62.992	0.7254	3.8615	NO	28.4680	0.8505	0.3222	2.4708	5.6796
2011	82.973	74.275	0.7706	1.4222	NO	31.1456	0.6458	0.3927	2.4621	5.1981

As it can be seen in Figure 4.7 all F-gases emissions have increasing tendency with exception of Transport Refrigeration (2.IIA.F.1.3) and Fire Extinguishers (2.F.3) sectors where emission decrease could be explained with inaccurate statistical data, closing of enterprises and changes of substances used in equipment. Many enterprises have changed their equipment filled with these HFCs gases to other equipment filled with more environment friendly gases and use them in their existing equipment. Also new technologies that are imported in Latvia already are filled with different gases but HFCs. Increase of F-gases emissions is explained mainly with improvement of data collection system when biggest part of F-gases consumers reported their operations with F-gases within national legislation rules. There are no emissions from halocarbons and SF_6 from metal production / Production of halocarbons and SF_6 in Latvia.

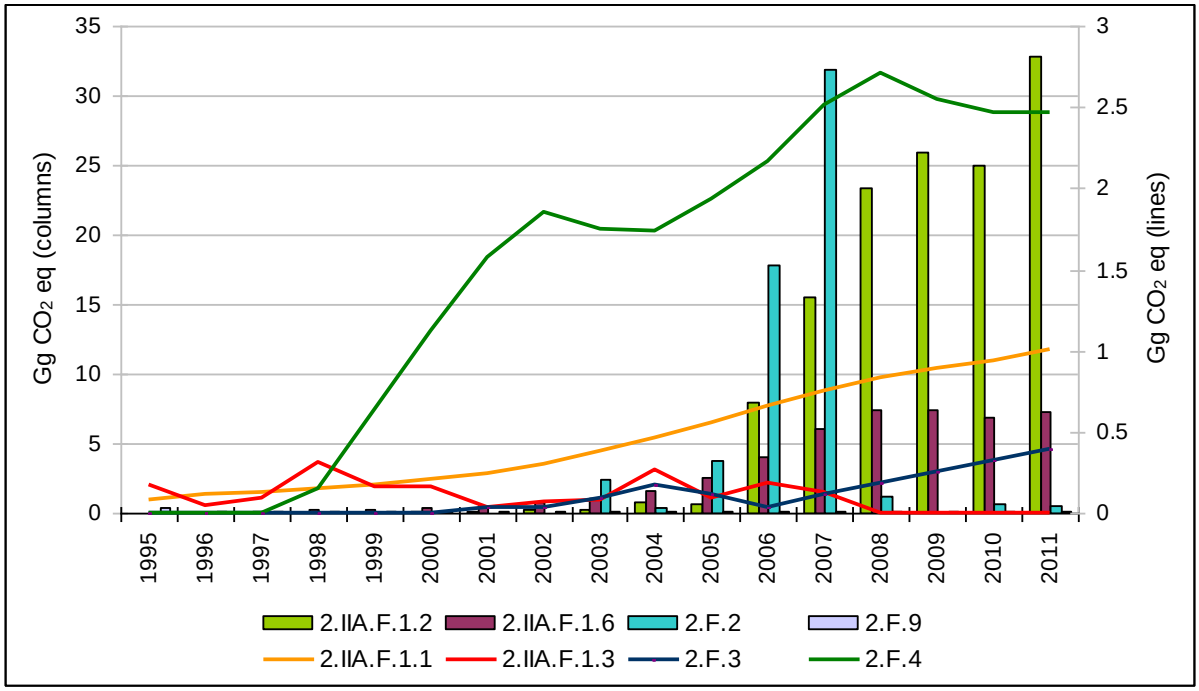


Figure 4.7 HFCs emissions from 2.F Consumption of Halocarbons and SF6 sector in 1990–2011 (Gg CO_2 eq)[47]

Still as it can be predictable the emissions that are generated in construction sector or are related to population well being are decreasing for example foam blowing (2.F.2) emissions where the highest point of the emissions were in 2007 (31.84Gg). After that emissions have decreased very sharply (0.65 Gg in 2010) because the foams are not almost imported in country and it is assumed that the foams previously imported and held in stocks are used. Also emissions from metered dose inhalers are decreasing that is also explained with the decrease of population purchase power as well as decrease of total population number. The emissions are increasing in domestic (2.IIA.F.1.1), commercial (2.IIA.F.1.2) and mobile air conditions (2.IIA.F.1.6) sectors. In 2011, there are increasing of overall HFC emissions due to growing of activity data used for sector 2.F. Consumption of Halocarbons and SF_6.

4.6.2 Methodological issues

The calculation of actual emissions is done in accordance with IPCC methodology.

[47] sectors 2.IIA.F.1.1, 2.IIA.F.1.3, 2.F.3 and 2.F.4 on the secondary axis

Data used in estimations of actual F-gases emissions and estimated emissions are reported in Annex III Relevant background information – Industrial Processes Sector.

4.6.1.1 Domestic Refrigeration (CRF 2.F.1.1)

HFC-134a emissions from domestic refrigerators and freezers are estimated by using IPCC 1996 and default emission factors. The basic data for HFC-134a emission estimation from domestic refrigerators and freezers are:

1. amount of inhabitants in Latvia – obtained by CSB[48];
2. amount of households in Latvia – for 1995 and 2001 data was taken from CSB report[49,50], data for 1996-2000 were extrapolated, for 2002-2011 data were taken from CSB database[51];
3. percentage amount of households using refrigerators and freezers – for 1996, 2001, 2006 and 2010-2011 data were taken from CSB that obtained data with questionnaires of households made every five years[52];
4. percentage amount of refrigerators and freezers charged with HFC-134a were determined by experts during report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003".

As percentage amount of the domestic refrigerating equipment containing HFC-134a obtained during the preparation of the report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003" is know only for 1999-2003, data for historical years prior this time period was extrapolated. Data for 2004-2008 was calculated assuming the average increase of 4%, due to improvement of wellbeing of population and the requirements of European Union. It is assumed that the percentage of the refrigerators containing HFC-134a is increasing as previously used CFC and HCFC is now prohibited since Latvia has undertook the obligations of the European Union in 2004. In 2009-2010 the increase of percentage amount of domestic refrigerators containing HFC-134a is assumed lower – 3%.

4.6.1.1.1 <u>HFC-134a from charging of domestic refrigerators and freezers</u>

There are no manufacturing companies in Latvia and all domestic refrigerators and freezers are imported.

Activity data for emission estimation from recharging of domestic refrigerators and freezers are amount of freezing equipments used in households that contain HFC-134a.

According to responses on the questionnaires submitted to report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003" average amount of HFC-134a used in charging of domestic freezing equipments is 176.25g and charging is made once in lifetime (15 years) – average after 7.5 years. That gives approximate annual amount of HFC-134a charged that is estimated with equation:

$$\boxed{HFC_{charged,t} = R \times n/f}$$

where:
$HFC_{charged}$ – amount of HFC-134a charged in year t (tonnes);

[48] http://data.csb.gov.lv/dialog/varval.asp?ma=IS0020&ti=ISG02%2E+PAST%C2V%CEGO+IEDZ%CEVOT%C2JU+SKAITS+P%C7C+DZIMUMA+UN+DZ%CEVESVIETAS+GADA+S%C2KUM%C2&path=../Database/Iedzsoc/Ikgad%E7jie%20statistikas%20dati/Iedz%EEvot%E2ji/&search=IEDZ%CEVOT%C2JU+SKAITS&lang=16

[49] Consumption in Energy resources in households in 1996, Riga 1998

[50] Consumption in Energy resources in households in 2001, Riga 2003

[51] http://data.csb.gov.lv/Dialog/varval.asp?ma=MA0161&ti=MA161%2E+M%C2JOK%CFU+SKAITS+STATISTISKAJOS+RE%CCIONOS%2C+REPUBLIKAS+PILS%C7T%C2S+UN+NOVADOS+GADA+BEIG%C2S&path=../DATABASE/Iedzsoc/Ikgad%E7jie%20statistikas%20dati/M%E2jok%EFi/&lang=16

[52] http://data.csb.gov.lv/Dialog/varval.asp?ma=0201&ti=epm2%2E1%2E+M%E2jok%EFu+skaits%2C+kuros+izmanto+elektroier%EEces%2C+un+elektroier%EE%E8u+vid%E7jais+vecums+&path=../DATABASE/vide/Energoresursu%20pat%E7ri%F2%F0%20m%E2jsaimniec%EEb%E2s/&lang=16

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

After the in country review in 12th – 17th October 2009 it was suggested to use average lifetime 15 years just for early years in time period but for last years use shorter lifetime period. So it was assumed to use 15 years lifetime factor for years 1995-2000 but for time period 2001-2011 lifetime factor used in emission estimation is assumed as 10 years. So for years 2001-2011 charging was assumed as made average after 5 years.

It is assumed that 2% of HFC-134a used in charging is emitted during charging process.[53]

Equation from IPCC 1996 for charging emissions estimation:

$$E_{charged} = HFC_{charged} \times k$$

where:
$E_{charged}$ – amount of emissions from charging of domestic refrigerators and freezers (t)
$HFC_{charged}$ – amount of HFC-134a charged in year t (tonnes);
k – charging losses (%)

4.6.1.1.2 HFC-134a from stocks of domestic refrigerators and freezers

Amount of HFC-134a in stocks is estimated by using the data mainly obtained from CSB. Approximate amount of HFC-134a stored in domestic refrigerators and freezers was estimated based on CSB data.

According to IPCC 1996 average percentage of losses during operation is 1% of the total quantity banked in the stock.[54]

Equation from IPCC 1996 for stocks emissions estimation:

$$E_{operation} = E_{stocks} \times x$$

where:
$E_{operation}$ – amount of emissions during equipment operation (t)
E_{stocks} – amount of HFC-134a held in stocks in year t (tonnes);
x – losses during operation period (%)

4.6.1.1.3 HFC-134a from disposal of domestic refrigerators and freezers

Emissions from disposal have to be estimated for time period 1995-2004. Separate expert assumptions were made to estimate the emissions from disposal. For years 1995-2000 percentage amount of HFC-134a were assumed as 80% from HFC-134a charged in previous years but for time period 2000-2004 the percentage losses were assumed lower as 60% as basic regulations of electric equipment that ruled the collection, recovery or export of disposed equipments were adopted.

Equation from IPCC 1996 for disposal emissions estimation:

$$E_{disposal} = E_{charged(t-n)} \times Q$$

where:
$E_{disposal}$ – amount of emissions from system disposal (t)
$E_{charged\ (t-n)}$ – amount of HFCs charged into domestic refrigerators and freezers in year (t-n) (t)
Q – losses after the equipment disposal (%)

Still the activity data for emission estimation is impossible to obtain as the data of HFC-134a charged in new equipment in time period 1980-1992 is needed. It isn't possible to obtain this data as basic statistical information for activity data estimation is necessary. Still according to research made for report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003" the

[53] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) Industrial Processes, p.2.56
[54] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) Industrial Processes, p.2.55

percentage of all freezing domestic equipments in 1995 is quite low as 5%. So for years 1980-1992 the percentage amount is assumed as low as 0-1%. As well as amount of freezing equipments in households is assumed as rather low in this time period. So it was assumed that disposal emissions for time period 1995-2004 is negligible and notation key "NA" for these years for disposal emissions is used.

Regulation of Cabinet of Ministers No 923 "Regulations Regarding the Management of Electrical and Electronic Equipment Waste" was adopted in 9th September 2004 according to what "merchants shall collect waste electric and electronic equipment separately and it shall be transported so that reuse and recycling of the entire electric and electronic equipment or components existing therein was promoted".[55] Also according to the previous mentioned regulations merchants have to remove separately all environment dangerous substances from electric and electronic equipment that includes chlorofluorocarbons (cryofluorane, CFC), hydrochlorofluorocarbons (HCFC) or hydrofluorocarbons (HFC), hydrocarbons (HC) and deliver them to particular treatment facilities. According to these regulations it is assumed that there are no disposal emissions from domestic and commercial refrigerators and freezers since 2005. The main aspect of choosing "0" emissions from disposal is that collected electric and electronic equipment is not disposed in Latvia. All the equipment is collected and transported to other countries for recycling or disposing. So the notation key "NO" is used for domestic refrigeration sector emissions for 2005-2011.

4.6.1.2 Commercial and Industrial Refrigeration (CRF 2.F.1.2, CRF 2.F.1.4)

According to "Regulations of ozone depleting substances and fluorinated greenhouse gases that are freezing agents" little less than 360 operators reported data of their operation with f-gases for submission 2013 for year 2011. For historical years data were obtained with questionnaire done within "SF_6, HFC and PFC emission inventory in Latvia 1995-2003". For 2004-2005 activity data were obtained from enterprises that responded on data request letters sent by LEGMC. For 2006-2011 data were obtained from reporting within previously mentioned new regulation act.

IPCC 1996 was used to estimate emissions from commercial freezing equipment.

4.6.1.2.1 F-gases from charging of commercial and industrial refrigeration

There are no manufacturing companies in Latvia and all refrigerators and freezers are imported.

Activity data of amount of F-gases and blends containing F-gases are obtained from operators.

Average 3.5% of HFC-134a used in charging is emitted during charging process according to IPCC 1996.[56] For time period 2006-2011 average 1.5% of HFC-134a charged into refrigerators is assumed as emitted into air. "Regulations of ozone depleting substances and fluorinated greenhouse gases that are freezing agents" was adopted in the second part of 2005 as is regulating the activities with F-gases and set out limitations for these activities. So it is assumed that more accurate operations with F-gases are taken.

Equation from IPCC 1996 for charging emissions estimation:

$$E_{charged} = HFC_{charged} \times k$$

where:
$E_{charged}$ – amount of emissions from charging of commercial and industrial refrigerators (t)
$HFC_{charged}$ – amount of F-gases charged in commercial and industrial refrigerators in year t (tonnes);
k – charging losses (%)

[55] http://www.likumi.lv/doc.php?id=96434&from=off
[56] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) Industrial Processes, p.2.53

4.6.1.2.2 F-gases from stocks of commercial and industrial refrigeration

Activity data of amount of F-gases and blends containing F-gases are obtained from operators.

According to IPCC 1996 average percentage of losses during operation is 17% (vary for different references)[57] but it was assumed average 15% losses for commercial refrigerators used in Latvia as stand-alone commercial applications are used in commercial refrigerating sector. This percentage is used for time period 1998-2005.

For time period 2006-2011 average 8% of HFC-134a stored in stocks is assumed as emitted into air. "Regulations of ozone depleting substances and fluorinated greenhouse gases that are freezing agents" was adopted in the second part of 2005 as is regulating the activities with F-gases and set out limitations for these activities. So it is assumed that more accurate operations with F-gases are taken.

Equation from IPCC 1996 for stocks emissions estimation:

$$E_{operation} = E_{stocks} \times x$$

where:
$E_{operation}$ – amount of emissions during equipment operation (t)
E_{stocks} – amount of F-gases held in stocks in year t (tonnes);
x – losses during operation period (%)

4.6.1.2.3 F-gases from disposal of commercial and industrial refrigeration

Emissions from disposal have to be estimated for time period 1995-2004. Separate expert assumptions were made to estimate the emissions from disposal. For years 1995-2000 percentage amount of HFC-134a were assumed as 80% from HFC-134a charged in previous years but for time period 2000-2004 the percentage losses were assumed lower as 60% as basic regulations of electric equipment that ruled the collection, recovery or export of disposed equipments were adopted.

Average lifetime of commercial and industrial refrigerating equipment is taken from IPCC 1996 and is 15 years[58] for early years in reporting period 1995-2000 (n in following equation). For years 2001-2005 it is assumed that average lifetime for commercial and industrial refrigerators is 10 years.

That gives emission factor of disposal emissions – 5.3% for time period 1995-2000 and 6% for time period 2001-2005.

Equation from IPCC 1996 for disposal emissions estimation:

$$E_{disposal} = E_{charged} \times Q$$

where:
$E_{disposal}$ – amount of emissions from system disposal (t)
$E_{charged}$ – amount of F-gases charged in commercial and industrial refrigerators in year (t-n) (t)
Q – losses after the equipment disposal (%)

According to Regulation of Cabinet of Ministers No 923 "Regulations Regarding the Management of Electrical and Electronic Equipment Waste" the F-gases remained in electronic and electric equipment have to be collected and transferred to waste treatment facilities for liquidation or to waste processors for regeneration.

Since 2005 the amount of recycled, regenerated and destroyed is known for time period 2006-2010. These amounts are very small. As the collected amounts of F-gases have to be collected

[57] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) Industrial Processes, p.2.56
[58] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) Industrial Processes, p.2.56

before the disposal of the refrigeration equipment and the collection has to be done according to rules without any possible leakage, it is assumed that the emissions from collection of the amount of F-gases destroyed or recycled after that are not occurring.

According to previously mentioned it is assumed that there are no disposal emissions from domestic and commercial refrigerators and freezers since 2005. So the notation key "NO" is used for domestic refrigeration sector emissions for 2005-2011.

4.6.1.3 Transport Refrigeration (CRF 2.F.1.3)

During the preparation of the report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003" transport enterprises and auto services were questioned. According to the responses only negligible amount of HFCs is used in railways and water transport. Small amount of HFC-23 is filled into ships refrigerating equipments. Reported HFC-134a and HFC-125 is filled into mobile refrigerators used in road transport.

According to "Regulations of ozone depleting substances and fluorinated greenhouse gases that are freezing agents" F-gases operators that charge and own the mobile refrigerating equipment have to report the amount of used F-gases. These operators use F-gases as freezing agents.

4.6.1.3.1 F-gases from charging of transport refrigeration

For historical years 1995-2006 it is almost impossible to obtain necessary data of F-gases used for charging to mobile refrigerators as enterprises don't have particular accounting and mainly enterprises serve not only mobile refrigerators but also stationary refrigeration equipment and stationary and mobile air conditioning equipment. So these enterprises have only total charged amount of HFCs. And also enterprises that own mobile refrigerators don't service their equipment. Till year 2006 there weren't any rules that enterprises that operate with f-gases have to report used amounts.

For years 2007-2011 it is very difficult or almost impossible to exclude the amount charged in transport refrigeration equipment from amount reported by F-gases operators within national regulation as charged in freezing and conditioning equipment because operators haven't such aggregated accounting

So the amount of F-gases charged in transport refrigeration and emissions from charging are reported under 2.F.1.2 Commercial Refrigeration sector and the notation key "IE" is used for reporting in CRF Reporter.

Equation from IPCC 1996 for charging emissions estimation:

$$\boxed{E_{charged} = HFC_{charged} \times k}$$

where:
$E_{charged}$ – amount of emissions from charging of commercial and industrial refrigerators (t)
$HFC_{charged}$ – amount of F-gases charged in transport refrigerators in year t (tonnes);
k – charging losses (%)

4.6.1.3.2 F-gases from stocks of transport refrigeration

For historical years 1995-2006 the amount of F-gases held in stocks in transport refrigeration equipment is estimated by using the information of road transport and ships refrigeration equipment reported by enterprises within preparation of report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003". Enterprises reported the amount of transport refrigerators they own, type of F-gases filled in it and amount of refrigerators used.

The amount of F-gases in mobile refrigeration equipment (stocks) for 2007-2010 is reported by enterprises within national legislation. Operators don't have to report their NACE code and

it's very difficult to exclude the enterprises operating as freight carriers from whole list of enterprises reporting their activities with F-gases. The amount of F-gases transport refrigeration and emissions from stocks are reported under 2.F.1.2 Commercial Refrigeration sector and the notation key "IE" is used for reporting in CRF Reporter.

Equation from IPCC 1996 for stocks emissions estimation:

$$E_{operation} = E_{stocks} \times x$$

where:
$E_{operation}$ – amount of emissions during equipment operation (t)
E_{stocks} – amount of F-gases held in stocks in year t (tonnes);
x – losses during operation period (%)

Average emission factor for stocks emissions is 15% for time period 1995-2005, since 2006 8% leakage factor is used because of adopting "Regulations of ozone depleting substances and fluorinated greenhouse gases that are freezing agents"

4.6.1.3.3 F-gases from disposal of transport refrigeration

Emissions from disposal have to be estimated for time period 1995-2004. Separate expert assumptions were made to estimate the emissions from disposal. For years 1995-2000 percentage amount of HFC-134a were assumed as 80% from HFC-134a charged in previous years but for time period 2000-2004 the percentage losses were assumed lower as 60% as basic regulations of electric equipment that ruled the collection, recovery or export of disposed equipments were adopted.

Equation from IPCC 1996 for disposal emissions estimation:

$$E_{disposal} = E_{charged} \times Q$$

where:
$E_{disposal}$ – amount of emissions from system disposal (t)
$E_{charged}$ – amount of F-gases charged in transport refrigerators in year (t-n) (t)
Q – losses after the equipment disposal (%)

According to Regulation of Cabinet of Ministers No 923 "Regulations Regarding the Management of Electrical and Electronic Equipment Waste" the F-gases remained in electronic and electric equipment have to be collected and transferred to waste treatment facilities for liquidation or to waste processors for regeneration.

According to these regulations it is assumed that there are no disposal emissions from domestic and commercial refrigerators and freezers since 2005. So the notation key "NO" is used for domestic refrigeration sector emissions for 2005-2011.

4.6.1.4 Mobile and Stationary Air Conditioning (CRF 2.F.1.5, CRF 2.F.1.6)

According to "Regulations of ozone depleting substances and fluorinated greenhouse gases that are freezing agents" also F-gases operators that charge the mobile and also own stationary air conditioning equipment have to report the amount of used and stored F-gases. These operators use F-gases as conditioning agents.

IPCC 1996 was used to estimate emissions from stationary and mobile air conditioners.

4.6.1.4.1 HFC-134a from charging of mobile and stationary air conditioning

For historical years 1995-2006 it is almost impossible to obtain precise data of F-gases used for charging of stationary or mobile air conditioners as enterprises don't have particular accounting as most enterprises serve refrigerating and conditioning equipment altogether. So these enterprises have only total charged amount of HFCs. Until year 2006 there weren't any rules that enterprises that operate with F-gases have to report used amounts.

For years 2007-2010 it is very difficult or almost impossible to exclude the amount charged in stationary and mobile air conditioning equipment from amount reported by F-gases operators within national regulation as charged in freezing and conditioning equipment because operators haven't such aggregated accounting.

So the amount of F-gases charged in stationary and mobile air conditioners and emissions from charging are reported under 2.F.1.2 Commercial Refrigeration sector and the notation key "IE" is used for reporting in CRF Reporter.

Equation from IPCC 1996 for charging emissions estimation:

$$E_{charged} = HFC_{charged} \times k$$

where:
$E_{charged}$ – amount of emissions from charging of mobile and stationary air conditioners (t)
$HFC_{charged}$ – amount of F-gases charged in year t (tonnes);
k – charging losses (%)

4.6.1.4.2 HFC-134a from stocks of stationary and mobile air conditioning

The amount of F-gases in stationary air conditioning equipment (stocks) is reported by enterprises within national legislation. Operators don't have to report the equipment type where F-gases are stored and it's very difficult to exclude the enterprises reporting F-gases filled in their stationary air conditioning equipment from total F-gases reported as stocks of enterprise

HFC-134a emissions from mobile air conditioning are estimated by using IPCC 1996 and default percentage amounts. The basic data for HFC-134a emission estimation from mobile air conditioners:

1. amount of passenger cars and trucks manufactured after 1995 – obtained by Road Traffic Safety Directorate and reported by CSB[59];
2. percentage of cars filled with HFCs – taken from report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003";

Percentage of cars filled with HFCs according to project report is 20% for passenger cars and 50% for trucks. This percentage is used for time period 1995-2000.

The fleet age is constantly improving when in 2002 only 2.13% of the total registered in country passenger cars manufacturing year were higher than year 2000, in 2005 this percentage was 5.99%m but in year 2008 21.64% of total registered passenger cars is younger than year 2000 (manufacturing year). For year 2009 22.51% of the total registered passenger cars have manufacturing year higher than year 2000 and 11% have manufacturing year higher than 2005.

According to this aspect it can be assumed that in year 2000 the percentage of passenger cars equipped with MACs filled with F-gases is higher than 20% and it percentage has to increase year by year. The expert judgement is – starting year 2000 the percentage of passenger cars with manufacturing year higher than 1995 equipped with F-gases filled MACs are constantly increasing and reaches 55% in year 2011. The same percentage increase has to be applied for trucks when percentage of trucks equipped with MACs increase from 50% in 2000 to 67.5% in 2011.

According to IPCC 1996 average percentage of losses during operation lifetime is 15% of the total quantity banked in the stock.[60]

Equation from IPCC 1996 for stocks emissions:

[59] http://data.csb.gov.lv/DATABASE/transp/Ikgadējie%20statistikas%20dati/Transports/Transports.asp
[60] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) Industrial Processes, p.2.57

$$E_{operation} = E_{stocks} \times x$$

where:
$E_{operation}$ – amount of emissions during equipment operation (t);
E_{stocks} – amount of F-gases held in stocks in year t (tonnes);
x – losses during operation period (%)

4.6.1.4.3 HFC-134a from disposal of stationary and mobile air conditioning

For emissions estimation according IPCC 1996 amount of F-gases charged in particular historical years is needed. It means that data for amount of F-gases charged in the eighties and nineties is needed. It is impossible to obtain data of these years.

During the project for the "SF_6, HFC and PFC emission inventory in Latvia 1995-2003" it was assumed that approximate 8% of total MACs is disposed every year. Average lifetime factor for MACs is 12 years.[61] According to assumption it is possible to estimate amount of F-gases remained in MACs after the disposal) every year by multiplying amount of MACs disposed with the approximate amount of F-gases remained in one amount. It is assumed that approximate 75% of F-gases filled in MACs is remained after the lifetime of MACs.

$$HFC_{remained} = MAC_{total} \times m \times HFC_{fill} \times r$$

where:
$HFC_{remained}$ – amount of F-gases remained in MACs after their lifetime in year (t)
MAC_{total} – total amount of MACs in passenger cars and trucks (pieces)
M – amount of MACs disposed (%)
HFC_{fill} – amount of F-gases filled in one MAC of passenger car or truck
R – amount of F-gases remained in one MAC (%)

It is assumed that 90% of F-gases remained in MACs after their lifetime is emitted as there is no national regulation that set out rules that F-gases from mobile air conditioning equipments from cars have to be treated in particular manner. The 90% range is default one taken from IPCC 1996 Chapter 2, page 2.56. It is assumed that the remaining 10% is left captured in the equipment. According to suggestions of ERT during in-country review in 2009 the 100% leakage at the disposal is unreal.

Equation from IPCC 1996 for disposal emissions:

$$E_{disposal} = HFC_{remained} \times Q$$

where:
$E_{disposal}$ – amount of emissions from system disposal (t)
$HFC_{remained}$ – amount of F-gases remained in MACs after their lifetime in year
Q – losses after the equipment disposal (%)

4.6.1.5 Potential Emissions from Refrigeration and Air Conditioning equipment

Data for potential HFCs emission from refrigerants and air conditioning equipment estimation was taken from LEGMC Chemical Substances Registry where all enterprises operating with any chemical substances have to report the amount of imported, produced and exported chemical substances according to "Chemical Substances and Chemical Preparations Law".[62]

Potential annual consumption of particular f-gas was estimated by following equation:

$$HFC_{potencial} = \sum HFC_{produced} + \sum HFC_{imported} + \sum HFC_{exported} + \sum HFC_{destruction}$$

[61] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref3.pdf (p.2.57)
[62] http://www.ttc.lv/export/sites/default/docs/LRTA/Likumi/Chemical_Substances_and_Chemical_Products_Law.doc

where:
$HFC_{potential}$ – amount of consumption of particular f-gas in year (t)
$HFC_{produced}$ – amount of produced particular F-gas in year (t)
$HFC_{imported}$ – amount of imported particular F-gas in year (t)
$HFC_{exporteded}$ – amount of exported particular F-gas in year (t)
$HFC_{destructed}$ – amount of destructed particular F-gas in year (t)

According to information from Chemical Substances Registry no F-gases are produced in Latvia or exported from Latvia that's why only imported data is used in emission estimation. Due to this potential annual consumption of particular F-gas was estimated by following equation:

$$HFC_{potential} = \sum HFC_{imported}$$

where:
$HFC_{potential}$ – amount of consumption of particular F-gas in year (t)
$HFC_{imported}$ – amount of imported particular F-gas in year (t)

According to information from the enterprises the F-gases are imported in bulk and in products. Only HFC-134a is reported as imported in bulk. Other F-gases are reported as imported in products.

The potential F-gases emissions from freezing and conditioning equipment is estimated by taking into account only the HFCs imported in products as it is not know where HFC-134a imported in bulk is used and when.

It is assumed that up to 100% of total imported in products HFC-134a potentially could be emitted in air in particular year.

The following equation is used to estimate potential emissions from refrigerating and conditioning equipment:

$$E_{PHFC} = HFC_{products}$$

where:
E_{PHFC} – potential F-gases emissions from refrigerating and conditioning equipment in year (t)
$HFC_{products}$ – amount of total HFCs imported in products in year (t)

4.6.1.6 Foam Blowing (CRF 2.F.2)

Although the activity of building sector in last years radically increased emissions were not estimated due to lack of activity data of imported and in-country used building foams or foams used in windows manufacturing and lack of data of containing F-gases.

Data of imported foams divided by particular foam type is known from Chemicals Register where all companies operating with products containing chemicals have to report their import/export and production amounts. No export and production data is reported to Register therefore only import amount is known. So only emissions from use of foams and disposal emissions after foam was been used – emissions from products left in foam packaging, containers etc.

Therefore only the potential emissions can be estimated for foam blowing as the emissions are based on import/export data (as for potential emissions estimations). Still taking into account the strong recommendations by ERT during centralized review 2010 these data was used to estimate actual emissions from foam use. The ERT requested to report potential emissions as actual emissions still this approach is very inappropriate as for potential emissions estimation it is assumed that 100% of HFCs stored in products is emitted. Still for actual emission estimation particular emission factors have to be used to estimate how much of HFCs stored in products are emitted during use / application.

4.6.1.6.1 HFCs emissions from processing of foams

The imported amount in Latvia is obtained from Chemicals Register where companies that import products containing specific chemicals have to report their data.

Although it can be assumed that not all foams imported in country in particular year are used in the same year the import data is used to estimate actual emissions as actual use or products sold data is not available.

According to data reported to Chemicals Register average percentage of HFC-134a and HFC-152 in mostly used types of foam is known. According to this information averagely 13% of HFC-134a and 10.5% of HFC-152 is stored in foams imported in country. So the data of particular HFCs in imported products can be estimated:

$$HFC = p \times AD_{foams}$$

where:
HFC – amount of particular HFC in total imported amount of foams (t)
p – percentage content of particular HFC in imported foams (%)
AD_{foams} – amount of imported foams (t)

According to IPCC 1996 the total quantity of HFC contained in the existing stock of insulating foam can be calculated as the product of the total quantity of insulating foam in use in year t and the average charge of chemical contained in each tonne of such installed insulating foam.[63]

Default emission factors from IPCC 1996 – 10% production lost, is used to estimate the emissions from foam use in particular year.[64]

Therefore the particular HFC emissions are estimated summing amount of each HFC in imported product (estimated using percentage amount of particular HFC in imported product) multiplied by default emission factor of use loss – 10%:

$$EM_{HFCs} = \sum HFC \times 10\%$$

where:
EM_{HFCs} – emissions of HFCs during application process (t)
HFC – amount of particular HFC in total imported amount of foams (t)
10% - default percentage amount of losses during application

For decommissioning losses estimation the manufacturing and/or processing of foams data in historical years have to be obtained. The product lifetime of foam is 20 years. Therefore it is necessary to obtain the data of the years prior 1989. 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 for foams use are assumed as not applicable.

4.6.1.6.2 Potential emissions from foam blowing

It is assumed that 100% of the amount of particular HFC in imported foams is used in the same year so 100% leakage factor is used for potential F-gases emissions estimation.

The following equation is used to estimate potential F-gases emissions from foam blowing:

$$E_{PHFC} = HFC_{products}$$

where:
E_{PHFC} – potential F-gases emissions from foam blowing in year (t)
$HFC_{products}$ – amount of total HFCs imported in products in year (t)

[63] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref3.pdf (page 2.59)
[64] http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch2ref3.pdf (page 2.59)

4.6.1.7 Fire extinguishers (CRF 2.F.3)

It is very difficult to estimate F-gases emissions from fire extinguishing because 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.

It is necessary to know at least percentage of total registered fire extinguishing equipment that is filled with F-gases.

4.6.1.7.1 HFC-227ea from charging of fire extinguishing equipment

During the project preparation for the report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003" it was found that there is no manufacturing of fire extinguishers containing F-gases. 19 enterprises were questioned including only manufacturer of fire extinguishers. According to responses fire extinguishers filled with F-gases are used in quite small amount. Only 2 enterprises reported the amount of HFC-227ea in installed equipment in particular year and amount of HFC-227ea held in stocks (containers) of fire extinguishing equipments. 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.

4.6.1.7.2 HFC-227ea from stocks of fire extinguishing equipment

Amount of F-gases in annually installed equipment and amount held in containers is used as activity data for emission estimation from stocks. It is assumed that 5% from total stocks is emitted during equipment operations annually according to IPCC GPG 2000.[65]

For 2007-2010 emission estimation data of year 2006 was used as no response was received on sent questionnaires

The equation for portable fire extinguishing equipment from IPCC 1996:

$$E_{stocks} = HFC_{charged} \times x$$

where:
E_{stocks} – Emissions of F-gases from fire extinguishing equipment (t)
$HFC_{charged}$ – amount of F-gases filled in equipment (t)
x – losses during operation period (%)

4.6.1.7.3 HFC-227ea from disposal of fire extinguishing equipment

In year 2006 one enterprise reported the amount of HFC-227ea disposed. It is assumed that only 5% is emitted from the disposal as in 2006 new national regulation for the operation with F-gases and for the dangerous waste treatment was adopted.

Equation from IPCC 1996 for disposal emissions:

$$E_{disposal} = HFC_{disposed} \times Q$$

where:
$E_{disposal}$ – amount of emissions from system disposal (t)
$HFC_{disposed}$ – amount of F-gases collected and disposed (t)
Q – losses during the collection of F-gases (%)

4.6.1.7.4 Potential HFC-227ea from fire extinguish equipment

Potential HFC-227ea emissions from fire extinguishing equipment was estimated taking into account actual emissions from fire extinguishing equipment and assuming 5% leakage factor for containers filled with HFC-227ea (x in following equation).

[65] http://www.ipcc-nggip.iges.or.jp/public/gp/english/3_Industry.pdf, p.3.117

Equation for potential HFC-227ea emission from fire extinguishing equipment estimation:

$$P_{EHFC} = E_{stocks} + HFC_{containers} \times x$$

where:
P_{EHFCs} – total potential emissions of HFC-227ea from fire extinguishing equipment (t)
E_{stocks} – Emissions of F-gases from fire extinguishing equipment (t)
$HFC_{containers}$ – amount of F-gases held in containers (t)
x – losses during operation period (%)

4.6.1.8 Emissions from Metered Dose Inhalers (CRF 2.F.4)

During the project within preparation of the report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003" 4 Latvia's enterprise producing household and professional cleaning agents and disinfectants were questioned. The enterprises stated that in the aerosols production F-gases are not used in Latvia. It means that all aerosols used in Latvia are imported. As it is stated in IPCC GPG 2000 it is very difficult to collect the data of imported aerosols as it is necessary to divide HFCs containing aerosols from others.[66] It is almost impossible to question all household and industrial aerosols importers in Latvia. Central Custom Service only register 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.

So only the aerosols used in medicine for asthmatics are estimated and reported under this sector. During the project for the preparation of the report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003" amount of inhalers contained HFC–134a were clarified 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.

For year 1998-2006 data of imported inhalers reported by importers of medical preparations was used as activity data. For years 2007-2010 data of imported inhalers obtained by State Agency of Medicine of Latvia was used. All importers of the medical preparations have to report the imported and sold amount of medicines so these data are very precise.

It is possible to estimate total amount of HFC-134a used in Latvia in particular year as metered dose inhaler if imported amount of inhalers containing HFC-134a is known as well as average amount of HFC-134a filled in each type of inhalers is known.

Equation for total amount HFC-134a used as medical preparation:

$$HFC_{sold} = \sum MDI_{sold} \times HFC_{filled}$$

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 IPCC 1996 50% leakage from metered dose inhalers sold in particular year and 50% from inhalers sold in year before particular year is assumed.[67]

Equation from IPCC 1996 for metered dose inhalers emissions:

$$E_{HFCs} = HFC_{sold} \times x_t + HFC_{sold} \times x_{t-1}$$

where:
E_{HFCs} – total emissions of HFC-134a from metered dose inhalers (t)
HFC_{sold} – total amount of HFC sold/imported in country (t)
x_t – leakage from inhaler in year t (%)
x_{t-1} – leakage from inhaler in year t-1 (%)

[66] http://www.ipcc-nggip.iges.or.jp/public/gp/english/3_Industry.pdf, p.3.87
[67] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) Industrial Processes, p.2.61

4.6.1.8.1 Potential HFC-134a emissions from metered dose inhalers

Potential emissions of metered dose inhalers use was estimated from the amount of HFCs imported to Latvia in particular year within inhalers.

It is assumed that 100% HFC-134a filled in inhalers imported in country in particular year is emitted to air.

Equation from IPCC 1996 for metered dose inhalers emissions:

$$P_{EHFCs} = HFC_{sold}$$

where:
P_{EHFCs} – total potential emissions of HFC-134a from metered dose inhalers (t)
HFC_{sold} – total amount of HFC sold/imported in country (t)

4.6.1.9 SF_6 emission from electrical equipment (CRF 2.F.8)

There is only one enterprise where huge amount of SF_6 is used in commutation and control installations. Installations are not produced in Latvia and the old equipment without any fill of the SF_6 was dismantled at the beginning of nineties. Only starting 1992 new equipment was gradually installed. Since 1992, it consumes small amount of SF_6 in electrical equipment, but since 1995 used amount is increasing.

4.6.1.9.1 SF_6 emissions from charging of electrical equipment

Enterprise only imports equipment already filled with SF_6. There is no manufacturing of the electric equipment containing SF_6 within country.

The amount of SF_6 in newly installed equipment is used as activity data for emission estimation and 2% leakage factor from IPCC GPG 2000 for operations was used.[68]

Equation from IPCC 1996 for charging emissions estimation:

$$E_{charged} = HFC_{charged} \times k$$

where:
$E_{charged}$ – amount of emissions from installation of electrical equipment (t)
$HFC_{charged}$ – amount of F-gases charged in particular year (t);
k – charging losses (%).

4.6.1.9.2 SF_6 emissions from stocks of electrical equipment

According to IPCC GPG 2000 2% leakage factor for operations was used.[69]

Equation from IPCC GPG 2000 for stocks emissions:

$$E_{stocks} = HFC_{stocks} \times x$$

where:
E_{stocks} – emissions of SF_6 from electrical equipment (t)
HFC_{stocks} – amount of SF_6 held in stocks in equipment (t)
x – losses during operation period (%)

4.6.1.9.3 SF_6 from disposal of electrical equipment

Lifetime of used equipment is 30 years and there is no equipment that lifetime would be approached. So no equipment was dismantled.

Still for years 2003-2011 enterprise report the emergency leakage from electrical equipment. As amount of SF_6 emergency leaked is known it is reported as 100% emissions and is reported as disposal emissions.

[68] http://www.ipcc-nggip.iges.or.jp/public/gp/english/3_Industry.pdf, p.3.57
[69] http://www.ipcc-nggip.iges.or.jp/public/gp/english/3_Industry.pdf, p.3.57

4.6.1.9.4 Potential SF6 emissions from electrical equipment

The potential SF_6 emissions from electrical equipment is estimated by taking into account actual emissions from charging and stocks and assuming 5% leakage factor for containers filled with SF_6 and held as reserve (x in following equation).

Equation for potential SF_6 emissions from electrical equipment estimation:

$$P_{E_{HFC}} = E_{charged} + E_{stocks} + HFC_{containers} + E_{emergency} \times x$$

where:
P_{EHFCs} – total potential emissions of HFC-227ea from electrical equipment (t)
$E_{charged}$ – amount of emissions from installation of electrical equipment (t)
E_{stocks} – emissions of SF_6 from electrical equipment (t)
$E_{emergency}$ – emergency leakage from electrical equipment (t)
$HFC_{containers}$ – amount of SF_6 held in containers (t)
x – losses from containers during operation period (%)

4.6.1.10 Emissions from shoes production (CRF 2.F.9)

Other source of HFC-134a emissions is production and use of shoes whose soles are filled with HFC-134a. Manufacturing of shoes (shoe soles) containing HFC-134a occurred in 1995-2002. After 2002 only HFC-134a emissions from stocks and disposal is emitted.

Activity data for emission estimation is taken from CSB databases about produced imported and exported amount of shoes.

Assumptions and default leakage factors from Danish project "The Greenhouse gases: HFCs, PFCs and SF6" since no researches of f-gases use in Latvia is done. [70]

4.6.1.10.1 HFC-134a emissions from manufacturing of shoes containing f-gases

The manufacturing of shoe soles containing HFC-134a occurred in Latvia in 1995-2002. The amount of produced shoes (shoe sole) is obtained by CSB. According to Danish project it is 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 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 (%)

[70] http://www2.mst.dk/common/Udgivramme/Frame.asp?http://www2.mst.dk/udgiv/publications/2009/978-87-7052-962-4/html/bred01_eng.htm

4.6.1.10.2 HFC-134a emissions from stocks in shoes containing F-gases

In whole period 1995-2010 amount of imported shoes in Latvia is increasing.

The amount of imported and exported as well as produced shoes (shoe sole) is obtained by CSB. According to Danish project it is 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:

$$E_{stocks} = HFC_{stocks} \times x$$

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 (%)

4.6.1.10.3 HFC-134a emissions from disposal of shoes containing F-gases

According to Danish project average lifetime of shoes is 3 years. It means that form HFC-134a emission estimation the amount of HFC-134a remained in shoe soles after their lifetime in year^{-3} has to no 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 (%)

4.6.1.10.4 Potential HFC-134a emissions from shoes containing F-gases

Potential emission from HFC-134a held in stocks – amount produced in country and imported within shoe soles, was estimated by taking into account assumption that 100% from amount of HFC-134a remained in shoe soles after the lifetime of shoes (Q in following equation).

As well as it was assumed annual 5% leakage from HFC-134a held as stocks in shoes soles during operation of the shoes (x in following equation)

$$E_{PHFC} = E_{production} + HFC_{stocks} \times x + HFC_{remained} \times Q$$

where:
E_{PHFC} – potential HFC-134a emissions from shoes (shoes soles) (t)
$E_{production}$ – HFC-134a emissions from shoe manufacturing (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 (%)
$HFC_{remained}$ – total amount of HFC-134a remained in shoes after their lifetime in year^{-3} (t)
Q – leakage from disposal (%)

4.6.3 Uncertainties and time series consistency

Activity data for HFCs is obtained from reports of enterprises operated with F-gases therefore it is assumed that uncertainty could arise to 75%. Also uncertainty of emission factors for HFCs is assumed as 75%.

More precise is SF_6 use data in electrical equipment category – one facility used this gas and reported it to LEGMC. Estimation of emissions also is quite precise. Uncertainty of activity data for SF_6 from electrical equipment is assumed as ±2%, but EF uncertainty is 10%.

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.

HFCs and SF_6 emissions in 1990-1994 are reported as "not estimated" due to lack of official statistical data. Particular HFCs emissions are not estimated for other years also due to lack of activity data.

4.6.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers.

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 Reporter and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

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.

4.6.5 Source-specific recalculations

In the sector 2.F.(a).3.- Fire extinguishers Latvia reports the same emission estimates for the entire time period 2007-2011 based on data from 2006. Furthermore, the emission estimate includes only emissions from stocks. Following by TERT recommendation assumed that the market situation for HFCs used in fire extinguishers might have changed, Latvia accepts to make data interpolation for years 2007-2011 in order to improve the accuracy of the estimates and avoid potential underestimation of emissions. Data for 2007-2011 was calculated assuming the average increase/decrease amount of HFC-227ae installed in fire extinguishers per year. There are calculated that activity data from years 2003-2006 increase/ decrease averagely about 0.486 tonnes per year.

In the sector 2.IIA.F.1.6 – Mobile Air-Conditioning by suggestions of ERT during centralized review in 2012 there are made recalculations for all time series with 100% leakage

at the disposal instead 90% that was assumed previously and with 40% amount of f-gases remained in one MAC after the disposal instead of 75% that was assumed previously.

According to previously mentioned changes data of whole sector 2.F wasrecalculated.

4.6.6 Source-specific planned improvements

It is necessary to implement Tier2 QA/QC procedures for the sector as HFCs and SF_6 emissions are key source category. Emission estimation for the sector is also done using default emission estimation methodology of IPCC 1996 and IPCC GPG 2000 but Tier2 level is needed for key source categories. So it is necessary to revise the estimates and improve emission estimation methodology for the sector.

4.7 POTENTIAL EMISSIONS OF HALOCARBONS AND SF_6 (CRF 2.F)

4.7.1 Source category description

Potential emissions are calculated only for 2004–2010 due to lack of historical statistical information regarding import and export of F– gases (Figure 4.8). Data for estimations are obtained from Division of Chemicals Registry of LEGMC where enterprises have to report data of F – gases with whom enterprises operated in current year.

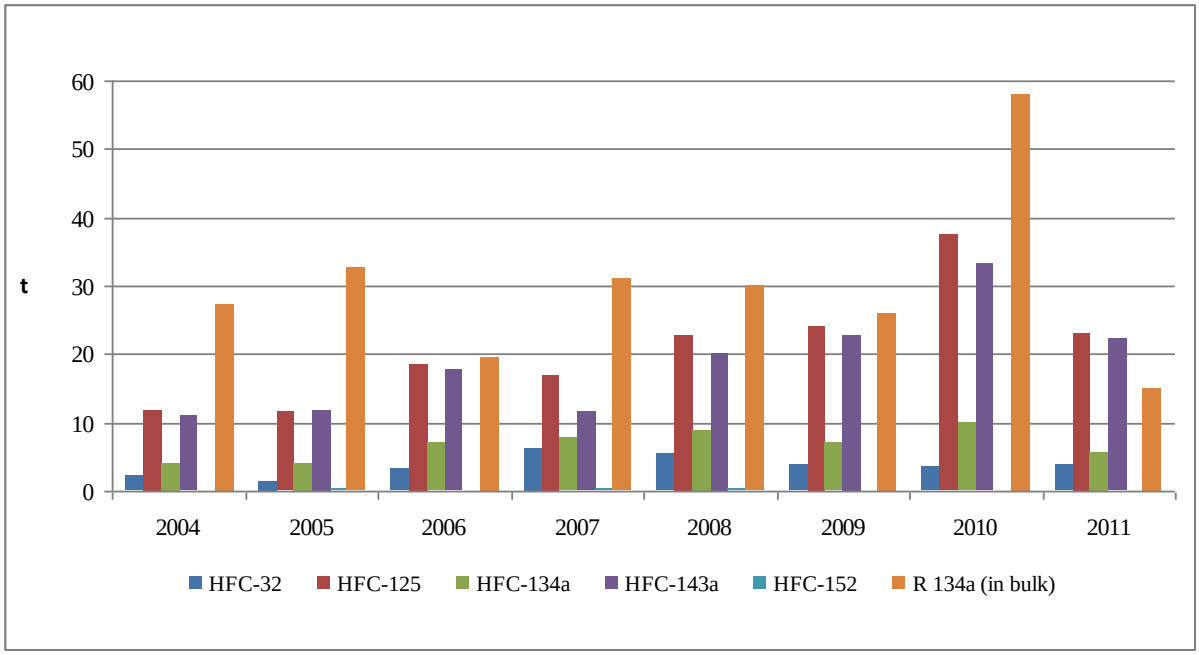


Figure 4.8 Total potential emissions of f-gases in 2004–2011 (t)

4.7.2 Methodological issues

Methods

It was assumed that 100% of F-gases imported in products and in bulk in current year could emit in air, so imported amount of gas is potential emissions of that gas.

Activity data

The activity data used in emission estimation is taken from Chemicals Register. The activity data is made confidential therefore it is not possible to report the import data in NIR.

The amount of HFCs in imported products is estimated taking into account product content data reported by importers. According to percentage amount (Table 4.34) of chemicals in imported freezing substances amount of chemicals were estimated and reported as potential emissions.

Table 4.34 Percentage amounts of chemicals in imported products 2004–2011 (%)

Chemicals, products	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea
R 410a	50%	50%				
R 407c	23%	25%	52%			
R 404a		44%	4%	52%		
R 507		50%		50%		
R 134a			100%			
SUVA MP 39, SUVA HP 80, SUVA HP 81					13%	
Tecfoam SP-27-B5/365/245						100%
DBS 9802 PUR B1			6.25%			
FIXER MEGAPRO			13%			
FIXER			13%			
DBS 9802 PUR B1			6.25%			
FIXER MEGAPRO			13%			
FIXER			13%			
FIXER			10.5%			
FIXER			10.5%			
R 417a		46.6%	50%			

4.7.3 Uncertainties and time series consistency

Activity data for this sub-sector were obtained from one source and used data were very inaccurate so uncertainties could arise to 100%.

Potential HFCs emissions are not estimated for time period 1990-2004 due to lack of official statistical data. Also potential SF_6 emissions are not estimated for all years also due to lack of imported SF_6 data.

4.7.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000. Latvia's national inventory QA/QC plan is ruled in national legislation and approved by Cabinet of Ministers.

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.

4.7.5 Source-specific recalculations

No recalculations were done in the sector since last submission.

4.7.6 Source-specific planned improvements

Within the EEA Financial Mechanism 2009-2014 Programme "National Climate Policy " it is planned to ensure detailed quality control procedures for quality assurance of Industrial process sector.

CHAPTER 5: SOLVENT AND OTHER PRODUCT USE (CRF 3)

5.1 OVERVIEW OF SECTOR

5.1.1 Quantitative overview

This sector contains CO_2, N_2O and NMVOC emissions from sectors (Table 5.1):

- Paint Application (CRF 3.A);
- Degreasing and dry cleaning (CRF 3.B);
- Chemical Products, Manufacture and Processing (CRF 3.C);
- Other (CRF 3.D):
  - Use of N_2O for Anaesthesia (CRF 3.D.1);
  - Printing (CRF 3.D.5.1)
  - Domestic solvent use including fungicides (CRF 3.D.5.2)
  - Other product use (CRF 3.D.5.3)

Emissions from Fire Extinguishers (3.D.2), N_2O emissions from Aerosol Cans (3.D.3) and Other Use of N_2O (3.D.4) are not estimated due to unavailability of statistical data.

Table 5.1 Reported emissions from Solvents and other product use in Latvia in 2011

Source	Emissions		
	CO_2	N_2O	NMVOC
Paint Application (CRF 3.A)	√		√
Degreasing and Dry Cleaning (CRF 3.B)	√	NO	√
Chemical Products, Manufacture and Processing (CRF 3.C)	√		√
Other (CRF 3.D)			
Use of N_2O for Anaesthesia (CRF 3.D.1)		√	
Fire Extinguishers (CRF 3.D.2)		NE	
N_2O from Aerosol Cans (CRF 3.D.3)		NE	
Other Use of N_2O (CRF 3.D.4)		NE	
Printing (CRF 3.D.5/3.D.1)	√	NO	√
Domestic Solvent Use (CRF 3.D.5/3.D.2)	√	NO	√
Other Product Use (CRF 3.D.5/3.D.3)	√	NO	√

5.1.2 Description

Solvent and Other Product Use sector GHG emissions contribute only about 0.4% of the total GHG emissions in Latvia (Table 5.2).

Table 5.2 Emissions from Solvent and Other Product use in 1990–2011 (Gg)

	CO_2	3.A Paint Application	3.B Degreasing and Dry Cleaning	3.C Chemical Products, Manufacture and Processing	3.D.5/3.D.1 Printing	3.D.5/3.D.2 Domestic Solvent Use	3.D.5/3.D.3 Other Product Use	N_2O	3.D.1 Use of N_2O for Anaesthesia	NMVOC	3.A Paint Aplication	3.B Degreasing and Dry Cleaning	3.C Chemical Products, Manufacture and Processing	3.D.5/3.D.1 Printing	3.D.5/3.D.3 Other Product Use	3.D.5/3.D.3 Other Product Use
1990	50.70	23.23	7.08	NE	5.41	14.98	NE	NE	NE	16.25	7.45	2.27	NE	1.73	4.80	NE
1991	46.49	19.13	7.05	NE	5.39	14.93	NE	NE	NE	14.90	6.13	2.26	NE	1.73	4.78	NE
1992	44.20	16.99	7.01	NE	5.36	14.84	NE	NE	NE	14.17	5.45	2.25	NE	1.72	4.76	NE
1993	41.35	14.73	6.85	NE	5.24	14.52	NE	NE	NE	13.25	4.72	2.20	NE	1.68	4.65	NE
1994	40.51	14.36	6.74	NE	5.15	14.26	NE	NE	NE	12.98	4.60	2.16	NE	1.65	4.57	NE
1995	36.96	11.23	6.63	NE	5.07	14.04	NE	0.01	0.01	11.85	3.60	2,12	NE	1.62	4.50	NE
1996	38.53	13.12	6.55	NE	5.01	13.86	NE	0.02	0.02	12.35	4.21	2.10	NE	1.60	4.44	NE
1997	39.12	13.81	6.48	0.16	4.96	13.72	NE	0.02	0.02	12.54	4.43	2.08	0.05	1.59	4.40	NE
1998	40.00	14.98	6.42	0.11	4.91	13.59	NE	0.01	0.01	12.82	4.80	2.06	0.04	1.57	4.35	NE
1999	40.76	16.01	6.36	0.06	4.86	13.46	NE	0.01	0.01	13.06	5.13	2.04	0.02	1.56	4.32	NE

	CO_2	3.A Paint Application	3.B Degreasing and Dry Cleaning	3.C Chemical Products, Manufacture and Processing	3.D.5/3.D.1 Printing	3.D.5/3.D.2 Domestic Solvent Use	3.D.5/3.D.3 Other Product Use	N_2O	3.D.1 Use of N_2O for Anaesthesia	NMVOC	3.A Paint Aplication	3.B Degreasing and Dry Cleaning	3.C Chemical Products, Manufacture and Processing	3.D.5/3.D.1 Printing	3.D.5/3.D.3 Other Product Use	3.D.5/3.D.3 Other Product Use
2000	41.62	17.01	6.30	0.15	4.82	13.34	NE	0.01	0.01	13.34	5.45	2.02	0.05	1.54	4.28	NE
2001	42.46	17.96	6.27	0.16	4.79	13.28	NE	0.03	0.03	13.61	5.76	2.01	0.05	1.54	4.26	NE
2002	30.54	2.76	6.22	0.02	4.76	2.12	14.67	0.02	0.02	10.19	0.94	1.99	0.01	1.52	0.72	5.00
2003	23.45	3.65	0.03	0.09	0.00	3.86	15.82	0.02	0.02	8.00	1.24	0.01	0.03	0.00	1.32	5.40
2004	29.68	5.89	0.09	0.03	0,00	6.15	17.51	0.02	0.02	10.13	2.01	0.03	0.01	0.00	2.10	5.97
2005	32.59	5.85	0.03	0.16	0.02	7.70	18.84	0.01	0.01	11.12	1.99	0.01	0.05	0.01	2.63	6.43
2006	43.38	8.97	0.03	0.38	0.04	13.28	20.67	0.04	0.04	14.80	3.06	0.01	0.13	0.01	4.53	7.05
2007	59.22	11.49	0.37	2.05	0.07	20.64	24.60	0.01	0.01	20.20	3.92	0.13	0.70	0.02	7.04	8.39
2008	39.28	7.02	0.23	1.31	0.04	16.17	14.52	0.01	0.01	13.40	2.39	0.08	0.45	0.01	5.52	4.95
2009	22.52	4.58	0.16	0.90	0.03	5.11	11.73	0.01	0.01	7.68	1.56	0.05	0.31	0.01	1.74	4.00
2010	40.60	12.72	0.01	1.25	0.32	8.24	18.05	0.02	0.02	13.85	4.34	0.00	0.43	0.11	2.81	6.16
2011	36.35	8.47	0.02	1.69	0.04	7.59	18.55	0.02	0.02	12.40	2.89	0.01	0.58	0.01	2.59	6.33

Emissions in the Solvent and Other Product Use sector are linked with the economic situation of the country. Decrease in emissions occurred between 1990 and 1995, when industry was going through a crisis (Figure 5.1).

It has to be noted that in the beginning of 90ties during the country wide change in government system and national economy statistics was not well kept. Therefore there is lack of statistical data.

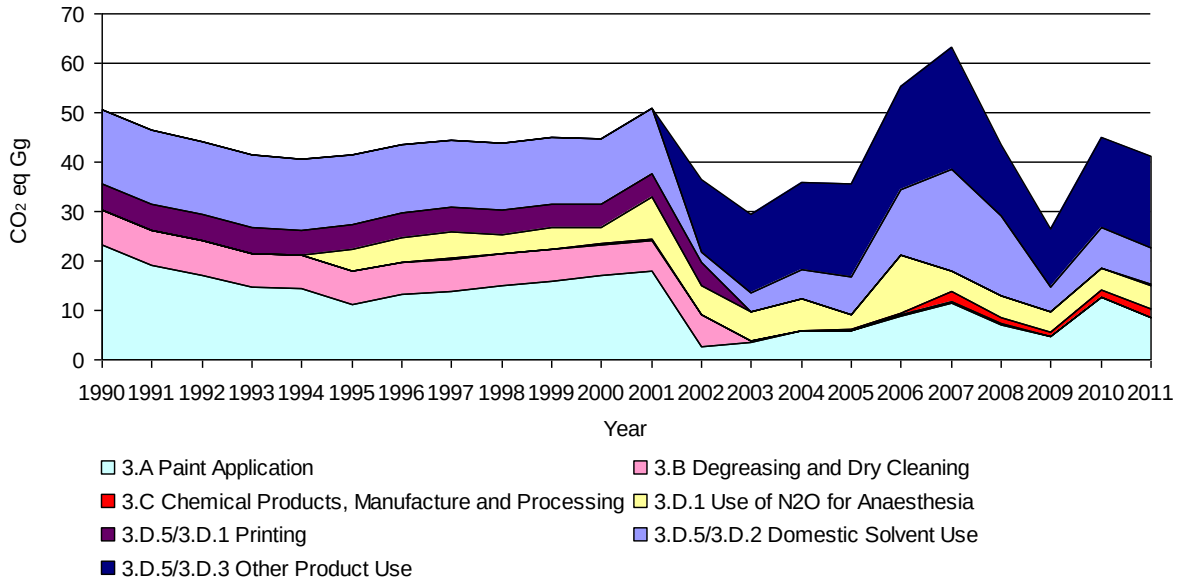


Figure 5.1 Emission from Solvent and Other Product Use in 1990-2011, CO_2 eq Gg

Still the data is quite incomparable for 1990-2001 (or 2002 for some sectors) mostly Tier1 default methodology is used when the number of population is used as activity data and the default EMEP/CORINAIR 2007 emission factors are used. Only after 2002 (or 2003) the most accurate statistics are being collected as Chemicals Register was established. In the Chemicals Register all companies operating with chemicals have to report their data of imported and produced amounts. From the Chemicals Register the produced and imported amounts of products containing NMVOCs are obtained together with the percentage of particular NMVOC in produced or imported product.

The NMVOC emissions from chemical products production process for 2002-2011 are obtained from national database "2-AIR" from paint, perfumery, pharmacy and other chemicals producers have reported their emissions. For 2002-2011 the NMVOC emissions from chemical products use – mostly foams, are also obtained from Chemical Register and

reported in 3.C sector. For 1997-2001 the NMVOC emissions from pharmaceutical formulations and perfumery products are reported.

In 2003-2011 the emissions have increasing tendency. This increase is explained with better statistical information.

Solvent and Other Product Use generates 17.7% from total Latvia's NMVOC emissions in 2011.

Key categories

There are no key categories in the sector.

5.2 PAINT APPLICATION (CRF 3.A)

5.2.1 Source category description

CO_2 and NMVOC emissions are estimated for the sector.

Paint application is the second biggest category of Solvent and Other Products Use sector with 23.3% of total this sector's CO_2 emissions.

The NMVOC emissions from production of paints, solvents, thinners, primers, hardeners, lacquers are reported under sector CRF 3.C according to EMEP/EEA 2009.

NMVOC emissions from 3.A Paint Application sector are decreasing since 2007 due to economical crisis and the aspects that lead to brake-down of national economy, but in 2010 emissions increased by 2.78 Gg compare with 2009. Since 2011 the emissions have decreased by 33.41%.

Table 5.3 Emission from Paint Application use in 1990-2011 (Gg)

	CO_2	NMVOC
1990	23.23	7.45
1991	19.13	6.13
1992	16.99	5.45
1993	14.73	4.72
1994	14.36	4.6
1995	11.23	3.6
1996	13.12	4.21
1997	13.81	4.43
1998	14.98	4.8
1999	16.01	5.13
2000	17.01	5.45
2001	17.96	5.76
2002	2.76	0.94
2003	3.65	1.24
2004	5.89	2.01
2005	8.85	1.99
2006	8.97	3.06
2007	11.49	3.92
2008	7.02	2.39
2009	4.58	1.56
2010	12.72	4.34
2011	8.47	2.89

5.2.2 Methodological issues

Methods

The IPCC 1996 allows using two basic approaches for emission estimation depending on the available activity data and emission factors: Production-based approach and Consumption-based approach. According EMEP/CORINAIR 2007 emissions can occur during production, during actual use and during disposal.

For years 1990-2001 the emissions are calculated basing on the data of paint use in country when data are obtained during the research of national expert. The methodology is assumed as Tier1 as not the actual (true) data is used for emission calculation. National expert determined during his research possible national NMVOC emission factors for water-based and for solvent-based paints.

NMVOC emissions are estimated using simpler default methodology:

$$E_{NMVOC} = AD_{paint} \times EF_{NMVOC}$$

where:
E_{NMVOC} – NMVOC emissions (Gg)
AD_{paint} – paint application consumption divided in water-based and solvent-based consumption (Gg)
EF_{NMVOC} – water-based or solvent-based paint's NMVOC emission factor (Gg/Gg)

For CO_2 emissions calculation the NMVOC emissions are taken as activity data and emissions were calculated using default carbon content conversion factor. The estimation is based on EMEP/CORINAIR 2007 methodology, the following equation being applied:

$$E_{CO_2} = 0.85 \times (44/12) \times NMVOC$$

where:
E_{CO2} – CO_2 emissions (Gg)
0.85 – carbon content conversion factor
NMVOC – NMVOC emissions (Gg)

For years 2002-2011 the data from Chemical Register of imported amounts of paint applications, solvents, thinners and other products reported in EMEP/EEA 2009 for sector 3.A are used for emission calculation. The NMVOC emissions are calculated basing of the percentage amount of NMVOC content in particular NMVOC containing products. The percentage content is used as emission factor.

It is assumed that the products imported in country in particular year are used in the same year as the actual use data is not available or is confidential.

It is assumed that 100% of all NMVOCs contained in products that are used in country in particular year are emitted during application process.

$$E_{NMVOC} = \sum (AD_{PA} \times p_{NMVOC})$$

where:
E_{NMVOC} – NMVOC emissions (Gg)
AD_{PA} – paint and other paint application products containing NMVOCs consumption (Gg)
p_{NMVOC} – percentage amount of particular NMVOC in NMVOC containing products (Gg/Gg)

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 (Gg)
EF_{CO2} – estimated CO_2 emission factor
NMVOC – NMVOC emissions (Gg)

Therefore as it is mentioned there are two different methodologies used in time series. For years 1990-2001 the estimations are based on activity data obtained during national expert's research and possible national emission factors were determined during same research. For 2002-2011 emission calculation are based on imported and produced amount of NMVOC containing paint and applications related products using percentage amount of each particular

NMVOC in particular products. As the methodology was changed from lower tier to higher tier the change of using methodology is acceptable in time series. Also it was not possible to recalculate historical emissions using same methodology as for latest years due to unavailable data needed for Tier3 methodology.

Emission factors

Emission factors used for paint application calculations for 1990-2001 are:

2. paint on water base – 0.2 t/t
3. paint on solvent base – 0.5 t/t.

For 2002-2011 average percentage amount of particular NMVOC is known in paint and applications products imported and assuming used in country in particular year. The exact amount of NMVOCs is estimated for each particular NMVOC in each solvent containing product.

For CO_2 emission estimation 80% of carbon content conversion factor is used. According to IPCC 2006[71], indirect emissions of CO_2 from atmospheric oxidation of emitted NMVOC are to be included in the national emission inventory. The average amount of carbon in NMVOC is assumed to be 80%[72]. The default carbon content conversion factor of IPCC 2006 that is 60% was assumed as too low.

So the CO_2 emission factor was estimated using following equation:

$$EF_{CO_2} = 80\% \times 44.0098/12.011$$

where

EF_{CO2} – CO_2 emission factor (Gg/Gg)
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

In Latvia NMVOC emissions for the Paint Application sub-sector was calculated for year 1990-2001, making use of activity data available from national expert's assumptions on realized paint amount and national emission factor. Expert divided realized paint amount in two parts – paint on water base and paint on solvent base.

Table 5.4 Activity data for paint application estimation in 1990-2001 (1000litres)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Population (thsnd.)	2.67	2.66	2.64	2.59	2.54	2.5	2.47	2.44	2.42	2.4	2.38	2.36
paint consumption per capita (l)	6	5	4.5	4	4	3.2	3.8	4.1	4.5	4.9	5.3	5.7
total consumption (1000litres)	17.6	14.63	13.07	11.4	11.18	8.8	10.32	11	12	12.94	13.88	14.8

Since 2002, the solvents containing product production and import has to be reported to LEGMC in Chemicals Registry according to national legislation. Therefore the amount of coating and paint applications as well as average percentage amount of particular NMVOCs divided by names and CAS numbers is known. According to EMEP/EEA 2009 in the particular sector coating and paint applications as well as thinners, hardeners, lacquers and varnishes are reported in this sector. Due to the fact that the actual data is used it is almost impossible to divide the applications used in industrial, domestic or other sectors.

Still according to national legislation export data given in same structure unfortunately is unknown. According to data of paints, varnishes, tanning and dyeing extracts reported by CSB the exported amount of these data is only about 1-4% of total produced in country

[71] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_7_Ch7_Precursors_Indirect.pdf (page 7.6)
[72] Basing of the most often used average carbon conversion factor

amount. So the export data was left in produced amount because it wasn't possible to exclude the data. Still the previously mentioned amount of export part is very small and is in range for small data uncertainty.

For 2002-2011 the activity data is reported as confidential as import and production amounts of paints and applications are used as activity data. The "C" instead of activity data also is reported just for non-misleading when the activity data is compared as for 2002-2011 different data source is used for the activity data.

5.2.3 Uncertainties and time series consistency

Activity data for last year estimated is taken from Chemical Register of Latvia where all paint and its products importers and producers have to report their data of imported/produced type of product, its amount and its content. The percentage amount of NMVOCs in products also is reported by these companies. Therefore uncertainty for activity data and emission factor is assumed as 10%.

The uncertainty of indirect CO_2 emissions estimated from NMVOC emissions is assumed as 75% as the NMVOC emissions are used as activity data and default carbon content amount is used to estimate carbon conversion factor.

There are two methodologies used in time series when emissions in 1990-2001 is estimated by using Tier1 method taking into account expert's data and expert's emission factors. In 2002-2011 Tier3 method is used. Still even though two methods are used time series are not defined as inconsistent as methodology approach was changed to higher approach and it was not possible to recalculate historical emissions using same methodology as for latest years.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level.

No issues of IEF change more than 10% is reported by the CRF Reporter Consistency check. Still the change for year 2002 (2003) – 2011 could be quite significant as the emission estimation approach and methodology for latest years is different from used in previous years.

5.2.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method according to IPCC GPG 2000 using special QC form for each category.

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 Reporter and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found. There are no specific issues in this sector.

5.2.5 Source-specific recalculations

During quality control procedures mistakes in database of emission calculation were found and therefore emissions were recalculated. In the database incorrect location of activity data were found for time period 2002 – 2011. It was corrected therefore % difference of activity data varies from +6.20 % (2007) and -0.58% (2006).

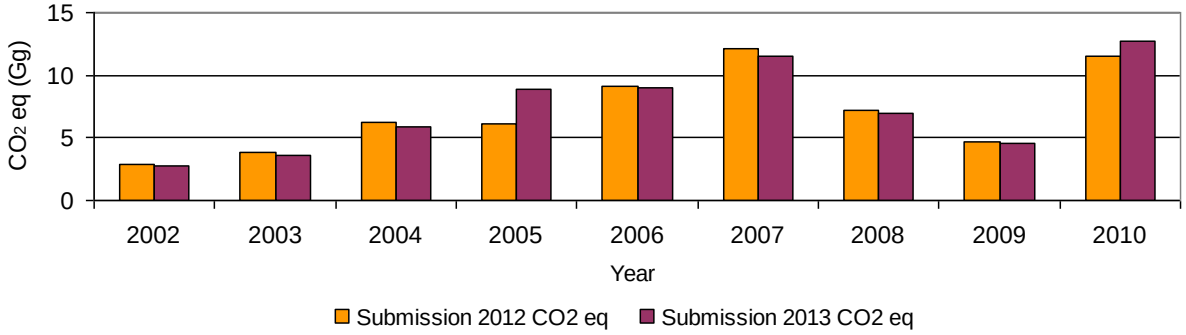


Figure 5.2 Difference of CO_2 emissions in Submission 2012 and 2013, Gg CO_2 eq

5.2.6 Source-specific planned improvements

In 2012, during the database improvement project, quality of databses in LEGMC was planned to improve. However, the project is still in progress, therefore the activity data and emissions will be checked for consistency purposes for submission 2014 the earliest.

5.3 DEGREASING AND DRY CLEANING

5.3.1 Source category description

CO_2 and NMVOC emissions are estimated for the sector.

Degreasing and Dry Cleaning sector consist 0.06% of total Solvent and Other Products Use sector CO_2 emissions.

The emissions are incomparable as for 1990-2002 Tier1 default methodology is used when the number of population is used as activity data and the default EMEP/CORINAIR 2007 emission factors are used but for 2003-2011 the most accurate statistics are being collected from Chemicals Register where importers and producers of products containing NMVOCs report the amounts their operating with and report the content data of these products.

Like in 3.A Paint Application sector the emissions from Degreasing and Dry Cleaning sector are decreasing since 2007 due to economical crisis and the aspects that lead to brake-down of national economy.

Table 5.5 Emissions from Degreasing and Dry Cleaning in 1990–2011 (Gg)

	CO_2	NMVOC
1990	7.08	2.27
1991	7.05	2.26
1992	7.01	2.25
1993	6.85	2.20
1994	6.74	2.16
1995	6.63	2.12
1996	6.55	2.10
1997	6.48	2.08
1998	6.42	2.06
1999	6.36	2.04
2000	6.30	2.02
2001	6.27	2.01
2002	6.22	1.99
2003	0.03	0.00
2004	0.09	0.03
2005	0.03	0.01
2006	0.03	0.01
2007	0.37	0.13
2008	0.23	0.08

	CO_2	NMVOC
2009	0.16	0.05
2010	0.01	0.00
2011	0.02	0.01

5.3.2 Methodological issues

Methods

For historical years 1990-2002 the NMVOC emissions were estimated using default EMEP/CORINAIR methodology. Simpler Tier1 methodology using number of population as activity data and using per capita emission factor is used in NMVOC emission estimation.

$$E = I \times EF_{NMVOC}$$

where
E – NMVOC emissions (Gg)
I – number of inhabitants
EF_{NMVOC} – per capita factor (Gg/cap/year)

CO_2 emissions were estimated using estimated NMVOC emissions and default carbon conversion factor.

$$E_{CO_2} = 0.85 \times (44/12) \times NMVOC$$

where:
E_{CO2} – CO_2 emissions
0.85 – carbon content conversion factor
NMVOC – NMVOC emissions

For 2003-2011 the data from Chemical Register of imported amounts of NMVOC containing products that could be used as degreasing and dry cleaning agents in sector 3.B are used for emission calculation. The NMVOC emissions are calculated basing of the percentage amount of NMVOC content in particular NMVOC containing products. The percentage content is used as emission factor.

It is assumed that the products imported in country in particular year are used in the same year as the actual use data is not available or is confidential.

It is assumed that 100% of all NMVOCs contained in products that are used in country in particular year are emitted during application process.

$$E_{NMVOC} = \sum (AD_{DG} \times p_{NMVOC})$$

where:
E_{NMVOC} – NMVOC emissions (Gg)
AD_{DG} – consumption of degreasing and dry cleaning products containing NMVOCs (Gg)
p_{NMVOC} – percentage amount of particular NMVOC in NMVOC containing products (Gg/Gg)

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 (Gg)
EF_{CO2} – estimated CO_2 emission factor
NMVOC – NMVOC emissions (Gg)

Therefore as it is mentioned there are two different methodologies used in time series. For years 1990-2002 the estimations are based on population number as activity data and default emission factors. The methodology is the simplest one. For 2003-2011 emission calculation

emission estimations are based on imported and produced amount of NMVOC containing degreasing and dry cleaning products using percentage amount of each particular NMVOC in particular products. As the methodology was changed from lower tier to higher tier the change of using methodology is acceptable in time series. Also it was not possible to recalculate historical emissions using same methodology as for latest years due to unavailable data needed for Tier3 methodology.

Emission factors

EMEP/CORINAIR Guidelines provide per capita emission factors if there are no locally available data and emission factors to apply detailed methodology. Emission factor used for Industrial Degreasing sub-sector calculation is 0.85 kg/cap/year.

For year 2003-2011 average percentage amount of particular NMVOC is known in degreasing and dry cleaning products imported and assuming used in country in particular year. The exact amount of NMVOCs is estimated for each particular NMVOC in each solvent containing product.

For CO_2 emission estimation 80% of carbon content conversion factor is used. According to IPCC 2006[73], indirect emissions of CO_2 from atmospheric oxidation of emitted NMVOC are to be included in the national emission inventory. The average amount of carbon in NMVOC is assumed to be 80%[74]. The default carbon content conversion factor of IPCC 2006 that is 60% was assumed as too low.

So the CO_2 emission factor was estimated using following equation:

$$\boxed{EF_{CO_2} = 80\% \times 44.0098/12.011}$$

where
EF_{CO2} – CO_2 emission factor (Gg/Gg)
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

The activity data for historical years emission estimation is taken from Statistical yearbook 2001 prepared by CSB for years 1990-2000; from Statistical yearbook 2007 prepared by CSB for 2000-2002. CSB updates number of population almost every year so historical statistical yearbooks were used to divert necessity to recalculate the emissions every year (Table 5.6).

Table 5.6 Activity data for degreasing emissions estimation in 1990-2002

	Population
1990	2667887
1991	2657709
1992	2642355
1993	2584792
1994	2539812
1995	2499327
1996	2468148
1997	2443414
1998	2419195
1999	2397557
2000	2375339

[73] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_7_Ch7_Precursors_Indirect.pdf (page 7.6)
[74] Basing of the most often used average carbon conversion factor

	Population
2001	2364254
2002	2345768

Since 2003, the solvents containing product production and import has to be reported to LEGMC in Chemicals Registry according to national legislation. Therefore the amount of products containing degreasing and dry cleaning agents as well as average percentage amount of particular NMVOCs divided by names and CAS numbers is known. According to EMEP/EEA 2009 in the particular sector all the products that assumingly could be used for degreasing and dry cleaning are used as activity data.

As the activity data for all time series are taken from two different sources and are incomparable the data for 2003-2011 was reported as "C" – confidential. It was done to avoid wrongly interpretation of time series curve where in 2002-2003 a significant decrease of activity data as well as emission factor would be observed as it is now for emission curve.

Still according to national legislation export data given in same structure unfortunately is unknown. According to CSB the exported amount of these data is very negligible. So the export data was left in produced amount because it wasn't possible to exclude the data.

Table 5.7 Activity data for degreasing emissions estimation in 2003-2011 (Gg)

	Production / import of NMVOC containing 3.B sector products
2003	0.033
2004	0.085
2005	0.046
2006	0.025
2007	0.160
2008	0.110
2009	0.079
2010	0.026
2011	0.159

The activity data in 2003-2011 (Table 5.7) has increased year by year due to improvement of population well-being and increase of demanding for this type of service. As well as data collection is improving from year to year. Since 2007, the activity data is decreasing due to economical and financial crisis that affected of purchasing power of population therefore the finances were switched to other needs and essential goods.

5.3.3 Uncertainties and time series consistency

Activity data for last year estimated is taken from Chemical Register of Latvia. The percentage amount of NMVOCs in products also is reported by these companies. Therefore uncertainty for activity data and emission factor is assumed as 10%.

The uncertainty of indirect CO_2 emissions estimated from NMVOC emissions is assumed as 75% as the NMVOC emissions are used as activity data and default carbon content amount is used to estimate carbon conversion factor.

There are two methodologies used in time series when emissions in 1990-2002 is estimated by using Tier1 method taking into account expert's data and expert's emission factors. In 2003-2011 Tier3 method is used. Still even though two methods are used time series are not defined as inconsistent as methodology approach was changed to higher approach and it was not possible to recalculate historical emissions using same methodology as for latest years.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level.

No issues of IEF change more than 10% is reported by the CRF Reporter Consistency check. Still the change for year 2002–2003 could be quite significant as the emission estimation approach and methodology for latest years is different from used in previous years.

5.3.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000 using special QC form for each category.

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 Reporter and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

5.3.5 Source-specific recalculations

During quality control procedures mistakes in database of emission calculation were found and therefore emissions were recalculated.

In the database incorrect location of activity data were found for time period 2003 – 2009. It was corrected therefore % difference of activity data varies from +68.00 % (2010) and -0.65% (2005) between Submission 2012 and 2013.

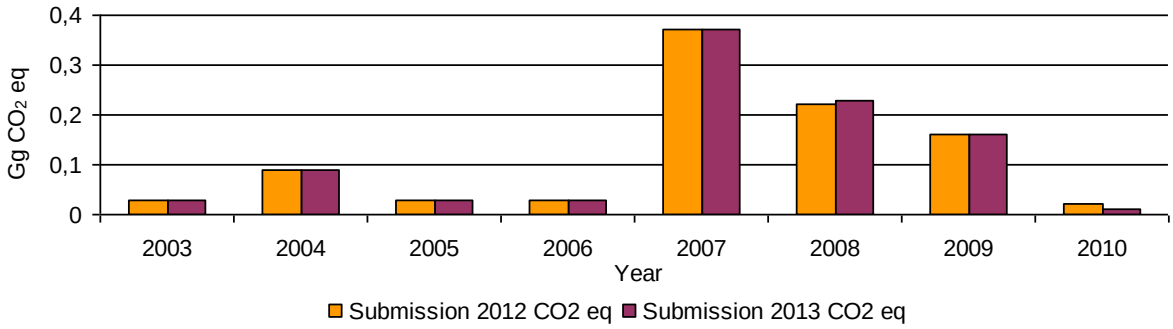


Figure 5.3 Difference of CO_2 emissions in Submission 2012 and 2013, Gg

5.3.6 Source-specific planned improvements

In 2012, during the database improvement project, quality of databses in LEGMC was planned to improve. However, the project is still in progress, therefore the activity data and emissions will be checked for consistency purposes for submission 2014 the earliest.

5.4 CHEMICAL PRODUCTS, MANUFACTURE AND PROCESSING (CRF 3.C)

5.4.1 Source category description

CO_2 and NMVOC emissions are reported from Chemical Products, Manufacture and Processing sector.

Chemical Products Manufacturing and Processing consist 4.65% of total CO_2 emissions from Solvents and Other Product Use sector.

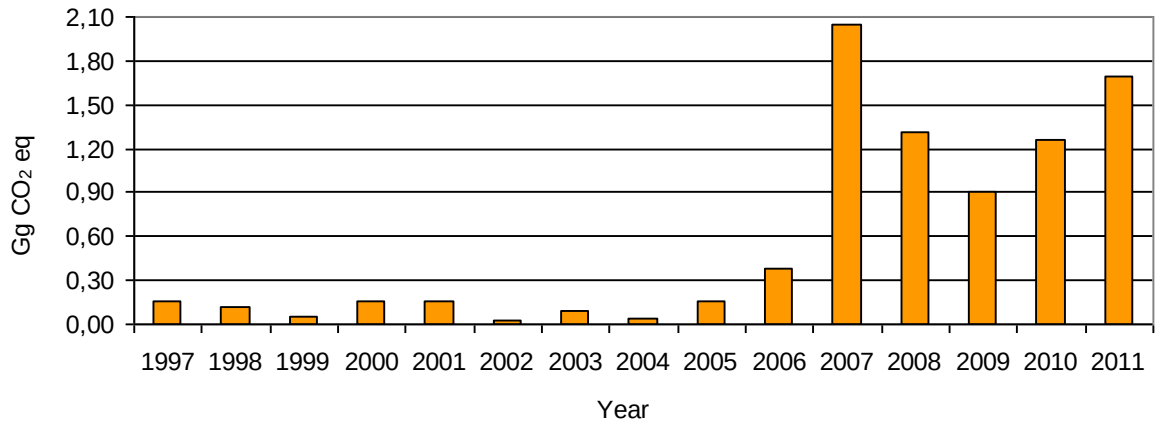


Figure 5.4 CO_2 emissions Chemical Products, Manufacture and Processing sector in 1997–2011 (Gg)

Clearly visible fluctuations of emissions can be observed in the sector (Figure 5.4). Still as emissions are reported by pharmaceutical and perfumery production plants it is quite difficult to explain these fluctuations.

5.4.2 Methodological issues

The NMVOC emissions for 1997-2004 were taken from database "2-AIR" on production of pharmaceutical formulations and perfumery products. "2-AIR" is the database where enterprises that do any pollution activity and have A, B or C category pollution permits report their emission data; it is approximately 3000 enterprises in total every year. From these approximately 3000 enterprises data from only the enterprises that product pharmaceutical formulations and perfumery products is used. The companies reported their NMVOC emissions divided in particular NMVOC.

For years 2003-2011 the data from database "2-AIR" was also collected. For these years also the data from Chemical Register of imported amounts of foams that could be used in particular year in country together with the data of paints and coating application production data was obtained. These data has to be reported in 3.C sector according to EMEP/EEA 2009. The NMVOC percentage amount in each produced and imported product was also reported to Chemical Register by companies. The percentage content is used as emission factor.

It is assumed that the products imported in country in particular year are used in the same year as the actual use data is not available or is confidential.

It is assumed that 100% of all NMVOCs contained in products that are used in country in particular year are emitted during application process.

$$E_{NMVOC} = \sum \left(AD_{DG} \times p_{NMVOC} \right)$$

where:
E_{NMVOC} – NMVOC emissions (Gg)
AD_{DG} – amount of imported foams and produced paint and paint application products containing NMVOCs (Gg)
p_{NMVOC} – percentage amount of particular NMVOC in NMVOC containing products (Gg/Gg)

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 (Gg)
EF_{CO2} – estimated CO_2 emission factor
NMVOC – NMVOC emissions (Gg)

Therefore as it is mentioned there are two different methodologies used in time series. For years 1990-2002 the estimations are based on population number as activity data and default emission factors. The methodology is the simplest one. For 2003-2010 emission calculation emission estimations are based on imported and produced amount of NMVOC containing degreasing and dry cleaning products using percentage amount of each particular NMVOC in particular products. As the methodology was changed from lower tier to higher tier the change of using methodology is acceptable in time series. Also it was not possible to recalculate historical emissions using same methodology as for latest years due to unavailable data needed for Tier3 methodology.

Emission factors

For years 1997-2001 the NMVOC emissions reported by pharmacy and perfumery companies were reported directly in CRF Reporter.

For year 2002-2011 average percentage amount of particular NMVOC is known in imported foams and produced paint and paint application products in country in particular year. The exact amount of NMVOC is estimated for each particular NMVOC in each solvent containing product.

For CO_2 emission estimation 80% of carbon content conversion factor is used. According to IPCC 2006[75], indirect emissions of CO_2 from atmospheric oxidation of emitted NMVOC are to be included in the national emission inventory. The average amount of carbon in NMVOC is assumed to be 80%[76]. The default carbon content conversion factor of IPCC 2006 that is 60% was assumed as too low.

So the CO_2 emission factor was estimated using following equation:

$$\boxed{EF_{CO_2} = 80\% \times 44.0098/12.011}$$

where
EF_{CO2} – CO_2 emission factor (Gg/Gg)
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

The activity data for 1997-2002 is not relevant as direct NMVOC emissions reported by companies are used. Also this activity data would be set as confidential as plant specific data of produced amount is confidential in Latvia.

Since 2002 the solvents containing product's production and import has to be reported to LEGMC in Chemicals Registry according to national legislation. Therefore the amount of products as well as average percentage amount of particular NMVOCs divided by names and CAS numbers is known. According to EMEP/EEA 2009 in the particular sector the amount of imported foams that assumingly could be used in country in the same year as well as paint and paint application production data are used as activity data.

Mostly the data is obtained from one data source still for years 2002-2010 the emissions are estimated additionally using the data from Chemicals Register. For 1997-2001 the data from Chemical Register is not possible to obtain.

Table 5.8 Activity data for estimation in 2003-2011 (Gg)

[75] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_7_Ch7_Precursors_Indirect.pdf (page 7.6)
[76] Basing of the most often used average carbon conversion factor

	Production / import of NMVOC containing 3.C sector products
2002	0.07
2003	0.27
2004	0.08
2005	0.42
2006	1.40
2007	3.44
2008	1.48
2009	0.79
2010	12.63
2011	6.81

The activity data in 2002-2007 and 2010-2011 has increased due to improvement of population well-being and construction and building sector in total. As well as data collection is improving from year to year. For year 2007-2009 the activity data is decreasing due to economical and financial crisis that affected of purchasing power of population and estate property sector.

5.4.3 Uncertainties and time series consistency

Activity data for last year estimated is taken from Chemical Register of Latvia where all paint and its products importers and producers have to report their data of imported/produced type of product, its amount and its content. The percentage amount of NMVOCs in products also is reported by these companies. Therefore uncertainty for activity data and emission factor is assumed as 10% for latest years. For 1997-2001 the uncertainty of reported emissions are assumed as lowest possible – 2%, as emissions are determined by companies and verified by Regional Environment Board experts.

The same methodology is used for 2002-2011 but emissions obtained directly from pharmacy and perfumery companies are reported together with estimated emissions. Therefore the time series is assumes as consistent because in 2002-2011 the additional data is just reported together with the data from 1997-2011 obtained with one constant methodology.

The uncertainty of indirect CO_2 emissions estimated from NMVOC emissions is assumed as 75% as the NMVOC emissions are used as activity data and default carbon content amount is used to estimate carbon conversion factor.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level. No issues of IEF change more than 10% is reported by the CRF Reporter Consistency check.

5.4.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000 using special QC form for each category.

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 Reporter and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

5.4.5 Source-specific recalculations

During quality control procedures mistakes in database of emission calculation were found and therefore emissions were recalculated. In the database incorrect location of activity data

were found for time period 2002 – 2011. It was corrected therefore % difference of activity data varies from +22.69% (2009) and -251.89% (2010) between Submission 2012 and 2013 when latest submissions are significantly higher due to additionally estimated emissions.

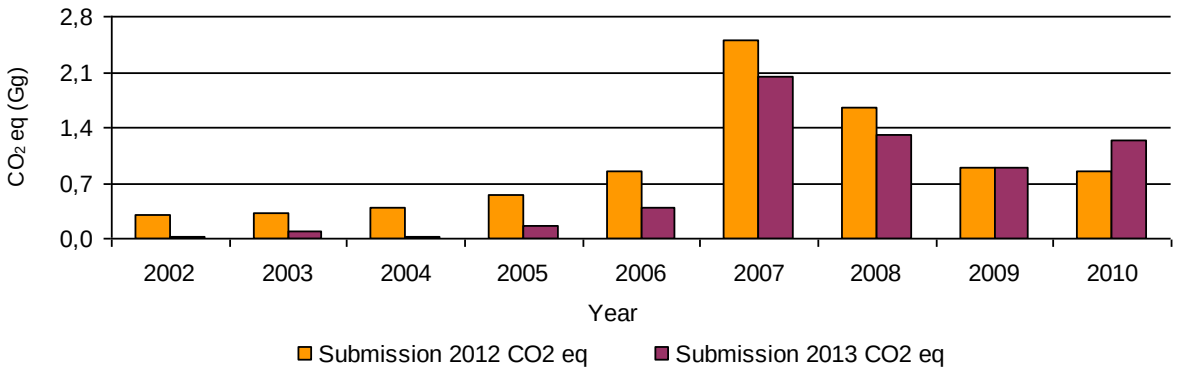


Figure 5.5 Difference of CO_2 emissions in Submission 2012 and 2013, Gg

5.4.6 Source-specific planned improvements

In 2012, during the database improvement project, quality of databses in LEGMC was planned to improve. However, the project is still in progress, therefore the activity data and emissions will be checked for consistency purposes for submission 2014 the earliest.

5.5 USE OF N_2O IN ANAESTHESIA (CRF 3.D.1)

5.5.1 Source category description

N_2O emissions from N_2O used in anaesthesia activities are estimated taking into account amount of N_2O actually used in medicine sector.

N_2O emissions from anaesthesia are negligible from total Solvents and Other Product Use CO_2 eq emissions (Figure 5.6).

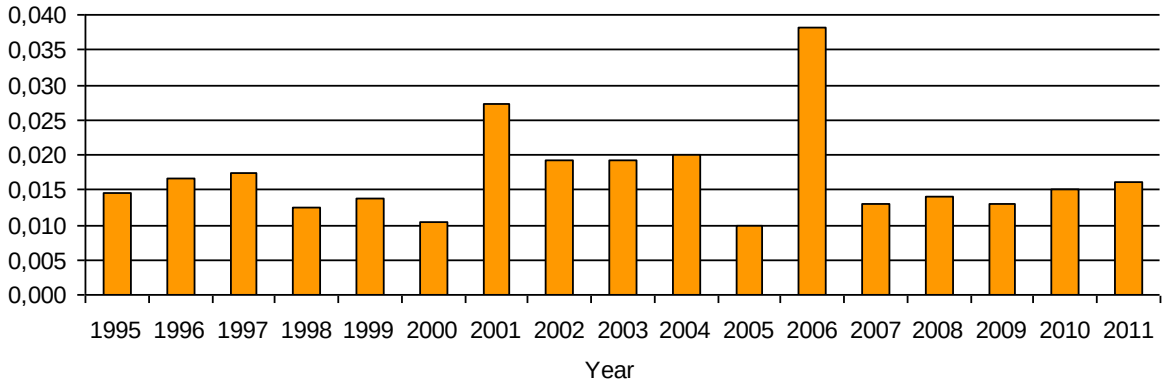


Figure 5.6 N_2O emissions from N_2O for anaesthesia 1995–2011 (Gg)

5.5.2 Methodological issues

It is assumed that 100% of N_2O used for anaesthesia needs is emitted to the air therefore activity data is equal to estimated emissions.

The data for the use of N_2O in anaesthesia are available since 1995. The activity data are taken from enterprises. Since 2007, activity data is taken from State Agency of Medicines of Latvia. The agency is obtaining information of used N_2O from all enterprises. Other sources of N_2O emissions are not estimated due to lack of activity data.

5.5.3 Uncertainties and time series consistency

Uncertainty of this sector can be assumed as rather low to 2% as bottom-up data reported from N_2O consumers and enterprises that import and/or realize this gas is used.

Time series of the estimated emissions are consistent because the same methodology, emission factors and data sources are used for sectors for all 1995-2011. N_2O emissions for 1990-1994 are not estimated due to lack of activity data.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level. There are no such issues.

5.5.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000 using special QC form for each category. Activity data reported to State Agency of Medicine by N_2O consumers of medicine sector is verified and checked by the agency.

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 Reporter and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

5.5.5 Source-specific recalculations

No recalculations were done for the sector.

5.5.6 Source-specific planned improvements

It is planned to revise time series fluctuation to obtain the explanation of sharp activity data and emission data fluctuation.

5.6 OTHER – PRINTING, DOMESTIC SOLVENTS USE AND OTHER PRODUCT USE (CRF 3.D.5.1, 3.D.5.2, 3.D.5.3)

5.6.1 Source category description

These three sectors are the most problematic as for historical years CO_2 and NMVOC emissions are estimated using one methodology taking into account number of population amount but for years 2002 (2003) – 2011 the import and or production data of NMVOC containing printing, domestic solvent and other products is used in emission calculation.

CO_2 emissions from these 3 sectors are 72.02% from total CRF 3 Solvents and Other Product Use emissions (Table 5.9).

Table 5.9 Emissions from 3.D.5 Other sectors in 1990–2011 (Gg)

	CO_2			NMVOC		
	3.D.5/3.D.1 Printing	3.D.5/3.D.2 Domestic Solvent Use	3.D.5/3.D.3 Other Product Use	3.D.5/3.D.1 Printing	3.D.5/3.D.2 Domestic Solvent Use	3.D.5/3.D.3 Other Product Use
1990	5.41	14.98	NE	1.73	4.80	NE
1991	5.39	14.93	NE	1.73	4.78	NE
1992	5.36	14.84	NE	1.72	4.76	NE
1993	5.24	14.52	NE	1.68	4.65	NE
1994	5.15	14.26	NE	1.65	4.57	NE
1995	5.07	14.04	NE	1.63	4.50	NE
1996	5.01	13.86	NE	1.60	4.44	NE
1997	4.96	13.72	NE	1.59	4.40	NE
1998	4.91	13.59	NE	1.57	4.36	NE

	CO_2			NMVOC		
	3.D.5/3.D.1 Printing	3.D.5/3.D.2 Domestic Solvent Use	3.D.5/3.D.3 Other Product Use	3.D.5/3.D.1 Printing	3.D.5/3.D.2 Domestic Solvent Use	3.D.5/3.D.3 Other Product Use
1999	4.86	13.47	NE	1.56	4.32	NE
2000	4.82	13.34	NE	1.54	4.28	NE
2001	4.79	13.28	NE	1.54	4.26	NE
2002	4.76	2.12	14.67	1.52	0.72	5.00
2003	0.00	3.86	15.82	0.00	1.32	5.40
2004	0.00	6.15	17.51	0.00	2.10	5.97
2005	0.02	7.70	18.84	0.01	2.63	6.43
2006	0.04	13.28	20.67	0.01	4.53	7.05
2007	0.07	20.64	24.60	0.02	7.04	8.39
2008	0.04	16.17	14.52	0.01	5.52	4.95
2009	0.03	5.11	11.73	0.01	1.74	4.00
2010	0.32	8.24	18.05	0.11	2.81	6.16
2011	0.04	7.59	18.55	0.01	2.59	6.33

The emissions are very incomparable as for 1990-2002 (2003) Tier1 default methodology is used (the number of population is used as activity data and the default EMEP/CORINAIR 2007 emission factors are used), but for 2002 (2003) – 2011 the most accurate statistics are being collected from Chemicals Register (importers and producers of products containing NMVOC report the amounts their operating with and report the content data of these products).

Since 2003, emissions are constantly increasing till 2007 due to improvement of national economy and well-being of population as well as due to improvement of statistical data collecting. Since 2007, emissions from Other sectors fluctuated due to economical situation in the country.

5.6.2 Methodological issues

Methods

For historical years 1990-2002 (2003) the NMVOC emissions for the sector were estimated using default EMEP/CORINAIR methodology. Simpler Tier1 methodology using number of population as activity data and using per capita emission factor is used in NMVOC emission estimation.

$$E = I \times EF_{NMVOC}$$

where
E – NMVOC emissions (Gg)
I – number of inhabitants
EF_{NMVOC} – per capita factor (Gg/cap/year)

CO_2 emissions were estimated using estimated NMVOC emissions and default carbon conversion factor.

$$E_{CO_2} = 0.85 \times (44/12) \times NMVOC$$

where:
E_{CO2} – CO_2 emissions
0.85 – carbon content conversion factor
NMVOC – NMVOC emissions

For years 2002 (2003) – 2011 the data from Chemical Register of imported amounts of NMVOC containing products that could be used for Printing or as Domestic Solvent Use and Other Product Use in sector 3.D.5 are used for emission calculation. The NMVOC emissions

are calculated basing of the percentage amount of NMVOC content in particular NMVOC containing products. The percentage content is used as emission factor.

It is assumed that the products imported in country in particular year are used in the same year as the actual use data is not available or is confidential.

It is assumed that 100% of all NMVOC contained in products that are used in country in particular year are emitted during application process.

$$E_{NMVOC} = \sum \left(AD_{DG} \times p_{NMVOC} \right)$$

where:
E_{NMVOC} – NMVOC emissions (Gg)
AD_{DG} – consumption of domestic and other solvents use as well as printing products containing NMVOCs (Gg)
p_{NMVOC} – percentage amount of particular NMVOC in NMVOC containing products (Gg/Gg)

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 (Gg)
EF_{CO2} – estimated CO_2 emission factor
NMVOC – NMVOC emissions (Gg)

Therefore as it is mentioned there are two different methodologies used in time series. For years 1990-2002 (2003) the estimations are based on population number as activity data and default emission factors. The methodology is the simplest one. For 2002 (2003)–2011 emission calculation emission estimations are based on imported and produced amount of NMVOC containing printing, domestic solvents and other solvents products using percentage amount of each particular NMVOC in particular products. As the methodology was changed from lower tier to higher tier the change of using methodology is acceptable in time series. Also it was not possible to recalculate historical emissions using same methodology as for latest years due to unavailable data needed for Tier3 methodology.

Emission factors

EMEP/CORINAIR Guidelines provide per capita emission factors if there are no locally available data and emission factors to apply detailed methodology. Emission factor used for other sub-sectors calculations are shown in Table 5.10.

Table 5.10 Emission factor for CRF 3.D.5 Other sectors for 1990-2002 (2003)

Sectors	Emission factor, kg/cap/year
Graphic Arts, Printing	0.65
Domestic Solvent Use	1.8

For year 2002 (2003)–2010 average percentage amount of particular NMVOC is known in printing products and solvents imported and assuming used in country in particular year. The exact amount of NMVOC is estimated for each particular NMVOC in each solvent containing product.

For CO_2 emission estimation 80% of carbon content conversion factor is used. According to IPCC 2006[77], indirect emissions of CO_2 from atmospheric oxidation of emitted NMVOC are to be included in the national emission inventory. The average amount of carbon in NMVOC

[77] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_7_Ch7_Precursors_Indirect.pdf (page 7.6)

is assumed to be 80%[78]. The default carbon content conversion factor of IPCC 2006 that is 60% was assumed as too low.

So the CO_2 emission factor was estimated using following equation:

$$EF_{CO_2} = 80\% \times 44.0098/12.011$$

where

EF_{CO2} – CO_2 emission factor (Gg/Gg)
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

The activity data for historical years emission estimation is taken from Statistical yearbook 2001 prepared by CSB for years 1990-2000; from Statistical yearbook 2007 prepared by CSB for 2000-2002. CSB updates number of population almost every year so historical statistical yearbooks were used to divert necessity to recalculate the emissions every year (Table 5.11).

Table 5.11 Activity data for emissions estimation in 1990-2003

	Population
1990	2667887
1991	2657709
1992	2642355
1993	2584792
1994	2539812
1995	2499327
1996	2468148
1997	2443414
1998	2419195
1999	2397557
2000	2375339
2001	2364254
2002	2345768
2003	2331480

The production and import of solvents containing product has to be reported to LEGMC in Chemicals Registry according to national legislation since 2002 (2003). Therefore the amount of printing and domestic and other solvents products as well as average percentage amount of particular NMVOC divided by names and CAS numbers is known. According to EMEP/EEA 2009 in the particular sector all the products that assumingly could be used for degreasing and dry cleaning are used as activity data.

As the activity data for all time series are taken from two different sources and are incomparable the data for 2003-2011 was reported as "C" – confidential. It was done to avoid wrongly interpretation of time series curve where in 2002-2003 a significant decrease of activity data as well as emission factor would be observed as it is now for emission curve.

Still according to national legislation export data given in same structure unfortunately is unknown. According to CSB the exported amount of these data is very negligible. So the export data was left in produced amount because it wasn't possible to exclude the data.

Table 5.12 Activity data for emissions estimation in 2002-2011 (Gg)

	Production / import of NMVOC containing 3.D.5 sector products

[78] Basing of the most often used average carbon conversion factor

	Production / import of NMVOC containing 3.D.5 sector products
2002	20.04
2003	64.28
2004	70.46
2005	109.42
2006	141.50
2007	234.59
2008	139.46
2009	80.37
2010	137.23
2011	114.25

The activity data in 2002 (2003)–2011 has increased by almost 4 times due to improvement of population well-being and increase of demanding for this type of service. As well as data collection is improving form year to year. Since 2007 the activity data is decreasing due to economical and financial crisis that affected of purchasing power of population therefore the finances were switched to other needs and essential goods (Table 5.12).

5.6.3 Uncertainties and time series consistency

Activity data for last year estimated is taken from Chemical Register of Latvia. The percentage amount of NMVOCs in products also is reported by these companies. Therefore uncertainty for activity data and emission factor is assumed as 10%.

The uncertainty of indirect CO_2 emissions estimated from NMVOC emissions is assumed as 75% as the NMVOC emissions are used as activity data and default carbon content amount is used to estimate carbon conversion factor.

There are two methodologies used in time series when emissions in 1990-2001 is estimated by using Tier1 method taking into account expert's data and expert's emission factors. In 2002-2011 Tier3 method is used. Still even though two methods are used time series are not defined as inconsistent as methodology approach was changed to higher approach and it was not possible to recalculate historical emissions using same methodology as for latest years.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level.

No issues of IEF change more than 10% is reported by the CRF Reporter Consistency check. Still the change for year 2002–2003 could be quite significant as the emission estimation approach and methodology for latest years is different from used in previous years.

5.6.4 Source-specific QA/QC and verification

QA/QC check is performed with Tier1 method from IPCC GPG 2000 using special QC form for each category.

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 Reporter and all IEF changes that are higher than 10% in time series are double-checked and reasonable explanation for IEF changes has to be found.

5.6.5 Source-specific recalculations

During quality control procedures mistakes in database of emission calculation were found and therefore emissions were recalculated. In the database incorrect location of activity data were found for time period 2002 – 2011. It was corrected, the % difference of activity data varies from +12.63% (2007) and -27.41 % (2010) between Submission 2012 and 2013.

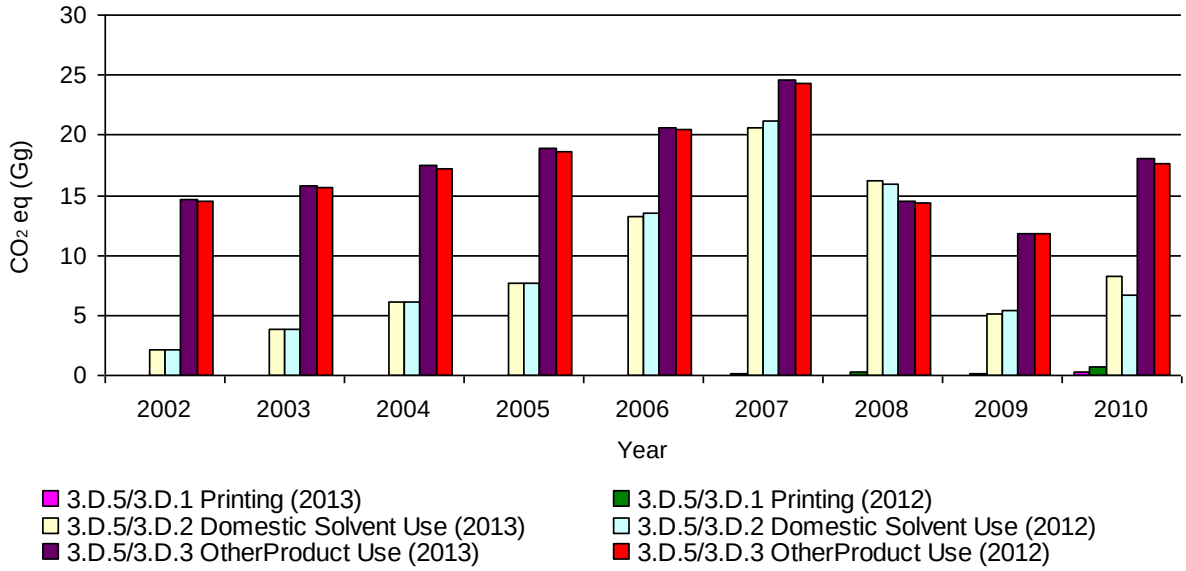


Figure 5.7 Difference of CO_2 emissions in Submission 2012 and 2013, Gg

5.6.6 Source-specific planned improvements

In 2012, during the database improvement project, quality of databses in LEGMC was planned to improve. However, the project is still in progress, therefore the activity data and emissions will be checked for consistency purposes for submission 2014 the earliest.

It is necessary to research the amount of NMVOC emissions that is left in products after the application and use as it could be assumed that not all 100% of NMVOC in products emit in air.

It is also necessary to prepare a full list of products imported and / or produced in Latvia that could be used for printing, domestic solvents and other solvents use for the best data aggregation.

CHAPTER 6: AGRICULTURE (CRF 4)

The emissions of greenhouse gases from the Agriculture sector include emissions of CH_4 from Enteric Fermentation, Manure Management and emissions of N_2O from Manure Management and Agricultural Soils. Direct N_2O emissions from Agricultural Soils include emissions from synthetic fertilizers, manure applied to soils, biological nitrogen fixation of N-fixing crops, crop residues and cultivation of organic soils. Indirect N_2O emission sources include atmospheric deposition and nitrogen leaching and run-off to watercourses.

The emissions are reported in CRF tables 4.A, 4.B (a), 4.B (b) and 4D. CO_2 emissions from agricultural soils are included in the Land use, Land-use change and Forestry (LULUCF) sector (Chapter 7) under Cropland and Grassland categories.

Rise isn't cultivated in Latvia and savannas don't exist therefore CRF Tables 4.C and 4E have not been completed. Field Burning of Agricultural Residues isn't taking place in Latvia, therefore notation key "NO" is used. Emissions from previous years grass burning are included under LULUCF sub sector Grassland.

6.1 OVERVIEW OF SECTOR

Agriculture is the second most significant source of GHG emissions, with approximately 20% of Latvia's total emissions. Emissions from agriculture include CH_4 and N_2O emissions. GHG emissions decreased in 2011 by 0.3% if to compare with 2010. The annual emissions have reduced approximately by 60% since 1990 due to decreases in the number of livestock, nitrogen fertilisation and etc. Given in CO_2 equivalents, the N_2O emission contributed with 67% of total GHG emission from the agricultural sector, but CH_4 contributed with the remaining 33% in 2011 (Table 6.1).

Table 6.1 Greenhouse gas emission in the agricultural sector in 1990 – 2011

Year	CH_4, Gg CO_2 eq.	N_2O, Gg CO_2 eq.	Total, Gg CO_2 eq.
1990	2421.81	3534.83	5956.64
1991	2308.58	3276.62	5585.20
1992	1881.06	2505.80	4386.86
1993	1167.20	1747.32	2914.52
1994	997.22	1515.56	2512.78
1995	979.06	1334.75	2313.81
1996	927.07	1317.75	2244.82
1997	910.24	1323.73	2233.97
1998	841.88	1274.62	2116.51
1999	732.82	1198.46	1931.27
2000	716.50	1234.30	1950.80
2001	757.34	1338.61	2095.95
2002	752.97	1306.49	2059.46
2003	734.83	1377.74	2112.57
2004	727.16	1348.96	2076.12
2005	751.03	1417.27	2168.30
2006	749.23	1413.68	2162.91
2007	782.81	1471.57	2254.39
2008	756.85	1461.86	2218.70
2009	752.81	1497.94	2250.75
2010	761.11	1560.58	2321.69
2011	762.90	1552.63	2315.52

Some inter-annual variation between the years can be noticed from the time series mainly caused by fluctuation in activity data between the years because of changes in animal

numbers, for example, which is largely affected by economical situation in country as well as agricultural policy.

CH_4 and N_2O emissions from manure management are affected by the fluctuation in animal numbers and the proportion of manure managed in different manure management systems which vary depending on animal species.

N_2O emissions from agricultural soils generally are affected by the cultivation of organic soils; amount of synthetic fertilizers sold annually, animal numbers and crop yields of cultivated crops, which may have large variation between the years.

Detailed information of recalculations is described under each sub-sector.

The calculations of the emissions are based on methods described in Revised 1996 IPCC and the IPCC GPG 2000.

Key categories

The key categories in agriculture in 2011 according to IPCC GPG 2000 Tier 1 method are summarized in Table 6.2.

Table 6.2 Key categories in Agriculture in 2011 (excluding LULUCF)

IPCC source category	Gas	Identification criteria
4.A. Enteric fermentation	CH_4	L, T
4.B. Manure management	N_2O	L,T
4.D. Agricultural soils: direct emissions	N_2O	L
4.D. Agricultural soils: indirect emissions	N_2O	L, T
4D. Pasture range and paddock	N_2O	L, T

6.2 ENTERIC FERMENTATION (CRF 4.A)

6.2.1 Source category description

Livestock are produced throughout the world and are a significant source of global methane (CH_4) emissions. The amount of enteric methane emitted is driven primarily by the number of animals, the type of digestive system, and the type and amount of feed consumed. Cattle are the largest source of enteric methane emissions.

The emission source covers domestic livestock (Table 6.3.). Latvia reports emissions from cattle (including dairy cows), swine, horses, goats and sheep. Emissions from poultry have not been estimated.

Table 6.3 Reported emissions under the subcategory Enteric Fermentation

CRF	Source	Emissions reported
4.A 1	Cattle Dairy Cattle Non-Dairy Cattle	CH_4
4.A 2	Buffalo	NO
4.A 3	Sheep	CH_4
4.A 4	Goats	CH_4
4.A 5	Camels and Lamas	NO
4.A 6	Horses	CH_4
4.A 7	Mules and Asses	NO
4.A 8	Swine	CH_4
4.A 9	Poultry	NE

In 2011, methane emissions from Enteric Fermentation of domestic livestock increased by 0.09 Gg if to compare with 2010 caused by the increase of the number of non-dairy cattle and sheep. Since 1990 generally due to evident fall of the number of cattle, emissions decreased by 69% (Table 6.4).

Table 6.4 Methane emissions from Enteric Fermentation by animal type in 1990–2011 (Gg)

Year	DC, Gg	NDC, Gg	Sh, Gg	G, Gg	H, Gg	Sw, Gg	Total CH_4, Gg	Total, Gg CO_2 eq.
1990	51.13	47.15	1.32	0.03	0.56	2.10	102.29	2148.05
1991	49.46	44.44	1.47	0.03	0.54	1.87	97.81	2053.98
1992	42.82	34.53	1.32	0.03	0.50	1.30	80.50	1690.59
1993	31.00	17.06	0.91	0.03	0.47	0.72	50.18	1053.88
1994	28.14	12.47	0.69	0.04	0.48	0.75	42.57	893.94
1995	26.79	12.78	0.58	0.04	0.49	0.83	41.51	871.75
1996	25.71	12.20	0.44	0.04	0.46	0.69	39.55	830.61
1997	26.35	11.16	0.33	0.04	0.41	0.65	38.94	817.70
1998	24.61	10.01	0.23	0.05	0.40	0.63	35.94	754.67
1999	20.92	8.97	0.22	0.04	0.34	0.61	31.10	653.13
2000	21.20	8.46	0.23	0.05	0.36	0.59	30.89	648.62
2001	22.03	9.18	0.23	0.06	0.36	0.64	32.51	682.64
2002	21.38	9.54	0.26	0.07	0.34	0.68	32.27	677.71
2003	20.07	10.07	0.31	0.08	0.27	0.67	31.46	660.70
2004	20.11	9.64	0.31	0.07	0.28	0.65	31.06	652.41
2005	20.37	10.43	0.33	0.07	0.25	0.64	32.10	674.16
2006	20.30	10.17	0.33	0.07	0.25	0.63	31.75	666.66
2007	20.43	11.42	0.43	0.07	0.23	0.62	33.21	697.34
2008	19.69	10.94	0.54	0.06	0.24	0.58	32.04	672.88
2009	19.28	11.09	0.57	0.07	0.23	0.56	31.79	667.68
2010	19.29	11.23	0.61	0.07	0.22	0.58	32.00	672.19
2011	19.33	11.29	0.64	0.07	0.20	0.56	32.10	674.12
Share of total % in 2011	60.23%	35.18%	1.99%	0.21%	0.64%	1.75%	100%	

DC=Dairy cows, NDC- Non-Dairy cattle, Sh=Sheep, G=Goats, H=Horses, Sw=Swine, P=Poultry.

6.2.2 Methodological issues

Emissions from Enteric Fermentation of domestic livestock have been calculated by using the IPCC Tier 1 and Tier 2 methodologies presented in the Revised 1996 IPCC and the IPCC GPG 2000.

CH_4 emissions from Enteric Fermentation for horses, swine and goats have been calculated with the IPCC Tier 1 method by multiplying the number of the animals in each category with the IPCC default emission factor of the respective animal category, IPCC GPG 2000, equation 4.12:

$$CH_4(Gg/year) = EF(kg/animal/year) \bullet population/(10^6 kg/Gg)$$

The total emission is the sum of emissions from each category, IPCC 2000, equation 4.13:

$$CH_4 = \sum_i E_i$$

The contribution of emissions from horses, swine, sheep and goats to the total emissions from Enteric Fermentation is less significant.

The Tier 2 method has been used for cattle as emissions from cattle make the biggest part of total agricultural sector CH_4 emissions. In the Tier 2 method the emissions have been

calculated as in the Tier 1 method above, but the emission factors for dairy cattle and non-dairy cattle has been calculated according to Equation 4.14 in the IPCC GPG 2000:

$$EF=(GE*Y_m* 365\ days/year)/(55.65\ MJ/kg\ CH_4),$$

where:
GE = Gross energy intake (MJ/animal/day)
Ym = Methane conversion rate, fraction of gross energy in feed converted to methane (IPCC default value 0.06 used)

The national values for gross energy intake (GE) of cattle have been used. The value of GE for Dairy cattle and Non-Dairy cattle has been calculated by using a slightly modified version of Equation 4.11 in the IPCC GPG 2000:

$$GE = \{[NEm + NEa + NE_1 + NEp) /(NEma/DE)] + [(NEg) / (NEga / DE)]\} / (DE / 100)$$

where:
NEm = Net energy required by the animal for maintenance, MJ/day
NEa = Net energy for animal activity, MJ/day
NE_l = Net energy for lactation, MJ/day (dairy cattle)
NEp = Net energy required for pregnancy, MJ/day (dairy cattle, corrected on 80% according to IPCC GPG 2000)
NEg = Net energy needed for growth, MJ/day (non dairy cattle).

The equations for calculating *NEm, NEa, NEl, NEp* and *NEg* are:

$$NEm= Cfi * (Weight)^{0.75}$$

$$NEa= [Cap* tp/365 + Cao * (1-(tp/365)) * NEm$$

$$NEl = My/365 * (1.47 + 0.40 * Fat)$$

$$NEp = Cp* NEm\ NEg = 4.18*\{0.0635*[0.891*(BW*0.96)*(478/(C*MW))]^{0.75} * (WG * 0.92)^{1.097}\}$$

$$NEma/DE = 1.123 - (4.092 * 10^{-3} * DE) + [1.126 * 10^{-5} * (DE)^2] - (25.4/DE)$$

$$NEga/DE = 1.164 - (5.160 * 10^{-3} * DE) + (1.308 * 10^{-5} * (DE)^2) - (37.4/DE)$$

where,
Cfi = Coefficient, the IPCC default value 0.335 for dairy cattle and the IPCC default value 0.322 for non-dairy cattle used;
Weight – dairy cattle (assumed according to available national information - average 550 kg); non-dairy cattle (assumed according to available national information - average 500 kg);
tp = Length of pasture season, 185 days non-dairy cattle, 145 days for dairy cattle;
Cap = Coefficient for pasture, the IPCC default value 0.17 used;
Cao = Coefficient for stall, the IPCC default value 0.00 used;
My = The amount of milk produced per year, kg a^{-1}/cow, Table 6.5.
Fat = Fat content of milk (%),Table 6.5;
Cp = Pregnancy coefficient, the IPCC default value 0.10 was used;
C = Coefficient related to growth for non- dairy cattle - 1.2 and for dairy cattle- 0.8 was used;
MW = Mature weight, (see IPCC 2000, p. 4.12);
WG = Average weight gain, (IPCC 2000, page 4.12) (kg/day), 0.25 kg for dairy cattle and for non- dairy cattle – 0.5 kg were used;
DE = Digestible energy (IPCC 2000, page 4.13), the proportion of feed energy (%) - 60% for dairy cattle and non- dairy cattle were used.

Table 6.5 Average milk yield per cow (kg/head/year) and Fat content, %

Year	Average milk yield (kg/year) according to information from CSB	Fat content, %
1990	3437	3.5*
1991	3205	3.5*

Year	Average milk yield (kg/year) according to information from CSB	Fat content, %
1992	2793	3.5*
1993	2741	3.5*
1994	2923	3.5*
1995	3074	3.5*
1996	3237	3.5*
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

*Fat content for 1990 - 1997 - expert judgment. Since 1997 - Central Statistical Bureau data

Emission factors and other parameters

To calculate CH_4 emissions from Enteric Fermentation the default emission factors as for developed countries according to Revised 1996 IPCC (Table 4-3, page 4.10) for sheep, goats, horses and swine were used (Table 6.6).

Table 6.6 Default CH_4 emission factors from Enteric Fermentation

Types of animals	EF (kg/head/year)
Sheep	8
Goats	5
Horses	18
Swine	1.5

Only for dairy cattle and non - dairy cattle separate emission factors (Table 6.7) have been calculated. For cattle, the gross energy intake (GE) has been calculated by using the IPCC GPG 2000 method. The calculation is based on the development of animal weight milk production, fat content and etc.

Table 6.7 Calculated CH4 emission factors for dairy cattle and non-dairy cattle from Enteric Fermentation, (kg/head/year)

Year	Dairy cattle	Non-Dairy cattle
1990	95.58	
1991	93.14	
1992	88.84	
1993	88.31	
1994	90.21	
1995	91.77	
1996	93.48	
1997	100.17	
1998	101.70	
1999	101.57	
2000	103.66	
2001	105.42	
2002	104.31	
2003	107.91	52.16

Year	Dairy cattle	Non-Dairy cattle
2004	108.20	
2005	110.00	
2006	111.54	
2007	113.51	
2008	115.53	
2009	116.48	
2010	117.56	
2011	117.82	

Activity data

The number Latvia and Collections of of cattle, sheep, horses, swine and goats were obtained from the Statistical yearbooks of statistical data "Agricultural farms of Latvia" (Table 6.8) .

Table 6.8 Number of livestock for 1990 -2011 at the end of the year (thousand heads)

Year	Dairy cattle	Non - Dairy cattle	Sheep	Goats	Horses	Swine	Poultry
1990	535.1	904.2	164.6	5.4	30.9	1401.1	10321.1
1991	531.4	851.5	183.7	6.1	30.0	1246.5	10395.1
1992	481.7	662.6	164.7	6.4	28.4	866.5	5438.3
1993	351.0	326.9	114.0	6.3	26.2	481.8	4123.7
1994	311.9	238.9	86.3	7.4	26.8	500.7	3699.6
1995	291.9	245.2	72.2	8.9	27.2	552.8	4198.3
1996	274.6	234.8	55.5	8.4	25.8	459.6	3790.7
1997	262.8	214.1	40.7	8.9	23.3	429.9	3550.7
1998	242.1	192.3	29.4	10.5	22.0	421.1	3208.8
1999	205.6	172.8	27.0	8.1	19.0	404.9	3236.9
2000	204.5	162.21	28.6	10.4	19.9	393.48	3104.6
2001	209.1	175.6	29.0	11.5	19.6	428.7	3621.2
2002	204.6	183.5	31.5	13.2	18.5	453.2	3882.0
2003	186.3	192.3	39.2	15.0	15.4	444.4	4002.6
2004	186.2	184.9	38.6	14.7	15.5	435.7	4049.5
2005	185.2	200.0	41.6	14.9	13.9	427.9	4092.3
2006	182.4	194.7	41.3	14.3	13.6	416.8	4488.1
2007	180.4	218.3	53.9	13.0	13.0	414.4	4756.8
2008	170.4	209.8	67.1	12.9	13.1	383.7	4620.5
2009	165.5	212.7	70.7	13.2	12.6	376.5	4828.9
2010	164.1	215.4	76.8	13.5	12.0	389.7	4948.7
2011	164.1	216.5	79.7	13.4	11.5	375.0	4417.9

Latvian livestock industry has been influenced by historical events and the changing world economic situation. Particularly significant changes in the livestock industry began in 1992 after the collapse of the Soviet Union and the restoration of Latvian independence. Since the Soviet Union had a planned economy, when Latvia was incorporated, most of the output of livestock products was carried out in other Soviet republics. Most farms which were a big dairy cows, fattening cattle, pig and poultry farms, went into liquidation. Many industrial companies ceased to operate, fell in purchasing power and demand for dairy products and meat and meat products, as well as their exports to Russia and CIS countries. Russian crisis almost stopped the export of livestock products. Reorientation of livestock product export to Western markets was more difficult in terms of market saturation and because the Latvian products are not necessarily in their requirements. All the above conditions affect the Latvian farmers and they were forced to reduce the milk, meat and egg production levels, and reduce and eliminate the herds. Consequently, livestock numbers declined most rapidly in 1990-1994 in all sectors, except for goat farming. Goat rearing is not particularly widespread in Latvia. Starting with 1995 dairy cattle numbers continued to decline. Beef cattle numbers continue to decline until 2001, which is due to the fact that the Latvian mostly subsistence farmers held from 1 to 2 dairy cows. At the process of the Soviet system farm liquidation even the sheep as engaged at the level of subsistence farms. Pig industry declined rapidly until 1996, but

starting in 1997 the reduction is no longer as sharp. In the case of stud-farms - after 1990 because of all the above-mentioned social and economic changes stud-farms eliminating, the horses were sold, only the strongest stud-farms continued to work. Poultry industry is related to the reduction of large poultry farms dissolution in 1990-1993 years. Starting with 2002 the number of animals has stabilized, but with 2004, according to Latvian accession to the European Union, the increase in the number of animals is seen for beef cattle, sheep and goat industries. The livestock sector has contributed to the development of European Union agricultural subsidies and public sectors.

6.2.3 Uncertainties and time series consistency

For estimating uncertainty for this category was used following assumptions:

Central Statistical Bureau (CSB) assessed that for number of livestock uncertainty could be 2-3%. In the calculations is used 2%. Emission factors estimated using the Tier 1 method may be uncertain to ±30% or ±50% [79]. Emission factor estimates using the Tier 2 method are likely to be in the order of ± 20% [80]. The overall uncertainty of 20% was assumed as biggest part of emissions consists from cattle.

6.2.4 Source-specific QA/QC and verification

General (Tier 1) Quality Control (QC) procedures applied to the category Enteric Fermentation based on the IPCC GPG 2000, Table 8.1, p. 8.8-8.9. These procedures are implemented every year during the agricultural inventory. If errors or inconsistencies are found they are documented and corrected. The QC checklist is used during the inventory.
The agricultural inventory has been reviewed several times by the UNFCCC Expert Review Teams, and improvements to the inventory have been made. Country-specific factors were calculated for dairy cattle and non dairy cattle. No source-specific recalculations were done.

6.2.5 Source-specific recalculations

No recalculations were done.

6.2.6 Source-specific planned improvements

Emissions from enteric fermentation report under the subgroups of non-dairy cattle for next inventory.

6.3 MANURE MANAGEMENT (CRF 4.B)

6.3.1 Source category description

The emission sources cover management of manure from domestic livestock. Latvia reports CH_4 and N_2O emissions from cattle (including dairy cows), swine, horses, goats, sheep and poultry (Table 6.9).

Table 6.9 Reported emissions under the subcategory Manure Management

CRF	Source	Emissions reported
4.B 1	Cattle Dairy Cattle Non-Dairy Cattle	CH_4, N_2O
4.B 2	Buffalo	NO
4.B 3	Sheep	CH_4, N_2O
4.B 4	Goats	CH_4, N_2O
4.B 5	Camels and Llamas	NO
4.B 6	Horses	CH_4, N_2O
4.B 7	Mules and Asses	NO
4.B 8	Swine	CH_4, N_2O
4.B 9	Poultry	CH_4, N_2O

[79] IPCC GPG 2000, p. 4.27
[80] IPCC GPG 2000, p. 4.28

CRF	Source	Emissions reported
4.B 11	Anaerobic Lagoons	NO
4.B 12	Liquid Systems	N_2O
4.B 13	Solid Storage and Dry Lot	N_2O
4.B 14	Other AWMS	N_2O

Production of nitrous oxide during storage and treatment of animal wastes can occur via combined nitrification-denitrification of nitrogen contained in the wastes. Nitrous oxide emissions from manure management have decreased by 79%, but Methane emissions by 68% over the time period 1990-2011 (Table 6.10; Table 6.11). The fluctuation in the emissions is related to the changes in animal numbers, which is largely dependent on agricultural policy, as well as changes in the distribution of animal waste management systems (AWMS).

Table 6.10 N_2O emissions from Manure Management in 1990-2011 by animal type*

Year	Dairy cattle	Non-Dairy cattle	Sheep	Goats	Horses	Swine	Poultry	CH_4 Manure Management Gg	Total Gg CO_2 eq
1990	2.94	3.62	0.03	0.00	0.04	5.60	0.81	13.04	273.76
1991	2.84	3.41	0.03	0.00	0.04	4.99	0.81	12.12	254.60
1992	2.46	2.65	0.03	0.00	0.04	3.47	0.42	9.07	190.47
1993	1.78	1.31	0.02	0.00	0.04	1.93	0.32	5.40	113.32
1994	1.62	0.96	0.02	0.00	0.04	2.00	0.29	4.92	103.28
1995	1.54	0.98	0.01	0.00	0.04	2.21	0.33	5.11	107.31
1996	1.48	0.94	0.01	0.00	0.04	1.84	0.30	4.59	96.47
1997	1.51	0.86	0.01	0.00	0.03	1.72	0.28	4.41	92.54
1998	1.41	0.77	0.01	0.00	0.03	1.68	0.25	4.15	87.21
1999	1.20	0.69	0.01	0.00	0.03	1.62	0.25	3.79	79.68
2000	1.16	0.22	0.01	0.00	0.03	1.57	0.24	3.23	67.87
2001	1.27	0.25	0.01	0.00	0.03	1.72	0.28	3.56	74.70
2002	1.18	0.25	0.01	0.00	0.03	1.81	0.30	3.58	75.26
2003	1.14	0.27	0.01	0.00	0.02	1.78	0.31	3.53	74.13
2004	1.20	0.27	0.01	0.00	0.02	1.74	0.32	3.56	74.75
2005	1.29	0.31	0.01	0.00	0.02	1.71	0.32	3.66	76.87
2006	1.52	0.37	0.01	0.00	0.02	1.67	0.35	3.93	82.58
2007	1.58	0.43	0.01	0.00	0.02	1.66	0.37	4.07	85.47
2008	1.64	0.44	0.01	0.00	0.02	1.53	0.36	4.00	83.96
2009	1.67	0.47	0.01	0.00	0.02	1.51	0.38	4.05	85.13
2010	1.74	0.52	0.01	0.00	0.02	1.56	0.39	4.23	88.92
2011	1.82	0.53	0.02	0.00	0.02	1.50	0.34	4.23	88.78
Share of total % in 2011	42.98%	12.61%	0.36%	0.04%	0.38%	35.48%	8.15%	100%	

***emissions from pasture not included, they are reported under 4.D Agricultural soils

Table 6.11 CH_4 emissions from Manure Management (MM) in 1990-2011 by animal type

Year	Dairy cattle	Non-Dairy cattle	Sheep	Goats	Horses	Swine	Poultry	CH_4 Manure Management Gg	Total Gg CO_2 eq
1990	2.94	3.62	0.03	0.00	0.04	5.60	0.81	13.04	273.76
1991	2.84	3.41	0.03	0.00	0.04	4.99	0.81	12.12	254.60
1992	2.46	2.65	0.03	0.00	0.04	3.47	0.42	9.07	190.47
1993	1.78	1.31	0.02	0.00	0.04	1.93	0.32	5.40	113.32
1994	1.62	0.96	0.02	0.00	0.04	2.00	0.29	4.92	103.28

Year	Dairy cattle	Non-Dairy cattle	Sheep	Goats	Horses	Swine	Poultry	CH_4 Manure Management Gg	Total Gg CO_2 eq
1995	1.54	0.98	0.01	0.00	0.04	2.21	0.33	5.11	107.31
1996	1.48	0.94	0.01	0.00	0.04	1.84	0.30	4.59	96.47
1997	1.51	0.86	0.01	0.00	0.03	1.72	0.28	4.41	92.54
1998	1.41	0.77	0.01	0.00	0.03	1.68	0.25	4.15	87.21
1999	1.20	0.69	0.01	0.00	0.03	1.62	0.25	3.79	79.68
2000	1.16	0.22	0.01	0.00	0.03	1.57	0.24	3.23	67.87
2001	1.27	0.25	0.01	0.00	0.03	1.72	0.28	3.56	74.70
2002	1.18	0.25	0.01	0.00	0.03	1.81	0.30	3.58	75.26
2003	1.14	0.27	0.01	0.00	0.02	1.78	0.31	3.53	74.13
2004	1.20	0.27	0.01	0.00	0.02	1.74	0.32	3.56	74.75
2005	1.29	0.31	0.01	0.00	0.02	1.71	0.32	3.66	76.87
2006	1.52	0.37	0.01	0.00	0.02	1.67	0.35	3.93	82.58
2007	1.58	0.43	0.01	0.00	0.02	1.66	0.37	4.07	85.47
2008	1.64	0.44	0.01	0.00	0.02	1.53	0.36	4.00	83.96
2009	1.67	0.47	0.01	0.00	0.02	1.51	0.38	4.05	85.13
2010	1.74	0.52	0.01	0.00	0.02	1.56	0.39	4.23	88.92
2011	1.82	0.53	0.02	0.00	0.02	1.50	0.34	4.23	88.78
Share of total % in 2011	42.98%	12.61%	0.36%	0.04%	0.38%	35.48%	8.15%	100%	

6.3.2 Methodological issues

Methods

Methane emissions from Manure Management for non-dairy cattle, sheep, goats, horses, and poultry are calculated by multiplying the number of the animals in each category with the emission factor for each category (Tier 1, IPCC GPG 2000).[81]

For dairy cattle and non-dairy cattle the Tier 2 approach was used for estimating CH_4 emissions from Manure Management systems as dairy cattle's represent a significant share of emissions. This method requires detailed information on animal characteristics and the manner in which manure is managed. Using this information, emission factors are developed that are specific to the conditions of the country.

Nitrous oxide emissions from Manure Management have been calculated by using IPCC GPG 2000 methodology equation 4.18. The amount of nitrogen excreted annually per animal has been divided between different manure management systems and multiplied with the IPCC default emission factor for each manure management system.

The manure management systems reported in the inventory is liquid system, solid storage and dry lot, pasture range and paddock and anaerobic digester. N excretion during the year per each animal type and the distribution of manure management systems are national calculated values.

Emissions from pasture are calculated under manure management, but are reported under pasture, range and paddock manure in CRF 4.D.

Emission factors and other parameters

Mainly default emission factors according to Revised 1996 IPCC (Tables 4-5, 4-6 pages 4.12-4.13) to calculate CH_4 emissions from Manure Management were used. Emission factors as

[81] IPCC GPG 2000, Equation. 4.15

for *cool* climate region were chosen (Table 6.12) because annual temperature in Latvia is 6.0 ºC.

Table 6.12 CH_4 emission factors from Manure Management

Types of animals	EF (kg/head/year)	Period
Other cattle	4	1990-1999
Sheep	0.19	1990-2011
Goats	0.12	1990-2011
Horses	1.4	1990-2011
Swine	4	1990-2011
Poultry	0.078	1990-2011

Tier 2 emission factors were developed for dairy cattle and other cattle for period 2000-2011 (Table 6.13) according to IPCC GPG 2000, Equation 4.16.

Table 6.13 CH_4 emission factors for dairy cattle from manure Management

Dairy cattle										
1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
5.5	5.3	5.1	5.1	5.2	5.3	5.4	5.8	5.8	5.8	5.7
2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
6.1	5.8	6.1	6.4	6.9	8.3	8.8	9.6	10.1	10.6	11.07
Other cattle										
2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
1.35	1.44	1.37	1.40	1.47	1.57	1.88	1.96	2.07	2.20	2.40
2011										
2.46										

Calculation of nitrous oxide emissions from Manure Management is also based on the Revised 1996 IPCC (Table 4-22, page 4.104) default emission factors (Table 6.14).

Table 6.14 IPCC default emission factors for N_2O from Manure Management

Manure Management System	Emission factor (kg N_2O – N/kg)
Liquid system	0.001
Solid storage and dry lot	0.020
Anaerobic digester	0.000

Activity data

Animal numbers were obtained from Central Statistical Bureau (CSB) (Table 6.8) and statistical bulletins for each year. The distribution of different manure management systems is shown in the Table 6.15 – Table 6.27 and used according to national studies.[82,83]

Table 6.15 Distribution of different manure management systems for 1990-1999 (%)

	Liquid system	Solid storage and dry lot	Pasture range and paddock
Dairy cattle	3.5	56.5	40
Non - Dairy cattle	2.1	52.7	45.2
Sheep		57.5	42.5
Goats		57.5	42.5
Horses		49.3	50.7
Swine	46	54	
Poultry	39	61	

[82] Ruža A. u.c. Lauksaimniecības rādītāju prognoze 2015. un 2020. gadam. 2011

[83] Research during the Project „CORINAIR – Institutional strengthening of National Air Emissions Inventories in Latvia", R. Sudārs. Nitrogen Separation

Table 6.16 Distribution of different manure management systems for 2000 (%)

	Liquid system	Solid storage and dry lot	Pasture range and paddock
Dairy cattle	8.6	36.6	54.8
Non - Dairy cattle	2.1	61.4	26.3
Sheep		40	60
Goats		70	30
Horses		48	52.0
Swine	42.5	53.8	3.7
Poultry		91.5	8.5

Table 6.17 Distribution of different manure management systems for 2001 (%)

	Liquid system	Solid storage and dry lot	Pasture range and paddock
Dairy cattle	13.3	60.8	25.9
Non - Dairy cattle	9.5	36.2	54.3
Sheep		40	60
Goats		70	30
Horses		50	50
Swine	48.5	48.2	3.3
Poultry		92.1	7.9

Table 6.18 Distribution of different manure management systems for 2002 (%)

	Liquid system	Solid storage and dry lot	Pasture range and paddock
Dairy cattle	12.5	61.2	26.3
Non - Dairy cattle	8.8	36.5	54.7
Sheep		40	60
Goats		70	30
Horses		50	50
Swine	54.8	42.4	2.8
Poultry		92.3	7.7

Table 6.19 Distribution of different manure management systems for 2003 (%)

	Liquid system	Solid storage and dry lot	Pasture range and paddock
Dairy cattle	13	60.9	26.1
Non - Dairy cattle	9.1	36.4	54.5
Sheep		40	60
Goats		70	30
Horses		50	50
Swine	60	37.5	2.5
Poultry		92.6	7.4

Table 6.20 Distribution of different manure management systems for 2004 (%)

	Liquid system	Solid storage and dry lot	Pasture range and paddock
Dairy cattle	14	60.2	25.8
Non - Dairy cattle	9.8	36.1	54.1
Sheep		40	60
Goats		70	30
Horses		50	50
Swine	65.6	32.2	2.2
Poultry		92.9	7.1

Table 6.21 Distribution of different manure management systems for 2005 (%)

	Liquid system	Solid storage and dry lot	Pasture range and paddock
Dairy cattle	15.3	59.3	25.4
Non - Dairy cattle	10.7	35.9	53.4
Sheep		40	60
Goats		70	30

	Liquid system	Solid storage and dry lot	Pasture range and paddock
Horses		50	50
Swine	69.4	28.6	2
Poultry		93.1	6.9

Table 6.22 Distribution of different manure management systems for 2006 (%)

	Liquid system	Solid storage and dry lot	Pasture range and paddock
Dairy cattle	19.5	56.3	24.2
Non - Dairy cattle	13.7	34.5	51.8
Sheep		40	60
Goats		70	30
Horses		50	50
Swine	77.4	21.2	1.4
Poultry		93.2	6.8

Table 6.23 Distribution of different manure management systems for 2007 (%)

	Liquid system	Solid storage and dry lot	Pasture range and paddock
Dairy cattle	20.5	55.6	23.9
Non - Dairy cattle	14.4	34.2	51.4
Sheep		40	60
Goats		70	30
Horses		50	50
Swine	80.1	18.6	1.3
Poultry		93.3	6.7

Table 6.24 Distribution of different manure management systems for 2008 (%)

	Liquid system	Solid storage and dry lot	Pasture range and paddock
Dairy cattle	22.5	54.2	23.3
Non - Dairy cattle	15.5	33.8	50.7
Sheep		40	60
Goats		70	30
Horses		50	50
Swine	80.8	17.8	1.4
Poultry		93.6	6.4

Table 6.25 Distribution of different manure management systems for 2009 (%)

	Liquid system	Solid storage and dry lot	Pasture range and paddock	Anaerobic digester
Dairy cattle	23.8	53.3	22.8	0.1
Non - Dairy cattle	16.7	33.3	50	
Sheep		40	60	
Goats		70	30	
Horses		50	50	
Swine	81.8	16.9	1.3	
Poultry		93.8	6.2	

Table 6.26 Distribution of different manure management systems for 2010 (%)

	Liquid system	Solid storage and dry lot	Pasture range and paddock	Anaerobic digester
Dairy cattle	25.1	52.1	22.3	0.5
Non - Dairy cattle	18.6	32.5	48.6	0.3
Sheep		40	60	
Goats		70	30	
Horses		50	50	

Swine	83.2	15.6	1.2	
Poultry		65.5	4.5	30

Table 6.27 Distribution of different manure management systems for 2011 (%)

	Liquid system	**Solid storage and dry lot**	**Pasture range and paddock**	**Anaerobic digester**
Dairy cattle	26.5	50.9	21.8	0.8
Non - Dairy cattle	19.3	31.1	49.2	0.4
Sheep		40	60	
Goats		70	30	
Horses		50	50	
Swine	84.1	14.7	1.1	0.1
Poultry		56.0	4.0	40

Data about annual N excretion per animal until 2004 (Table 6.28) obtained from national studies. National expert made an account, based on a research, in which livestock manure amount and nitrogen amount was analyzed over a long time period as well as different available information. Since 2005, annual N excretion per animal for emission calculation is corrected according to results of newest studies on development of manure normative and livestock units carried out by the State Ltd. "Agrochemical Research Centre". The mass balance approach was used for estimating N excretion by farm livestock. It requires information on both input (N_{intake}) and output ($N_{products}$) factors. N_{intake} was calculated as feed intake (kg of dry matter) x N content of the feed while $N_{products}$ includes the N in live weight gain, milk, etc.

According to information from previous national studies regarding average Nex for sheep and goats (Table 6.28) in Latvia there was very low level of produced nitrogen (6 kg/animal/yr) in difference from IPCC default (13 kg/animal/yr)[84] nitrogen amount because:

- basis of sheep and goats nutrition was rather poor as sheep and goats usually were not fed additionally;
- mainly local breed was used which is not very productive;
- in general sheep and goats farming as a branch in Latvia was relatively weakly developed.

Since Latvia accession to European Union in 2004 the increase in the number of animals is seen for sheep and goats. The reason is increase of funding formed by EU budget and state subsidies. Technologies and quality of production were improved and the capacity of realization of products was increased. The nitrogen extraction from those categories of livestock has increased.

Table 6.28 Average N excretions per head of animal

Types of animals	**N, kg/year till 2004**	**N, kg/year starting from 2005**
Other cattle	50	50
Dairy cattle	71	70
Swine	10	10
Sheep, Goats*	6	13
Horse	46	48
Poultry	0.6	0.6

*value of Nex for Goats is assumed as for sheep

N excretion by swine remains 10 kg nitrogen per animal in a year, that is low value compared with IPCC default (20 kg/animal/yr). The newest studies show a big difference in N excretion

[84] Revised 1996 IPCC, Table 4-20, page 4.99.

(4.5-19.4 kg/animal/yr) by different sub-categories of swine, but in average N excretion is about 10 kg/animal/yr.

N excretion for swine in average:

Livestock Category	Number of livestock in average 2005-2008, thousd	N excretion kg/head/yr*
Piglets (7.0-30.0 kg)	91.7	4.5
Fattening pigs (30-100 kg)	157.8	10,2
Young breeding sow (80-180 kg)	15.3	15.6
Breeding sows (180- 240 kg)	35.7	19.4
Total	**300.5**	
In average		**9.7**

**No. of production cycles/year: 6.4 for piglets, 3.2 for fattening pigs, 1,85 for young breeding sows, 2.35 for breeding sows*

The Central Statistical Bureau (CSB) of Latvia is collecting data on population of swine of such sub- categories:

- piglets, live weight less than 20 kg (including sucking piglets);
- young pigs, live weight 20- 50 kg;
- fattening pigs;
- young breeding sows;
- breeding sows.

Commercial pig production in Latvia mainly includes four or five phases, to take account of changes in nutrient requirements with increasing age of the pig: piglets with live weight 7-30 kg, fattening pigs 30-100 kg or 7-100 kg, young breeding sows and breeding sows. Therefore there are not researches data on N excretion by young pigs with live weight 20-50 kg. N excretion for breeding sows is calculated taken into account N excretion by sucking piglets.

The average N excretion values for pigs in other European countries vary from 9.0 until 12.4 kg per animal per year (Witzke, H.P. & Oenema, O. Assessment of most promising measures. Service contract „Integrated measures in agriculture to reduce ammonia emissions". Alterra, Wageningen, 31 May 2007).

6.3.3 Uncertainties and time series consistency

For estimating uncertainty for this category was used following assumptions:

- CSB assessed that for number of livestock uncertainty could be 2-3%;
- For emission calculation was used default emission factors (Tier 1) and in the IPCC GPG 2000 is described that they are with very large uncertainty, therefore was used 30% uncertainty.

6.3.4 Source-specific QA/QC and verification

General (Tier 1) Quality Control (QC) procedures applied to the category Manure management. The QA/QC plan for the agricultural sector includes the QC measures based on the guidelines of the IPCC (IPCC GPG 2000, Table 8.1). These activities are implemented every year in preparation process of agriculture inventory. If errors or inconsistencies are found they are documented and corrected. The QC checklist is used during the inventory.

Tier 2 QC for activity data: a checklist is used for ensuring consistency of the activity data in different sections of the agricultural inventory. Tier 2 QC for emission factors and other parameters will be checked annually if new data for updating emission factors has been published.

6.3.5 Source-specific recalculations

For submission 2013, recalculations of CH_4 emissions from non-dairy cattle manure management for period 2000-2011 are done based on the use of method Tier 2 instead of Tier 1. Calculation of CH_4 emissions from non-dairy cattle manure management for period 2000-2011 are done based on previously (submission 2012) corrected AWMS data prepared by Latvia University of Agriculture. Consequently, recalculations of CH_4 emissions from non-dairy cattle are done based on this update. Due to the lack of precise AWMS data for period 1990-1999 such recalculations are not possible. The use of different calculation methodology results in evident decrease of methane EF 1999-2000.

6.3.6 Source-specific planned improvements

It is planned to improve calculations with Tier 2 for Animal Waste Management Systems according to scientific studies by Latvia University of Agriculture.

6.4 AGRICULTURAL SOILS (CRF 4.D)

6.4.1 Source category description

This source category includes direct and indirect nitrous oxide emissions from Agricultural Soils (Table 6.29). Direct N_2O emissions include emissions from synthetic fertilizers, animal manure, biological nitrogen fixation, crop residues and cultivation of Histosoils. The emissions from nitrogen excreted to pasture range and paddocks by animals are reported under "animal production" in CRF tables. Indirect N_2O emissions from atmospheric deposition of NH_4 and NO_x as well as from leaching and run-off of the applied or deposited nitrogen are included in the inventory.

Table 6.29 Reported emissions under the subcategory Agricultural Soils

CRF	Source	Emissions reported
4.D 1	Direct Soil Emissions	N_2O
4.D 2	Pasture, Range and Paddock Manure	N_2O
4.D 3	Indirect Emissions	N_2O
4.D 4	Other	NO

Direct and indirect nitrous oxide emissions from agricultural soils have decreased in 2011 by 48.2% comparing with 1990 (Table 6.30). The main reason is decreasing of animal numbers that affected the amount of nitrogen excreted annually to soil. In the latest years emissions have increased. The main reason is increasing use of synthetic fertilizers and cultivation of organic soils.

Table 6.30 Direct and indirect nitrous oxide emissions from agricultural soils 1990-2011 by source category

Year	SF, Gg	MS, Gg	N, Gg	C, Gg	H, Gg	MP, Gg	A, Gg	L, Gg	Total, Gg
1990	2.32	0.94	0.01	0.11	1.69	1.16	0.54	2.8	9.57
1991	1.99	0.9	0.01	0.09	1.69	1.12	0.5	2.52	8.82
1992	1.17	0.7	0.00	0.08	1.68	0.93	0.36	1.74	6.67
1993	0.7	0.43	0.00	0.08	1.68	0.57	0.22	1.06	4.74
1994	0.51	0.38	0.00	0.06	1.67	0.48	0.18	0.85	4.13
1995	0.2	0.38	0.00	0.05	1.67	0.46	0.15	0.64	3.55
1996	0.26	0.35	0.00	0.06	1.66	0.44	0.15	0.64	3.57
1997	0.34	0.33	0.00	0.07	1.66	0.41	0.15	0.67	3.63
1998	0.35	0.30	0.01	0.06	1.65	0.37	0.14	0.63	3.51
1999	0.34	0.27	0.00	0.05	1.64	0.32	0.13	0.58	3.33
2000	0.41	0.32	0.002	0.060	1.64	0.29	0.13	0.62	3.46
2001	0.56	0.34	0.002	0.062	1.63	0.30	0.15	0.74	3.78
2002	0.49	0.35	0.002	0.070	1.62	0.31	0.14	0.70	3.68

Year	SF, Gg	MS, Gg	N, Gg	C, Gg	H, Gg	MP, Gg	A, Gg	L, Gg	Total, Gg
2003	0.66	0.33	0.003	0.065	1.62	0.30	0.16	0.80	3.93
2004	0.62	0.33	0.002	0.081	1.61	0.29	0.15	0.77	3.86
2005	0.72	0.34	0.002	0.101	1.60	0.30	0.16	0.85	4.08
2006	0.75	0.34	0.001	0.087	1.59	0.29	0.16	0.87	4.09
2007	0.81	0.35	0.001	0.118	1.58	0.30	0.17	0.92	4.27
2008	0.84	0.34	0.002	0.126	1.57	0.29	0.17	0.92	4.26
2009	0.92	0.34	0.003	0.125	1.57	0.29	0.18	0.97	4.38
2010	1.05	0.35	0.003	0.115	1.57	0.28	0.19	1.07	4.62
2011	1.06	0.34	0.004	0.114	1.57	0.28	0.19	1.06	4.61
Share of total % in 2011	22.91%	7.34%	0.10%	2.47%	33.93%	6.08%	4.11%	23.06%	100%

SF=synthetic fertilisers, MS= manure applied to soils, MP=manure deposited on pastures, C=crop residues, N=N-fixation, H=cultivation of organic soils, A=atmospheric deposition, L=leaching and run-off

6.4.2 Methodological issues

Methods

Nitrogen inputs to soils from all sources were calculated using IPCC Guidelines.

Direct N_2O emissions from agricultural soils are estimated as follows (IPCC GPG 2000, Equation 4.20):

$$N_2O_{DIRECT} - N = [(F_{SN} + F_{AW} + F_{BN} + F_{CR}) * EF_1] + F_{OS} * EF_2$$

$N_2O = N_2O\text{-}N * 44/28$

Nitrogen input through application of mineral fertilizers

The method applied for calculation of emissions is IPCC GPG 2000 Tier 1a, Equation 4.22:

$$F_{SN} = N_{FERT} * (1\text{-}Frac_{GASF})$$

F_{SN} – annual amount of synthetic fertilizer nitrogen applied to soils
N_{FERT} – annual amount of nitrogen in synthetic fertilizers applied to soils, thsd.t (Table 6.34)
$Frac_{GASF}$ – fraction of nitrogen lost through gaseous emissions of NH_3 and NOx (**0.1** kg NH_3-N +NOx-N/kg of synthetic fertiliser N applied, Revised 1996 IPCC, Table 4-19)

Nitrogen input through application of animal manure

For emission calculation is used equation from IPCC GPG 2000 Tier 1a-approach, Equation 4.23:

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

F_{AW} - animal manure nitrogen used as fertilizer, adjusted for volatilization;
$\sum_T (N_{(T)} \bullet Nex_{(T)})$ - total amount of animal manure nitrogen produced annually, kg/Nyr;
$Frac_{FUEL\text{-}AM}$ – amount of animal manure that is burned for fuel, such activities not occurred in Latvia;
$Frac_{PRP}$ – amount of animal manure that is deposited onto soils by grazing livestock;
$Frac_{GASM}$ – fraction of livestock nitrogen excretion that volatilises as NH3 and NOx (**0.2** kg NH_3-N+NOx-N/kg, Revised 1996 IPCC, Table 4-19).

N fixed by Crops (F_{BN})

The method applied for calculation of emissions is IPCC GPG 2000 Tier 1b, Equation 4.29, modified:

$$F_{BN} = \sum_i (Crop_{BF_i} \bullet (1 + \mathrm{Re}\,s_{BFi} / Crop_{BFi}) \bullet Frac_{DM} \bullet Frac_{NCRBFi}) \bullet EF \bullet 44/28$$

CropBFi – seed yield of pulses (peas and beans) (Table 6.35);
ResBFi/CropBFi – residue to crop product ratio (Table 6.33);
Frac DM – dry matter fraction (Table 6.33);
Frac NCRBFi – nitrogen fraction (Table 6.33);
EF – emission factor (0.0125 kg N2O –N/kg N load).

Nitrogen input from crop residues

The method applied for calculation of emissions is IPCC GPG 2000 Tier 1b, Equation 4.29, modified:

$$F_{CR} = \sum_i [(Crop_{Oi} \bullet \mathrm{Re}\,s_{Oi} / Crop_{Oi} \bullet Frac_{DM} \bullet Frac_{NCROi}) \bullet (1 - Frac_r) + \sum_i [Crop_{BFj} \bullet \mathrm{Re}\,s_{BFj\bullet} / Crop_{BFj} \bullet Frac_{DM} \bullet Frac_{NCRBFj}) \bullet (1 - Frac_R)] \bullet EF \bullet 44/28$$

$Crop_{BFj}$ – crop production (each nitrogen-fixing crop type) (Table 6.35);
$Res_{oi}/Crop_i$; $Res_{BFj}/ Crop_{BFj}$ - residue to crop product ratio (Table 6.33);
Frac $_{DM}$ – dry matter fraction (Table 6.33);
Frac $_{NCRBFj;}$ Frac $_{NCROi}$ – nitrogen fraction (Table 6.33);
$Frac_R$ – crop biomass removed from field as product = 0.45 kg N/kg crop-N, Revised 1996 IPCC, Table 4-19);
EF – emission factor (0.0125 kg N_2O –N/kg N load).

Area of cultivated organic soils (Histosols- F_{OS})

The IPCC GPG 2000 defines Histosoils as the area of organic soils cultivated annually. For Submission 2013, areas of cultivated Histosoils were recalculated for period 2000-2011 (Table 6.31) according to newest available information provided by Latvian State Forest Research Institute "Silava". Area of organic farmlands is changed because of update of the National forest inventory data on cropland and grassland area. Both, organic soils in cropland and grassland is considered in estimation, assuming that share of organic soils is equal in cropland and grassland (5.18 % of the total area). The share of organic soils in farmlands is estimated by the L.U. Consulting company (2009) by evaluation of historical soil maps (representing situation in 60ths to 80ths of the last century). Due to the fact that land use is changed since that (croplands converted to grasslands, grasslands to forest lands and vice versa) actual distribution of organic soils in cropland and grassland is not known. The study on spatial assessment of organic soils in cropland and grassland is started in 2012. Preliminary results of the study (20% of the NFI sample plots visited) shows, that actual share of organic soils in cropland is below 0.5%, in grassland – below 2% and in afforested areas – about 3%; therefore, these results approves that emissions are not underestimated from organic soils in cultivated farmlands. Actual figures will be used as soon as at least 50% of sample plots will be visited. Detailed description is included under LULUCF chapter.

Table 6.31 Areas of Histosols*

Year	Area of cultivated organic soils, ha/year
1990	134610.23
1991	134246.97
1992	134005.51
1993	133635.97
1994	133238.39
1995	132824.62
1996	132276.93
1997	131734.17
1998	131308.17
1999	130723.35
2000	130230
2001	129558
2002	129071
2003	128548

Year	Area of cultivated organic soils, ha/year
2004	127931
2005	127295
2006	126639
2007	125965
2008	125270
2009	124542
2010	124553
2011	124559

Latvian State Forest Research Institute "Silava".

Atmospheric Deposition (NH_3 and NO_x)

Atmospheric deposition of nitrogen compounds such as nitrogen oxides (NO_x) and ammonium (NH_4) fertilizes soils and surface waters that results in enhanced biogenic N_2O formation[85].

The default IPCC Tier 1 method (eq. 4.31) is used to estimate emissions from the atmospheric deposition:

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

$N_2O_{(G)}$ – N_2O produced from atmospheric deposition of N, kg N/yr;
N_{FERT} – total amount of synthetic nitrogen fertiliser applied to soil, kg N/yr (Table 6.34)
$Frac_{GASF}$ – fraction of synthetic N fertiliser volatilises as NH_3 and NOx, kg NH_3-N and NOx-N/kg of N input;
$Frac_{GASM}$ – fraction of animal manure N volatilises as NH_3 and NOx, kg NH_3-N and NOx-N/kg of N excreted;
EF_4 – emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, kg N_2O-N/kg NH_3-N and NOx-N emitted (Table 6.32).

Leaching/runoff of applied or deposited nitrogen

A large proportion of nitrogen is lost from agricultural soils through leaching and runoff. This nitrogen enters the groundwater, riparian areas and wetlands, rivers, and eventually the ocean, where it enhances biogenic production of N_2O [86].

The default IPCC Tier 1 method (eq. 4.34) is used to estimate emissions from the leaching/runoff:

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

N_{FERT} – total amount of synthetic nitrogen fertiliser applied to soil, kg N/yr;
$Frac_{LEACH}$ – fraction of N input that is lost through leaching and runoff;
EF_5 – emission factor for leaching and runoff, kg N_2O-N/kg N leached and runoff (Table 6.32).

Emission factors and other parameters

IPCC default emission factors, national values and other parameters have been used. Emission factors and other parameters are presented in Table 6.32.

Table 6.32 N_2O emission factors for emissions calculation from agricultural soils

Categories	Emission factors	Reference
Synthetic fertilizers	0.0125 kg N_2O-N/kg N	IPCC GPG 2000, Table 4.17
AWAS	0.0125 kg N_2O-N/kg N	IPCC GPG 2000, Table 4.17
N-fixing Crops	0.0125 kg N_2O-N/kg dry biomass	IPCC GPG 2000, Table 4.17
Crop residue	0.0125 kg N_2O-N/kg dry biomass	IPCC GPG 2000, Table 4.17
Organic soils	8 kg N_2O – N/ha	IPCC GPG 2000, Table 4.17
Atmospheric deposition (EF_4)	0.01 kg N_2O-N/kg NH_3-N&NOx-N deposited	IPCC GPG 2000, Table 4.18
N-leaching and run-off (EF_5)	0.025 kg N_2O-N/kg N yr	IPCC GPG 2000, Table 4.18

[85] IPCC GPG 2000, page 4.68.
[86] IPCC GPG 2000, page 4.70.

Categories	Emission factors	Reference
N excretion on pasture range and paddock	0.020 kg N_2O-N/kg N yr	Revised 1996 IPCC, Table 4-22

The nitrogen excreted per animal is the same used for calculating nitrous oxide emissions from Manure Management (Table 6.28).

Values of dry matter fraction, nitrogen fraction and residue/crop production ratio are presented in the Table 6.33.

Table 6.33 Values of Residue/Crop product ratio, Dry Matter Fraction and Nitrogen content of crops

	Dry Matter Fraction	Nitrogen Fraction (Frac NCRBF)	Residue/Crop product ratio
Wheat*	0.86	0.005	1.2
Barley*	0.86	0.006	1.0
Triticale*	0.86	0.005	1.1
Oats*	0.86	0.006	1.1
Rye *	0.86	0.005	1.3
Rape*	0.86	0.007	2.0
Mixed cereals and pulses*	0.86	0.01	1.1
Buckwheat**	0.86	0.0106	2.0
Potatoes*	0.16	0.003	0.3
Sugar beet*	0.13	0.004	0.8
Feedbeet*	0.11	0.003	0.5
Maize for silage and forage***	0.25	0.0028	0.3
Crops for green feed and silage***	0.18	0.004	0.3
Vegetable*	0.13	0.015	0.2
Peas and beans *	0.86	0.0148	1.1

*A. Kārkliņš. Plant nutrient off-take as agro-environmental indicator. Latvian Academy of Agricultural and Forestry sciences, Latvia University of Agriculture: Proceedings in agronomy, No. 3, Jelgava, 2001, pp. 14-19 (all values , excl. Residue/crop product ratio on maize and other crops for green feed and silage)

**Augkopība. A.Ružas red. Latvijas lauksaimniecības universitāte, 2004.,4. pielikums.

***Trockenmassebilding und Stickstoffmengen in den Stoppeln und Wurzeln bei vershiedenen Zwishenfruchtformen. Nach V. Boguslawski, 1981. Faustzahlen fur Landwirtschaft un Gartenbau. 12. Auflage. Verlagsunion Agrar, 1993, s. 278 (Values on Residue/crop product ratio on maize and other crops for green feed and silage).

Activity data

Activity data obtained from the Central Statistical Bureau (CSB) animal numbers – used the same as for calculating CH_4 and N_2O emissions from Enteric Fermentation and CH_4 and N_2O emissions from Manure Management (Table 6.8), use of N synthetics and productions of crops.

Other data sources (distribution of different manure management systems) are shown in the Tables 6.15 - 6.27.

Table 6.34 Amount of use of N synthetic fertilizers

Year	N synthetic fertilizers (thsd.t)
1990	131.4
1991	112.4
1992	66.0
1993	39.7
1994	29.0
1995	11.5
1996	14.5
1997	19.4
1998	19.6

Year	N synthetic fertilizers (thsd.t)
1999	19.0
2000	23.0
2001	31.6
2002	27.6
2003	37.4
2004	35.2
2005	40.9
2006	42.7
2007	46.1
2008	47.5
2009	51.9
2010	59.5
2011	59.8

There are same differences between Central Statistical Bureau of Latvia and FAO data about N synthetics fertilizers use. The data officially submitted to the FAO by CSB (Central Statistical Bureau of Latvia) covers physical volume consumed broken down by type of N fertiliser starting from 2007 and total volume of N consumed, expressed as 100% of nutrients from 2005 to 2006. The information on other years is not familiar to the CSB. The data possibly were sent to the FAO by some other Latvia institution. According to the FAO explanation, the total volume of nitrogen consumed is recalculated as 100% of nutrients by the FAO itself with the help of data on consumed fertilisers at physical weight. The data acquired in such a way are not precise. The results are influenced by the recalculation of the complex fertilisers consumed to 100% of nutrients, because N content differs. The calculations of the CSB are more precise, because the data have been calculated from the primary data in which the N content in each specific fertiliser has been indicated. The CSB confirms that in GHG Inventory calculations the official statistical data on volume of N consumed expressed as 100% of nutrients have been used. CSB consider that no corrections should be made in the Latvian GHG Inventory N-synthetic fertilizer consumed data. Amount of sewage sludge applied to agricultural soils in Latvia is very small. Also official country-specific data provided by CSB is not available to allow the preparation of emission estimates in accordance with the IPCC good practice guidance.

Table 6.35 Crops production (thsd.t) used for calculation of N_2O emissions

Year	Wheat	Barley	Triticale	Maize for silage and forage**	Oats	Rye	Crops for green feed and silage**	Rape	Mixed cereals and pulses	Buckwheat*	Potatoes	Sugar beet	Feedbeet	Vegetable	Peas and beans
1990	371.8	697		967.3	176.1	323.6	952.8	3.7	30.7	0	1016.1	439.1	1388.4	169.4	22.7
1991	190.2	764.9	7.4	785	177.2	145.8	894.1	0.9	29.3	0	944	377.9	1211.8	209.2	20.7
1992	432.4	433.5	8.6	317.5	60	295	442	1.4	13.3	0	1167.4	462.6	901.5	250.8	8.6
1993	338.3	455.5	13.6	137.6	73.7	340.7	341.6	2.5	8.8	0.1	1271.7	298	859	284.8	4.3
1994	199.4	481.1	5.6	26.5	88.9	113.4	206.6	1.8	7.6	0.1	1044.9	228.2	687.2	233.2	4.5
1995	243.7	284	4.9	13	73.2	71.3	164.8	0.9	11.9	0	863.7	250	432.7	223.7	4.7
1996	357.5	371.5	3.4	11.9	101.4	112.9	151.3	1.3	14	0.1	1081.9	257.8	399.1	179.5	7.8
1997	394.6	359.8	7.5	10.4	116.5	133.5	154.3	0.5	22.5	0.8	946.2	387.5	404	162.5	8.3
1998	385.3	321.7	12.6	13.3	103.6	104.8	164.3	1.6	29.3	1.6	694.1	597	347	119.6	11.3
1999	351.9	232.6	11.9	15.7	66.1	88.7	128	11.7	16.2	2.2	795.5	451.5	235.1	130.1	3.6
2000	427.4	261.1	13.5	24.1	79.6	110.7	137.6	10	25.4	5.9	747.1	407.7	222.3	105.8	3.9
2001	451.7	231.1	28.9	25.1	82.4	107.2	98	13	16.9	9.8	615.3	491.2	203	159.3	4
2002	519.5	262.4	40.9	25.7	79.7	101.5	98.4	32.7	16.2	8.3	768.4	622.3	153.7	148.2	4.2
2003	468.4	246.6	33	44.3	78.3	87.6	140.3	37.4	13.1	5.4	739	532.4	158.5	217.5	5
2004	499.9	283.5	42.1	52.8	107.4	96.8	148.5	103.6	22.9	6.9	628.4	505.6	130.1	180.8	4.5
2005	676.5	365.8	31.8	58	122	87.2	112.1	145.7	21.1	9.9	658.2	519.9	88.3	172.2	3.5
2006	598.3	307	22.2	63.8	91.6	116.8	110.7	120.6	15.9	6.9	550.9	473.9	61.4	174.4	1.4
2007	807.3	350.5	37.9	122.6	130.2	181.1	148.6	196.9	17.1	11.1	642.1	11	53.2	155.9	2.6
2008	989.6	307.1	35.2	125.3	141.5	194.9	109.9	198.5	14	7.1	673.4	-	22.4	143.2	2.9
2009	1036.4	265.4	33.3	226.6	141.4	162.2	90.7	204.7	19.6	4.8	525.4	-	17.6	182.5	5.2

Year	Wheat	Barley	Triticale	Maize for silage and forage**	Oats	Rye	Crops for green feed and silage**	Rape	Mixed cereals and pulses	Buckwheat*	Potatoes	Sugar beet	Feedbeet	Vegetable	Peas and beans
2010	989.3	228.5	26.4	209	100.6	70.2	82.6	226.3	15	5.5	484.3	-	20.4	151.0	5.4
2011	939.5	236.7	21.4	345.6	120.9	64	84	219.1	19.9	9.6	498.6	-	14.8	168.2	8.4

Activity data is taken from Central Statistical Bureau (CSB). Statistical surveys are the source of data on crop in commercial companies, private farms and individual merchants. All crop areas are included in the inventory crop production data, also crop production on agricultural land smaller than 1 ha. CSB arrange surveys to largest farms, but data from smallest farms are incorporated in the official state statistics. Fluctuations in activity data is observed due to economical situation in the country. Since 2007, two sugar companies stopped their activity therefore no data presented further.

6.4.3 Uncertainties and time series consistency

For estimating uncertainty for this category was used following assumptions:

- CSB assessed that for number of livestock uncertainty could be 2-3%;
- For emission calculation was used default emission factors (Tier 1) and in the IPCC GPG 2000 is described that they are with very large uncertainty, therefore was used 30% uncertainty.

6.4.4 Source-specific QA/QC and verification

General (Tier 1) Quality Control (QC) procedures were applied. The QA/QC plan for the agricultural sector includes the QC measures based on the guidelines of the IPCC (IPCC GPG 2000, Table 8.1). These activities are implemented every year in preparation process of agriculture inventory. If errors or inconsistencies are found they are documented and corrected. The QC checklist is used during the inventory.

Tier 2 QC for activity data: activity data were checked for ensuring consistency of the different sections of the agricultural inventory. The activity data was checked also by CSB and third part expert (not involved in GHG inventory preparation).
Tier 2 QC for emission factors: the agricultural inventory has been reviewed several times by the UNFCCC Expert Review Teams.

6.4.5 Source-specific recalculations

For submission 2013, following recalculations were done: estimation of emissions from area of cultivation of histosoils for period 2000-2010 is done based on updating cultivated organic soils area numbers provided by Latvian State Forest Research Institute "Silava".

6.4.6 Source-specific planned improvements

In the future submissions it is planned to evaluate new methodology for assessing area of cultivated organic soils (Histosols) for N_2O emission calculation.

6.5 FIELD BURNING OF AGRICULTURAL RESIDUES (CRF 4.F)

Field Burning of Agricultural Residues isn't taking place in Latvia therefore notation key – NO is used. 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. Available at http://www.likumi.lv/doc.php?id=89648.

CHAPTER 7: LAND-USE, LAND-USE CHANGE AND FORESTRY (CRF 5)

7.1 LAND-USE, LAND-USE CHANGE AND FORESTRY (CRF 5)

7.1.1 Overview of sector

This category comprises CO_2 emissions and removals arising from Land Use, Land Use Change and Forestry (LULUCF). This sector is very important in Latvia in 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 that the increment of timber wood in Latvia is one of the largest in Europe. According to data provided by National statistical forest inventory (NFI) total forest area (including afforested lands) in 2011 was 3347 kha (52 % of total country area). Forest area is estimated using the National forest inventory (NFI) data, correction is applied to demonstrate projected impact of deforestation, afforestation and other land use changes. Updated figures will be applied for the period 2008-2013, when the NFI will complete second round of the inventory plots measurement (end of 2013). Total area of afforested lands from 1990 to 2011 is 204.7 kha, excluding areas afforested in 1990 and 1991 (14.1 kha), which are now relocated to the forest land remaining forest category in the convention reporting. The afforestation occurs on grassland being grassland since 1990 or lands converted from cropland to grassland during the reporting period. No afforestation is reported in 2010 and 2011, because of lack of reliable data. Information about afforested lands will be updated in 2014, when the field measurement data of the second round of the NFI will be available. Deforestation in 2010-2011 is calculated using the extrapolation method, assuming that deforestation to cropland and to settlements will follow to a linear regression based on data from 1990 to 2009. The same approach is not used for afforestation, because there are clear evidences that afforestation rate is decreasing due to growing subsidies to farmers and larger motivation to return abandoned lands into agricultural production. Considering that the intermediate report on the second round of the NFI will be available in 2014, partial data (80 % of all plots) will be used to recalculate land use at the end of 2013. According to the experience in the first round of the NFI, 80 % of data are sufficient for statistical analysis.

Forest area and deforested area were estimated in 2009 using remote sensing approach – vegetation index were estimated in all the NFI points, including those outside forest lands in satellite image (LANDSAT) 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. Empirical data from site visits of the NFI plots (2004-2008) were used to identify if forest land is converted to settlements or cropland. Emissions due to deforestation were estimated as losses in living and dead wood, litter and soil carbon pool as well as N_2O emissions related to disturbances due to conversion to cropland. Losses in living biomass are accounted as average harvesting losses according to the annual figures of commercial felling accounted by the State forest service (SFS). Instant oxidation considered for all living and dead biomass carbon pools in case of deforestation. Carbon stock changes in soil in case of deforestation are accounted considering transition period of 20 years, assuming that in case of deforestation to cropland carbon stock in 0-30 cm deep soil layer will reach average values in historical cropland, but in case of deforestation to settlements carbon stock in soil in 0-30 cm layer will reach zero level during this period.

Afforested lands (land converted to forest) were estimated using different approach of evaluation of the NFI data – plots covered by woody vegetation on non-forest lands (less than 20 years old forest stands with no identified stumps on plain areas characteristic for croplands and grasslands) were separated from other forest lands and after mathematical reduction of age of the forest stands actual area of afforested lands in every year since 1990 were estimated. Increment in living biomass were estimated as stock difference assuming that

growing characteristics of different stand types did not change since 1990 (for instance, 5 years old stands on fertile dry mineral soils in 1995 had the same increment as the ones on fertile dry mineral soils in 2000). Results of the estimation are presented in the research conference Students on Their Way to Science[87] and summarized in research report published in 2010[88]. Changes in dead wood and litter carbon pools are estimated assuming that these pools will reach average values in forest lands within 45 years following to a linear regression of accumulation of dead wood in afforested lands. The figures will be updated as soon as more detailed information will be provided by the NFI. No carbon stock changes due to afforestation are considered in soil carbon pool to avoid overestimation of removals. The project on evaluation of average carbon stock in land historically being cropland and grassland is started in 2012 and the first results shows, that there is significant difference between forest land, grassland and cropland soil; however, only 20 % of sample plots are covered up to now and these results can be considered as preliminary. The project on evaluation of carbon stock in soil in recently afforested grassland (2012) demonstrated that there is no statistically significant difference between carbon stock in soil in historical grassland and typical afforested land.

Significant share of forested land fitting to the National definition (forest infrastructure, mares and wetlands) which do not fit to the forest definition under the convention are reported under settlements, wetlands or grasslands. No removals are reported under these categories due to a high uncertainty level of the increment data of living biomass.

Category other lands consist of degraded and recultivated areas. No removals or emissions are reported under this category, as it is not managed by definition.

In submission 2013, for 1990-2011 Latvia reports carbon stock changes and GHG emissions from forest land, wetland, cropland and grassland using the CRF tables. 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 as well as the land use information. Calculations were done by Latvia 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), liming of agricultural soils (cropland), controlled burning (forest land, grassland) and wildfires (forest land) were estimated using Tier 1 and Tier 2 methods and country specific activity data. Emissions associated with industrial peat extraction in wetlands are reported under the Wetlands' category using Tier 1 approach and default activity data (IPCC GPG LULUCF 2003, TABLE 3a.3.3 Estimates of peatland areas and use for tier 1 in 1000 hectares). Emissions from deforestation (living and dead wood, litter and soil carbon pools) were introduced in 2011 and the reporting methodology is now updated to switch from instant oxidation to periodic changes in soil carbon pool calculations. Currently dead wood and litter is reported using instant oxidation method in deforested areas. 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; however, due to limited knowledge about carbon stock changes "Not a source" assumption was considered for soil carbon pool in case of conversion from cropland to grassland. The study on comparison

[87] Lazdiņš, A., 2011. Harmonization of land use matrix in Latvia according to requirements of international greenhouse gas reporting system - extending outputs of National Forest inventory program, in: Collection of Abstracts. Presented at the 6th Internationasl Scientific Conference Students on Their Way to Science, Latvia University of Agriculture, Faculty of Social Sciences, Faculty of Engineering, Forest Faculty, Jelgava, p. 10.

[88] Lazdiņš, A., Āboliņa, L., Zariņš, J., Jansons, J., Razma, Ģ., Donis, J., 2010. Mežu zemes izmantošanas maiņas matricas izstrādāšana un integrēšanu nacionālajā siltumnīcefekta gāzu inventarizācijas pārskatā par Kioto protokola 3.3 un 3.4 pantā minētajiem pasākumiem (Elaboration and integration with the GHG inventory report of the activities under Kyoto protocol articles 3.3 and 3.4 of forest land use change matrix). LVMI Silava, Salaspils.

of carbon stock in agricultural soils is started in 2012 and will be completed until the end of the reporting period. The study is based on activities previously started in forest lands within the scope of the NFI. Carbon stock changes in forest soils and litter will be reported in 2014 on the base of the Level 1 forest monitoring plots (95 plots distributed in 16 km grid). In case of additional funding number of the soil monitoring plots will be increased to 210. Similar sample plots are established in 2012 on cropland remaining cropland and grassland remaining grassland (up to now 20 % of sampling and analytical work is completed, it means 40 sample plots). According to preliminary results carbon stock in soil (0-30 cm) in land being cropland since 1990 is 61.8 ± 1.7 tons ha^{-1} and in land being grassland since - 86,8 ± 6,5 tons ha^{-1}. We will use these values to approve that conversion of croplands to grasslands is not a source of soil emissions; however, we would like to complete at least 40 % of the project to put these results into the GHG inventory to avoid serious mistakes. This work will be done during 2013.

Emissions of GHG due to forest fires in LULUCF sector in this report are calculated using data about areas of forest fires provided by the State forest service (SFS) . Default values for incinerated biomass and emission factors were used in calculation. More detailed explanation is provided in chapter 7.8.4 Methodological issues. The same approach is utilized to estimate emissions from burning of grass on grasslands. Negligible emissions from wildfires on wetlands are reported under forest lands due to the fact that the national statistics do not separate these areas.

This is the first year, when Latvia reported harwested wood products (HWP) pools using data, which were obtained during elaboration of the Forest management reference level (FMRL). The most of methodologies, like historical data on increment and mortality rate in forests were borrowed from the methodology of the FMRL calculations.

Land use categories according national and IPCC GPG LULUCF classification are listed in Table 7.1.

Table 7.1 Land use categories in NFI

No.	Land use categories in NFI	Relevant land use category in IPCC GPG LULUCF 2003
1	Yards And Gardens	
2	Cropland	
3	Animal feeding glade	Cropland
4	Sparse Forest In Farmland	
5	Forest in farmland	
6	Clear-cut area	
7	Windblown area	
8	Forest fire area	
9	Decayed stand	
10	Forest	Forest land
11	Grassland	
12	Glade	Grassland
13	Recultivated Land	
14	Sands and dunes	
15	Moorland	Other land
16	Other Special Purpose Land	
17	Resting-Place	
18	Seed Orchard	
19	Ditch	
20	Mineralized Band, Fire-Break	Settlements

No.	Land use categories in NFI	Relevant land use category in IPCC GPG LULUCF 2003
21	Forest Compartment Break	
22	Industrial Networks	
23	Cities	
24	Quarry, Fresh	
25	Quarry, Abandoned	
26	Railway	
27	Road	
28	Fire-break	
29	Forest road	
30	Channel	
31	Alluvial Land	
32	Ditch In Farmlands	
33	Lake, Pond	
34	River	
35	Forest ditch	
36	Flood land	
37	Transitional swamp	
38	Grass swamp	
39	Moss swamp	Wetlands

Initial 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. Land use changes for the forest lands (deforestation) are estimated using satellite images (the project mentioned above) and the NFI data on afforestation. Conversion of cropland to grassland is estimated mathematically using interpolation method comparing reliable data about area of cropland in 1990-1994 and 2006-2009.

The data on land use change reported in 2011 are based on extrapolations and will be updated in the inventory as soon as the NFI will process at least 80 % of data from the second inventory period. The areas of IPCC land-use categories and Latvia's official land area are given in Table 7.2.

Table 7.2 Areas of IPCC land-use classes in 1990-2011, kilo ha

Year	Total area[89]	Forests	Cropland	Grassland	Wetland	Settlement	Other lands
1990	6 458.9	3 168.6	1 751.4	844.7	448.3	238.8	4.3
1991	6 458.9	3 175.0	1 719.3	869.8	448.3	239.4	4.3
1992	6 458.9	3 179.0	1 687.3	897.2	448.3	240	4.3
1993	6 458.9	3 185.6	1 655.2	922.1	448.3	240.6	4.3
1994	6 458.9	3 192.7	1 623.2	946.5	448.3	241.2	4.3
1995	6 458.9	3 200.0	1 591.1	970.6	448.3	241.8	4.3
1996	6 458.9	3 210.1	1 559.0	992.1	448.3	242.3	4.3
1997	6 458.9	3 220.1	1 527.0	1 013.7	448.3	242.7	4.3

[89] Total area of the country where estimated from digital map which was used to separate the NFI plots, which are located in Latvia and abroad (http://www.envirotech.lv/index.php?v=1&s1_id=396), therefore this area differs from official figures provided by the CSB (GZG01. GEOGRAPHICAL POSITION OF THE REPUBLIC OF LATVIA, 64569 km^2).

Year	Total area[89]	Forests	Cropland	Grassland	Wetland	Settlement	Other lands
1998	6 458.9	3 227.9	1 494.9	1 037.6	448.3	243.2	4.3
1999	6 458.9	3 238.7	1 462.8	1 058.3	448.3	243.7	4.3
2000	6 458.9	3 247.7	1 430.8	1 080.9	448.3	244.1	4.3
2001	6 458.9	3 259.8	1 398.7	1 100.0	448.3	245	4.3
2002	6 458.9	3 268.3	1 366.7	1 122.6	448.3	245.9	4.3
2003	6 458.9	3 277.5	1 334.6	1 144.6	448.3	246.8	4.3
2004	6 458.9	3 288.5	1 302.5	1 164.8	448.3	247.7	4.3
2005	6 458.9	3 299.9	1 270.5	1 184.6	448.3	248.6	4.3
2006	6 458.9	3 311.6	1 238.4	1 204.0	448.3	249.5	4.3
2007	6 458.9	3 323.8	1 206.3	1 223.0	448.3	250.4	4.3
2008	6 458.9	3 336.3	1 174.3	1 241.7	448.3	251.2	4.3
2009	6 458.9	3 349.4	1 142.2	1 259.7	448.3	252.1	4.3
2010	6 458.9	3 348.3	1 142.4	1 259.7	448.3	253.1	4.3
2011	6 458.9	3 347.2	1 142.5	1 259.7	448.3	254.1	4.3

Net emissions of aggregated GHGs (CO_2, CH_4 and N_2O) in LULUCF sector in 2011 were -17179.2 Gg of CO_2 equivalents (Figure 7.1). The most of the emissions and removals are associated with the carbon stock changes, mainly in forest living biomass. Aggregated net removals of the GHGs reduced by 23 % in 2011 compared to 1990. Considerable reduction is associated with increase of the harvesting rate and increase of age of forests.

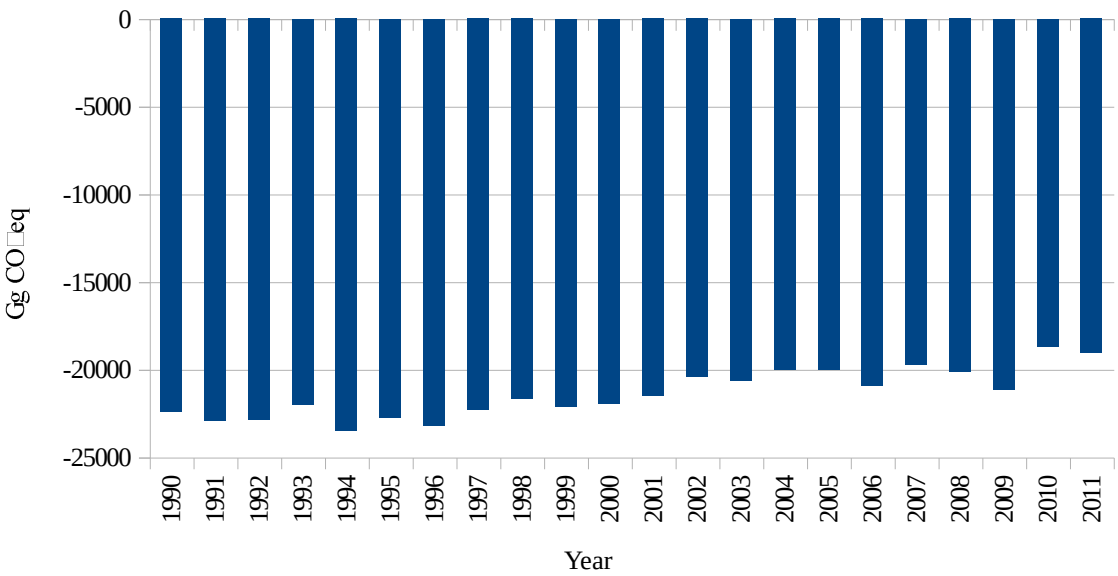


Figure 7.1 Net emissions of CO_2, CH_4 and N_2O in the LULUCF sector

In 2011, the LULUCF sector in Latvia is a sink because the total sector emissions are considerably smaller than removals; generally, due to accumulation of carbon in living biomass in forest lands (

Table 7.**3**). Emissions increased in grassland and settlements category during the reporting period. These changes are associated with land use changes – conversion of considerable area of croplands to grasslands including organic soils, which are source of CO_2 emissions, and conversion of forest lands to settlements causing emissions due to deforestation.

Table 7.3 Aggregated net emissions of GHGs (CO_2, CH_4 and N_2O) in LULUCF

Year	Forest lands	Cropland	Grassland	Wetland	Settlements	HWP
1990	-22903.3	604.34	40.15	21.12	104.59	-173.00
1991	-23686.2	621.2	41.34	21.12	133.88	-170.00
1992	-24006.4	638.06	42.64	21.12	163.16	25.00
1993	-23144.5	654.88	43.87	21.12	192.44	420.00
1994	-23734.7	671.74	45.17	21.12	221.73	-109.00
1995	-22129.3	688.6	47.13	21.12	251.01	-497.00
1996	-22254.6	515.3	49.46	21.12	255.53	-678.00
1997	-19514.7	516.55	49.27	21.12	278.86	-1 572.00
1998	-18079.0	520.69	51.68	21.12	302.19	-2 021.00
1999	-17896.1	524.18	55.36	21.12	325.52	-2 378.00
2000	-17693.9	529.91	55.63	21.12	348.84	-2 505.00
2001	-17525.3	509.82	61.33	21.12	469.02	-2 403.00
2002	-16160.9	526.2	75.13	21.12	513.19	-2 470.00
2003	-16865.7	537.62	81.43	21.12	557.36	-2 443.00
2004	-16597.2	517.13	68.02	21.12	601.54	-2 363.00
2005	-16874.1	519.8	60.24	21.12	645.71	-2 365.00
2006	-18742.7	521.88	105.88	21.12	689.88	-2 414.00
2007	-18540.3	527.49	65.76	21.12	734.06	-1 404.00
2008	-19945.8	527.64	61.21	21.12	778.23	-1 103.00
2009	-18719.1	463.79	68.28	21.12	825.10	-2 524.00
2010	-15601.7	406.42	64.49	21.12	855.87	-2 157.00
2011	-16095.8	381.37	65.11	21.12	883.03	-2 434.00

Area of organic soils in croplands and grasslands is updated according to the inventory of historical data about farmlands implemented in 2009[90]. Area of organic soils in cropland and grassland represented in the inventory characterizes situation before 1990. It is assumed that the share of organic soils in cropland and grassland is equal and do not changes in time, because no better data are available. 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 7.4.

Figure 7.2 demonstrates equation used for linear interpolation of cropland area between 1990 and 2009. Grassland is calculated from total area of grassland and cropland (lands not covered by trees and not being settlements, wetlands or other lands according to the satellite image analysis of the NFI points) by mathematical subtraction of the interpolated area of cropland. Historical area of grassland is updated by inclusion of afforested areas into grassland category. Share of organic soils in cropland and grassland is estimated according to results of the study[90].

Data on increment of aboveground biomass in forest lands are taken from the NFI. Recalculation to the total aboveground and underground biomass is done using national activity data on the gross increments, mortality rate and forest area and default wood density

[90] 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.

coefficients and biomass expansion factors in the IPCC GPG LULUCF 2003. Significant changes are introduced into the activity data, like mortality figures and harvested wood products. National spreadsheet based model is used to calculate carbon stock changes and GHG emissions due to forest management.

Emissions from drained organic and mineral soils are calculated using Tier 1 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).

Table 7.4 Land use change matrix

Changes	Forest	Cropland	Grassland	Wetland	Settlements	Other lands
Land use change: 1990-1991						
1990	3168.6	1751.4	844.7	448.3	238.8	4.3
Forest		1.9			0.6	
Cropland			34			
Grassland	8.9					
Wetland						
Settlements						
Other lands						
Land use change: 1991-1992						
1991	3175	1719.3	869.8	448.3	239.4	4.3
Forest		1.9			0.6	
Cropland			34			
Grassland	6.6					
Wetland						
Settlements						
Other lands						
Land use change: 1992-1993						
Changes	Forest	Cropland	Grassland	Wetland	Settlements	Other lands
1992	3179	1687.3	897.2	448.3	240	4.3
Forest		1.9			0.6	
Cropland			34			
Grassland	9					
Wetland						
Settlements						
Other lands						
Land use change: 1993-1994						
1993	3185.6	1655.2	922.1	448.3	240.6	4.3
Forest		1.9			0.6	
Cropland			34			
Grassland	9.6					
Wetland						
Settlements						
Other lands						
Land use change: 1994-1995						
1994	3192.6	1623.2	946.5	448.3	241.2	4.3
Forest		1.9			0.6	
Cropland			34			
Grassland	9.9					
Wetland						
Settlements						
Other lands						
Land use change: 1995-1996						
1995	3200	1591.1	970.6	448.3	241.8	4.3
Forest		0.8			0.5	

Changes	Forest	Cropland	Grassland	Wetland	Settlements	Other lands
Cropland			32.9			
Grassland	11.4					
Wetland						
Settlements						
Other lands						
Land use change: 1996-1997						
1996	3210.1	1559	992.1	448.3	242.3	4.3
Forest		0.8			0.5	
Cropland			32.9			
Grassland	11.3					
Wetland						
Settlements						
Other lands						
Land use change: 1997-1998						
1997	3220.1	1527	1013.7	448.3	242.7	4.3
Forest		0.8			0.5	
Cropland			32.9			
Grassland	9					
Wetland						
Settlements						
Other lands						
Land use change: 1998-1999						
1998	3227.9	1494.9	1037.6	448.3	243.2	4.3
Forest		0.8			0.5	
Cropland			32.9			
Grassland	12.1					
Wetland						
Settlements						
Other lands						
Land use change: 1999-2000						
1999	3238.7	1462.8	1058.3	448.3	243.7	4.3
Forest		0.8			0.5	
Cropland			32.9			
Grassland	10.3					
Wetland						
Settlements						
Other lands						
Land use change: 2000-2001						
2000	3247.7	1430.8	1080.9	448.3	244.1	4.3
Forest		0.7			0.9	
Cropland			32.8			
Grassland	13.7					
Wetland						
Settlements						
Other lands						
Land use change: 2001-2002						
2001	3259.8	1398.7	1100	448.3	245	4.3
Forest		0.7			0.9	
Cropland			32.8			
Grassland	10.1					
Wetland						
Settlements						
Other lands						

Changes	Forest	Cropland	Grassland	Wetland	Settlements	Other lands
Land use change: 2002-2003						
2002	3268.3	1366.7	1122.6	448.3	245.9	4.3
Forest		0.7			0.9	
Cropland			32.8			
Grassland	10.7					
Wetland						
Settlements						
Other lands						
Land use change: 2003-2004						
2003	3277.5	1334.6	1144.6	448.3	246.8	4.3
Forest		0.7			0.9	
Cropland			32.8			
Grassland	12.6					
Wetland						
Settlements						
Other lands						
Land use change: 2004-2005						
2004	3288.5	1302.5	1164.8	448.3	247.7	4.3
Forest		0.7			0.9	
Cropland			32.8			
Grassland	13					
Wetland						
Settlements						
Other lands						
Land use change: 2005-2006						
2005	3299.9	1270.5	1184.6	448.3	248.6	4.3
Forest		0.7			0.9	
Cropland			32.8			
Grassland	13.3					
Wetland						
Settlements						
Other lands						
Land use change: 2006-2007						
2006	3311.6	1238.4	1204	448.3	249.5	4.3
Forest		0.7			0.9	
Cropland			32.8			
Grassland	13.7					
Wetland						
Settlements						
Other lands						
Land use change: 2007-2008						
2007	3323.8	1206.3	1223	448.3	250.4	4.3
Forest		0.7			0.9	
Cropland			32.8			
Grassland	14.1					
Wetland						

Changes	Forest	Cropland	Grassland	Wetland	Settlements	Other lands
Settlements						
Other lands						
Land use change: 2008-2009						
2008	3336.3	1174.3	1241.7	448.3	251.2	4.3
Forest		0.4			0.9	
Cropland			32.5			
Grassland	14.4					
Wetland						
Settlements						
Other lands						
Land use change: 2009-2010						
2009	3349.4	1142.2	1259.7	448.3	252.1	4.3
Forest		0.2			1	
Cropland						
Grassland						
Wetland						
Settlements						
Other lands						
Land use change: 2010-2011						
2010	3348.3	1142.4	1259.7	448.3	253.1	4.3
Forest		0.1			1.0	
Cropland						
Grassland						
Wetland						
Settlements						
Other lands						
2011	**3347.2**	**1142.5**	**1259.7**	**448.3**	**254.1**	**4.3**

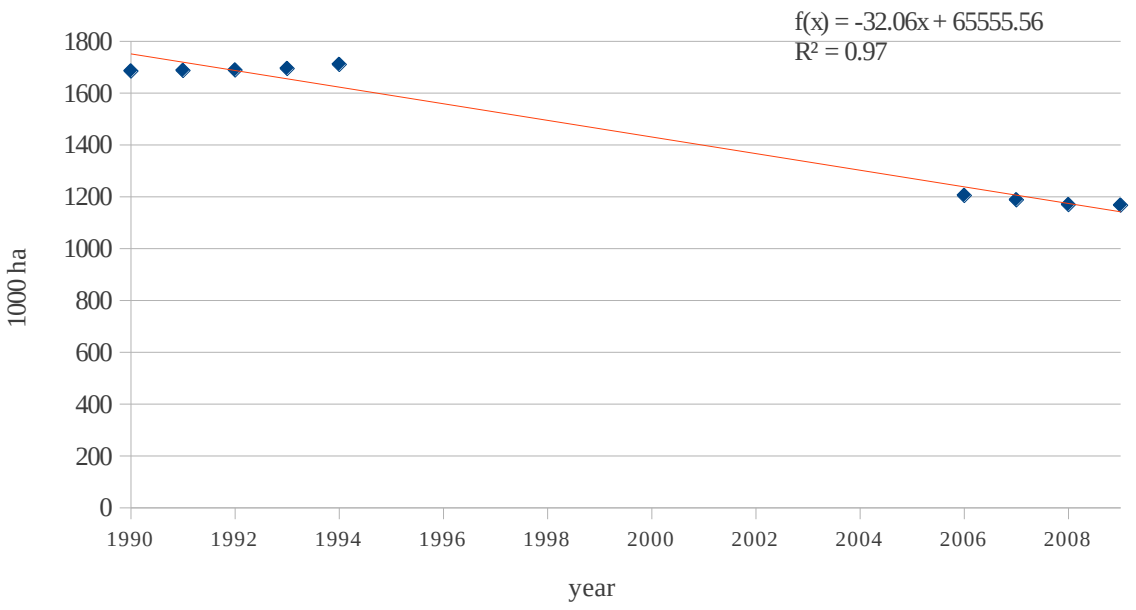


Figure 7.2 Chart used for linear interpolation of area of cropland using statistical data for 1990-1994 and 2006-2009

Emissions from mineral soil due to deforestation are estimated using Equation 3.3.3 of the IPCC GPG LULUCF 2003. Relative stock change factors are taken from the Table 3.3.4 of the IPCC GPG LULUCF 2003. Default transition period of 20 years is assumed in calculations. Emission factor used to estimate emissions from cropland on organic soil is used for deforested areas transformed to cropland on organic forest soil. Data about carbon stock in soil and litter in forest soil is taken as averages from the results of international forest soil inventory project BioSoil[91]. Average stock of dead wood in forests is estimated from the NFI database[92].

Knowlagde about dynamics of dead wood in forest lands is insufficient, both in terms of mortality factors and decay periods, because forest management principles was significantly changed since 1990, for instance, in 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 anymore 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[93]) demonstrates constant increase of dead wood stock in forests during the last decade; however, it could be result of several extreme events. Mortality factors excluding extreme events were elaborated in 2012 on the base of the NFI data (sample plots measured in 2006 and 2011) for the FMRL calculations[94].

Emissions from drained forest soils are extended by calculation of N_2O emissions (separately from mineral and organic soils). Emissions of CO_2 from organic soils are calculated using

91 Arta 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)," *Mežzinātne | Forest Science* 20 (53) (2009): 105–124; Andis Lazdiņš et al., *Mežsaimniecisko Darbību Ietekmes Uz Siltumnīcas Efektu Izraisošo Gāzu Bilanci Pētījuma Programmas Izstrāde* Pārskats par pirmā etapa izpildi (Salaspils: LVMI Silava, 2010).

92 http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls

93 FAO Forestry Department, *Global forest resources assessment 2010. Country report - Latvia* (Rome: Forestry Department, Food and Agriculture Organization of the United Nations, 2010); FAO, *State of the world's forests 1997* (Rome: FAO, 1997); FAO Forestry Department, *Global Forest Resources Assessment 2000*, FAO Forestry Paper (Food and Agriculture Organization of the United Nations, 2000).

94 Lazdiņš, Donis, and Strūve, *Latvijas Meža Apsaimniekošanas Radītās Ogļskābās Gāzes (CO□) Piesaistes Un Siltumnīcefekta Gāzu (SEG) Emisiju References Līmeņa Aprēķina Modeļa Izstrāde*.

default emission factors (0.68 tons C ha^{-1} annually in forest land, 1 ton C ha^{-1} in cropland, 0.25 tons C ha^{-1} in grassland and 0.2 tons C ha^{-1} in peatlands).
The key categories in LULUCF sector in 2011 in Latvia are summarised in Table 7.5. The most significant key category is Forest land remaining forest land contributing to 49 % of level of the emissions and 56 % to the trend. Harvested wood products included into the inventory in 2011 are also a key category by level of net emissions.

Table 7.5 Key categories in LULUCF sector

IPCC GHG Source and Sink Categories	Gas	Identification criteria[95]
5.A.1 Forest Land remaining Forest Land	CO_2	L/T/Q
5.B.1 Cropland remaining Cropland	CO_2	L/T/Q
5.A.2 Land converted to Forest Land	CO_2	L/T/Q
5.A.1 Forest Land remaining Forest Land	N_2O	L/T/Q
5.B.2 Land converted to Cropland	CO_2	L/T/Q
5.C.1 Grassland remaining Grassland	CO_2	T/Q
5.E.2 Land converted to Settlements	CO_2	L/T/Q
5.G Other	CO_2	L, T/Q

7.2 FOREST LAND (CRF 5)

7.2.1 Source category description

There are 3 key source and sink categories in forest lands in Latvia – CO_2 in Forest Land remaining Forest Land and CO_2 in Land converted to Forest Land and N_2O in Forest Land remaining Forest Land. The accounting of N_2O from drained forest lands is not mandatory according to the IPCC GPG LULUCF 2003, but taking in account considerable area of forests on drained soils Latvia decided to account the N_2O using Tier 1 approach described in the IPCC GPG LULUCF 2003 to avoid underestimation of the total emissions. Lands converted to forest became a sink because of massive afforestation of farmlands after 1990.
The estimation of the area of Forest land is based on the National Forest Inventory (NFI)[96]. Parks and yards, for example, are accounted as settlements regardless of whether they would meet the Forest land definition. Forest Land is divided in two categories: forest land remaining forest land and land converted to forest land. No forests are considered unmanaged. Removals and emissions are reported in the category forest land remaining forest and land converted to forest.
The NFI data are used to estimate time series for areas and gross increment. Mortality data are calculated on the base of the NFI data (sample plots measured twice in 2006 and 2011 and not affected by extreme events)[97]. Distinction between forest land remaining forest land and areas converted to forest land is made according to age of dominant species in forests on afforested land – if age of dominant specie 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. Exception is areas fulfilling criteria of forest definition on non-forest land where trees are less than 2 cm in diameter at breast height. These areas are accounted under grasslands. Taking into account that afforestation takes place on managed land, all afforested areas are considered managed.

Only the carbon stock changes in above and below ground living and dead biomass are reported in the 2011 submission and are accounted as removals. Mortality rate is taken from research data, decay factor 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 Tier 1 approach of the IPCC GPG LULUCF 2003. However, there are preliminary data from

95 L/T – level and trend assessment, L – only level assessment, T – only trend assessment.
96 http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls
97 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).*

repeated measurements of carbon stock in soil in the sample plots selected for the soil monitoring demonstration project BioSoil, showing statistically significant increase in carbon stock between 2006 and 2012 (Figure 7.3) 2.6 ± 1.4 tons C annually in average at 0-30 cm depth.

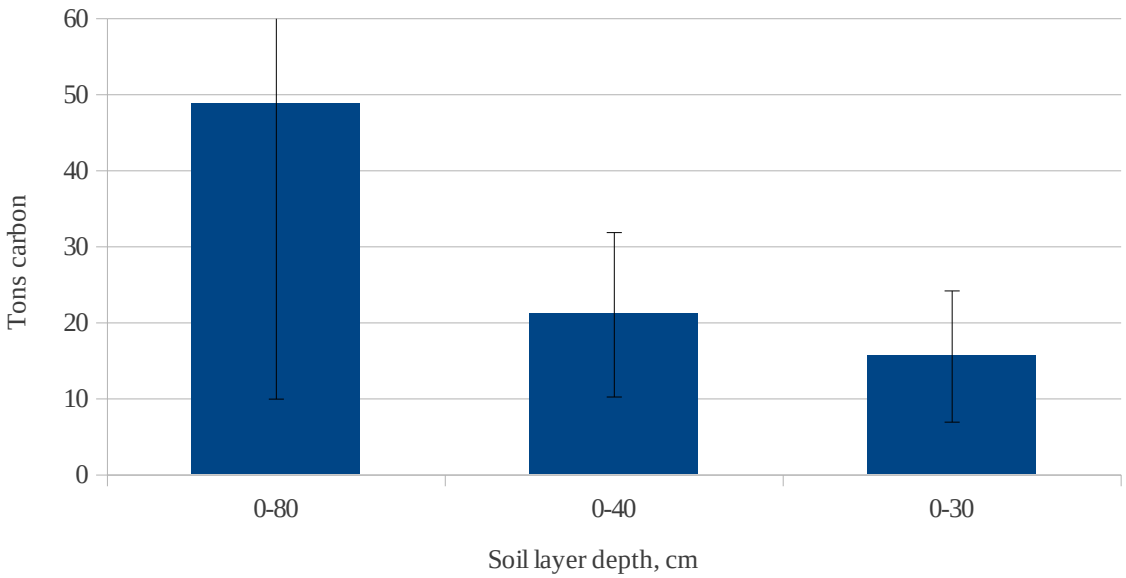


Figure 7.3 Carbon stock changes in soil different depths according to BioSoil project results[98]

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 30 cm deep. Distribution of the forest site types according to the NFI is shown in Figure 7.4.

[98] Lazdiņš, A., Liepiņš, K., Lazdiņa, D., Jansons, Ā., Bārdule, A., 2012. Mežsaimniecisko darbību ietekmes uz siltumnīcefekta gāzu emisijām un CO_2 piesaisti novērtējums, pārskats par 2012. gada darba uzdevumu izpildi. No. 5.5-5.1/001Y/110/08/8 (Evaluation of impact of the forest management measures on the GHG emissions and CO_2 removals, report on the Project results in 2012). LVMI Silava & Meža nozares kompetences centrs, Salaspils.

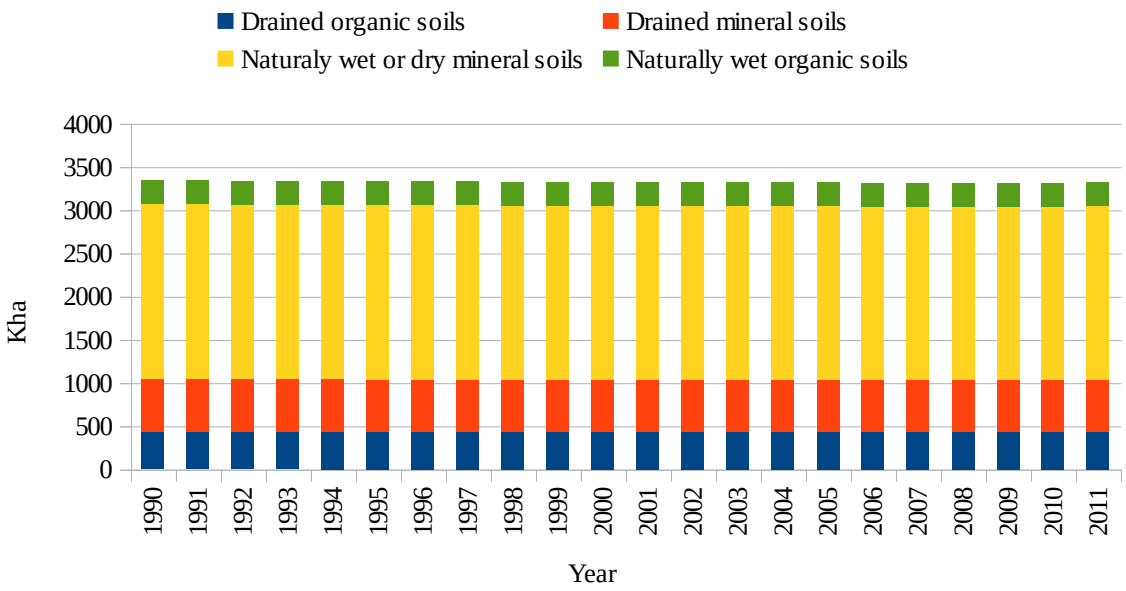


Figure 7.4 Distribution of drained, naturally dry and wet mineral and organic soils in Latvia's forests[99]

The carbon stock change in living biomass is estimated with the default method of the IPCC GPG LULUCF 2003, Equation 3.2.2 – 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.

Considerable part of non-CO_2 emissions is associated with incineration of harvesting residues in clear-cuts. The activity data for this calculation was based on an outdated study until 2010[100]. Now questionnaire of private forest owners about utilization of harvesting residues is used[101]. According to this questionnaire about 18 % of harvesting residues were incinerated during last 3 years (Figure 7.5).

99 http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls

100 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.

101 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.

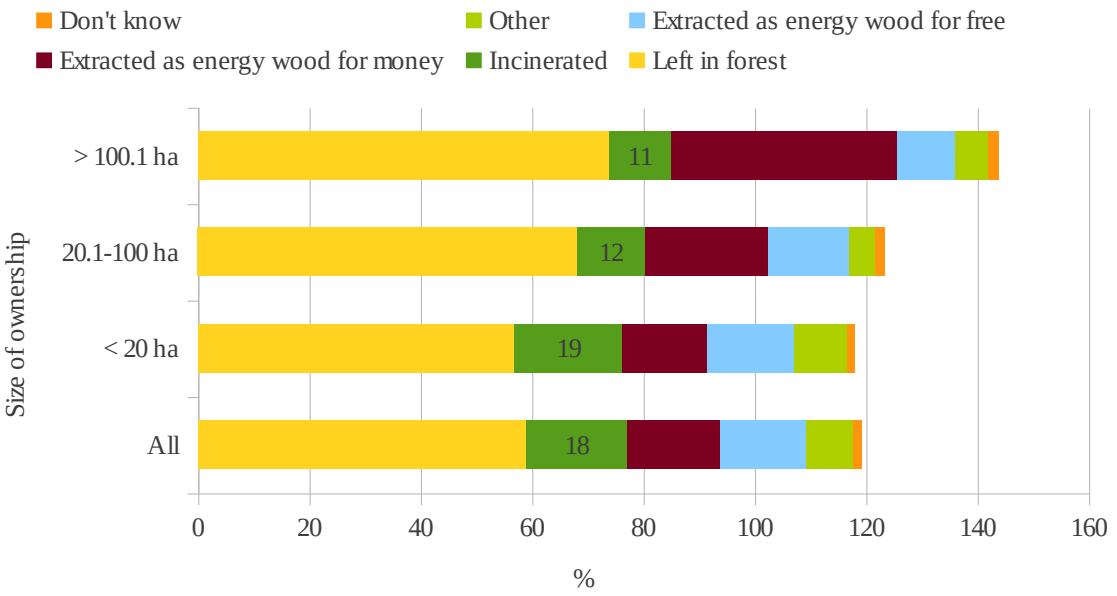


Figure 7.5 Utilization of harvesting residues in private forests[102]

The time series for annual increment of growing stock of trees on a forest land remaining forest are given in Figure 7.6 and in the Land converted to forest – in Figure 7.7.

Chart in Figure 7.8 shows that after recalculation average values for gross increment are used for 5 years period. The annual gross increment of growing stock of trees in a forest land increased by 7 % in 2010 in a compare to 1990. That comes from the increased growth of trees due to productivity targeted management of forests in 70^{ths} and 80^{ths} as well as due to significant increase of area of premature forests with the highest values of the stock increment. Annual increment of growing stock of trees has raised almost steadily; therefore, the CO_2 uptake has also has grown. The total drain of trees 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 nineteen's and reached top average in early 2000s (Figure 7.8).

The Land converted to forest land provides relatively small net increment of growing stock of trees – about 0.3 mill. m^3 in 2010. Taking in account that these forests are generally young stands no emissions from commercial felling are considered. Areas afforested 20 years ago (in 1990 and 1991) are moved to the forest land remaining forest land category. Therefore, area of afforested lands is decreasing in the convention reporting because of completion of 20 years transition period in certain areas.
No afforestation is reported in 2011 to avoid overestimation of removals, because the NFI field measurement data are not available yet. This category will be recalculated in the end of 2013 (after at least 80 % of the NFI field measurement data from the second cycle will be entered into the data base).

[102] Lazdiņš, A., Zariņš, J., 2013. Meža ugunsgrēku un mežizstrādes atlieku dedzināšanas radītās siltumnīcefekta gāzu emisijas Latvijā (GHG emissions due to forest fires and incineration of harvesting residues), in: Referātu Tēzes. Presented at the Latvijas Universitātes 71. zinātniskā konference "Ģeogrāfija, ģeoloģija, vides zinātne", Latvijas Universitāte, Rīga, pp. 133–137.

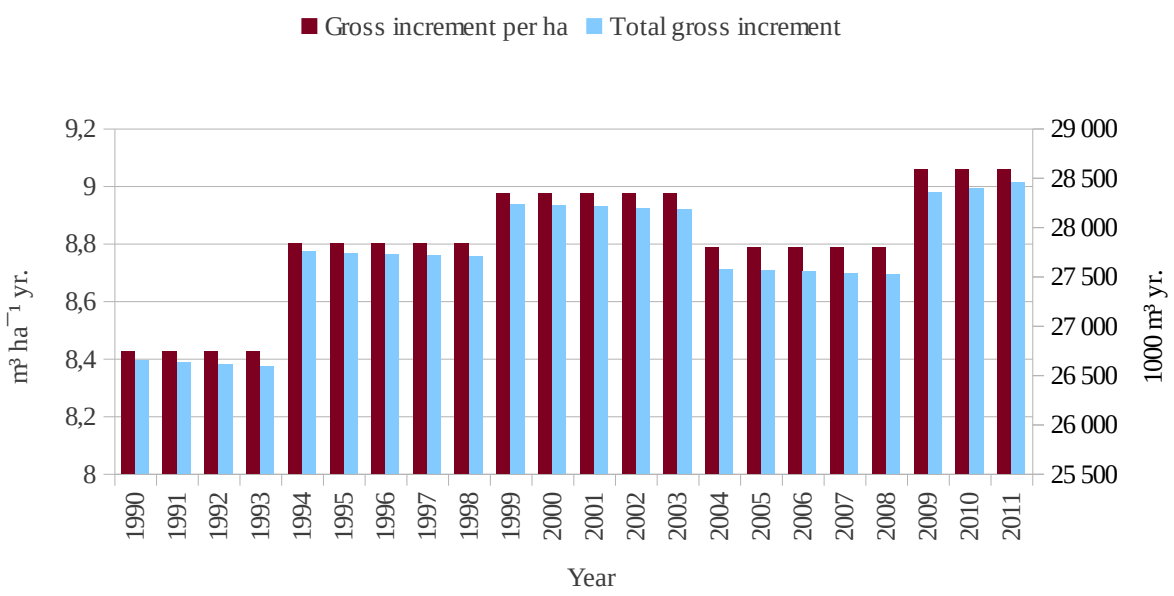


Figure 7.6 Annual increment of growing stock of trees on the Forest land remaining forest

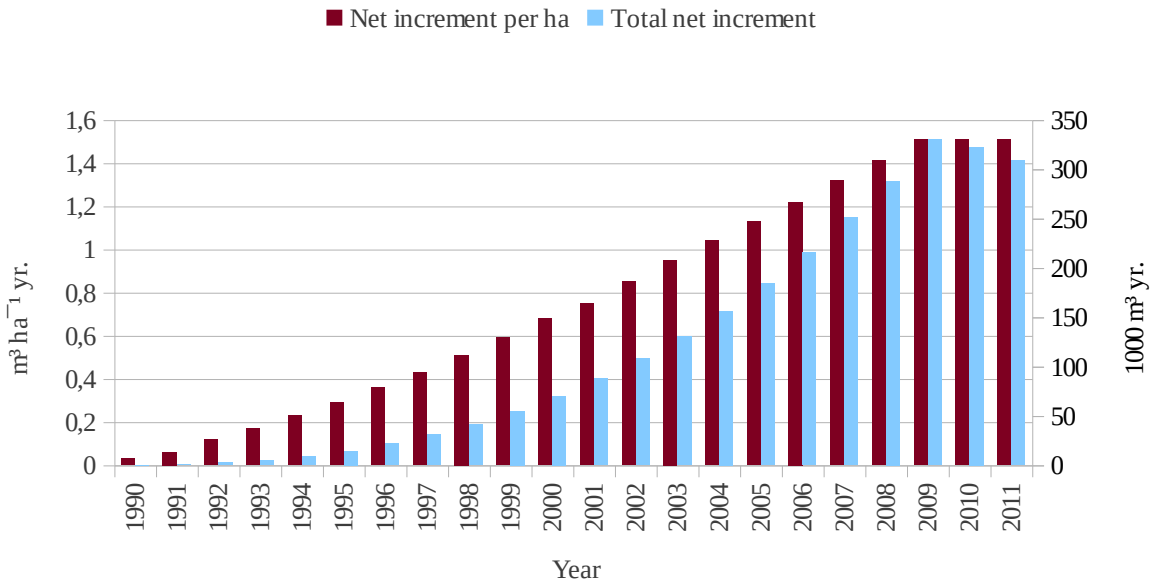


Figure 7.7 Increment of growing stock of timber on the Land converted to forest[103]

[103] 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).

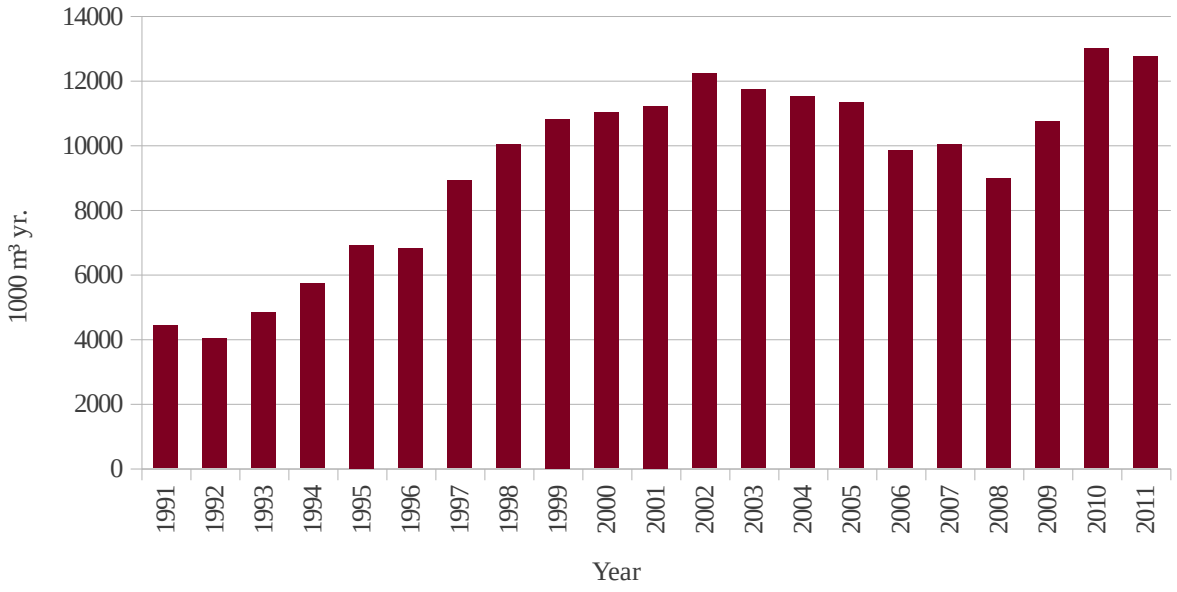


Figure 7.8 Annual harvesting stock of roundwood[104]

The aggregated net emissions from forest lands were -17959 Gg of CO_2 equivalents in Latvia in 2011, excluding removals in harvested wood products. The most of the emissions are associated with commercial felling (Figure 7.8). Both, the harvesting related emissions and removals in living biomass increased during the reporting period (Figure 7.9). Impact of HWP on the net removals is shown in Figure 7.10.

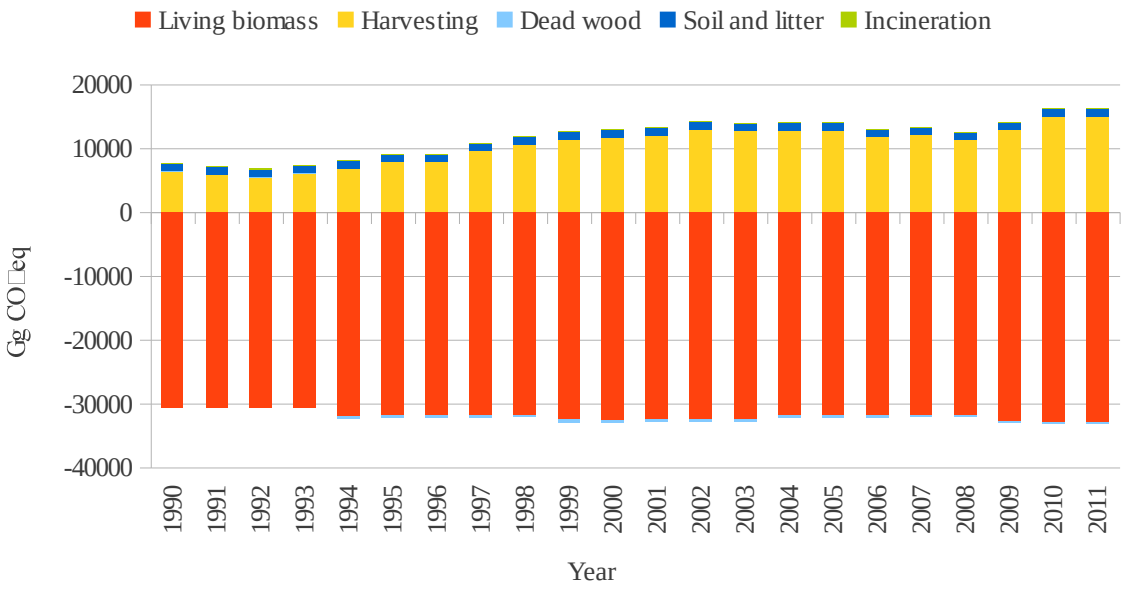


Figure 7.9 Structure of emissions in the forest lands

[104] https://sites.google.com/site/lvlulucf/activity/nir-1990-2010/Mezizstrade1991-2010.html?attredirects=0&d=1

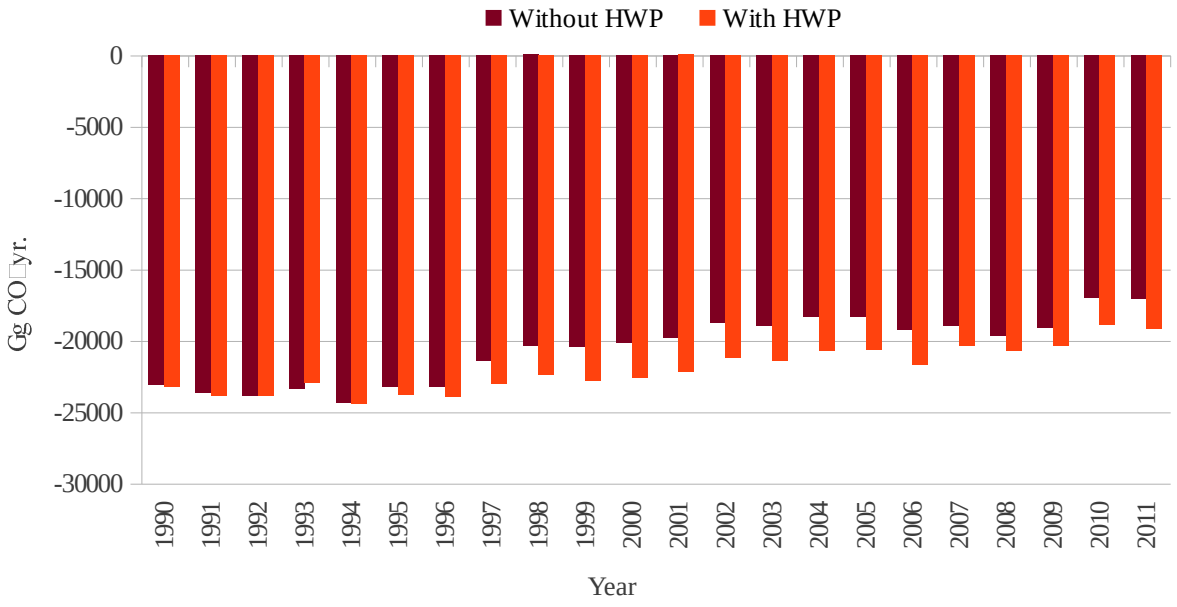


Figure 7.10 Net emissions with and without HWP

Emissions associated with the biomass burning in the forest land are calculated in the category the forest land remaining forest due to the fact, that there is no distinguish in statistics, if the forest fire takes place in the historical forest land or afforested land. In case of on-site incineration of harvesting residues during commercial harvesting, all emissions also are applied to the forest land remaining forest land's category, because no commercial felling takes place in young stands (younger than 20 years) on land converted to forest land.

Estimation of on-site incineration in 2011 is based on the questionnaire of private forest owners where they responded that only 18 % of harvesting residues are left for incineration in private forests and no harvesting residues are incinerated in state forests. Previous studies demonstrated that about 50 %[105] of harvesting residues were left for incineration and 66 % of them are actually incinerated[106]. Fraction of biomass oxidized on-site is assumed 90 % in average. Amount of the harvesting residues is calculated according to weighted average share of crown biomass in above-ground biomass.

7.2.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Forest land area and deforested area were estimated in 2009 using remote sensing approach – vegetation index were estimated in all the NFI points, including those outside forest lands in satellite image (LANDSAT) 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.

Source data are provided by the NFI. The same rules are applied to the forest land remaining forest and land converted to forest. The last category is identified by the age of dominant tree species in the NFI category afforested lands – if age of the stand was above zero in 1990, it is moved to the Forest land remaining forest's category, and otherwise it stays in the converted land category. Recalculation of age of forest marked as forests growing on farmlands is the reason, why area of managed forest increases since 1990. This approach is quite robust; however, it leaves possibilities of underestimation of the conversion due to wrong identification of the land use type during a field visits. The total area of the Land converted to

105 30 % after 2001.

106 Līpiņš, "Assessment of wood resources and efficiency of wood utilization (Koksnes izejvielu resersu un to izmantošanas efektivitātes novērtējums)."

forest is shown in Figure 7.11. In 2010 it start to reduce, because are afforested in 1990 and 1991 in the convention reporting is moved to the forest land remaining forest category. No afforestation is considered after 2009 to avoid overestimation of removals. These figures will be updated ass soon as the undated information will be available from the NFI.

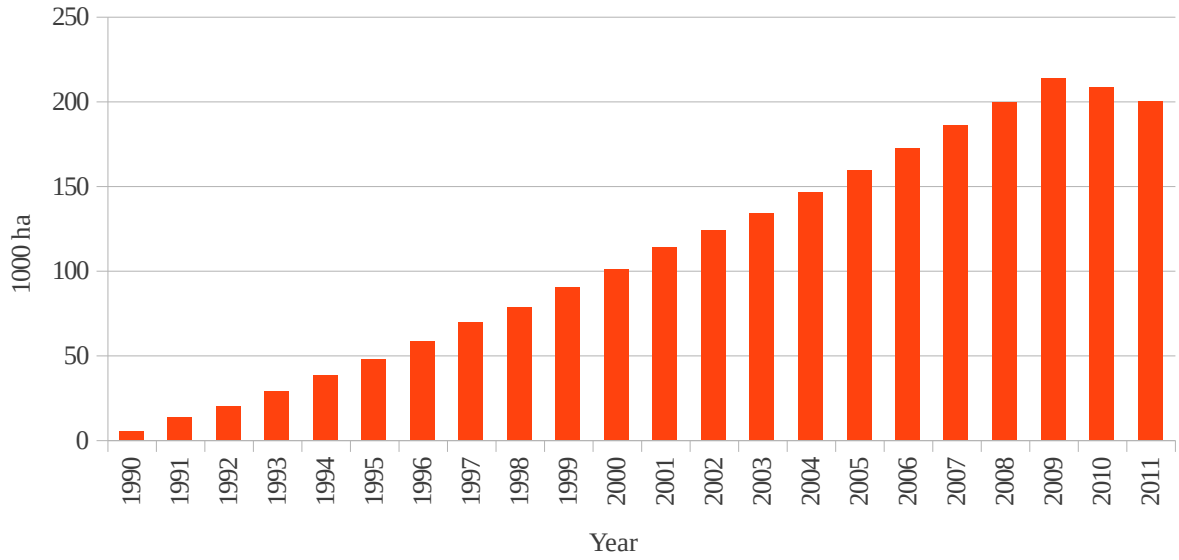


Figure 7.11 Total area of the land converted to forest

7.2.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Forest is a minimum area of land 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 are accounted under forest land; as well as the 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. Parks and yards are excluded and accounted under settlements (as area) regardless of whether they would meet the Forest land definition. The forest land covers the nationally defined productive forest land and part of the poorly productive forest land. Area estimates are derived from the NFI data[107].

7.2.4 Methodological issues

Calculations of carbon stock changes and GHG emissions in forest lands are based on the NFI (area, living biomass, dead wood) and Level I forest monitoring data (soil). National statistics (State forest service) are used to estimate forest fires and 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"[108].

Changes of the carbon stock and GHG emissions are estimated according to the Tier 2 methods with country specific activity data. Default method (the carbon loss to be subtracted from the carbon removals for the reporting year) is used in calculations of removals and

[107] http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls

[108] 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).

emissions of CO_2 in living biomass according to the Equation 3.2.2 of the IPCC GPG LULUCF 2003.

Methodologies for estimation of carbon stock changes and GHG emissions are considerably improved since last reporting because of the efforts devoted to elaboration of the national forest management reference level in 2012. The metdologies are merged together into the "Forest data modelling tool", which is actually complex spreadsheet elaborated according to the LVS ISO/IEC 26300:2009 standard (fully compatible with office applications like Libreoffice and OpenOffice.org). Some functionality is not compatible with Microsoft Excel; therefore, it is not recommended to use the model in this office suite. Separate versions (with different input data) are elaborated for convention and the Kyoto protocol reporting. The model is still under development, current working version can be downloaded from the website "Land use, land use change and forestry sector in Latvia"[109]. The model is only in Latvian now.

The rationale and concept of the "Forest data modelling tool":

- why to make yet another tool instead of existing ones;
  - GHG accounting requires complex calculations and methodology is developing rapidly; therefore, changes in another tools like the NFI database would require considerable efforts every year and could lead to mistakes in already existing functions,
  - several data sources should be used in calculations and the easiest way to merge these sources is elaboration of separate product for additional calculations instead of expanding other products dedicated for specific operations,
- 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, key innovations in 2012 – species specific mortality factors and gross annual increment values; 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.

Content of the model (separate calculation sheets):

- living biomass (gross annual increment of living biomass);
- mortality (natural reduction of number and stock of living trees);
- commercial harvesting (input to the harvested wood products, decomposition of harvesting residues and below-ground biomass);
- harvested wood products (carbon stock change in locally originated and consumed harvested wood products);
- emission from soils (CO_2 and N_2O from drained organic soils and N_2O emissions from drained mineral soils);
- fire (emissions of CO_2, CH_4 and N_2O due to incineration of harvesting residues and wildfires);
- deforestation (as a land use change to estimate area of managed forests).

Deforestation and afforestation modules are not yet fully implemented therefore these calculations are done in separate spreadsheets.

Module for estimation of the gross annual increment of living biomass:

[109] https://sites.google.com/site/lvlulucf/activity/nir-1990-2011/Meza%20apsaimniekosana%20%28FMRL%2020120730%29.ods?attredirects=0&d=1

- increment figures on the base of the NFI (Table 7.6), historical recalculations (before 2004) was done together with mortality rate (Table 7.10) estimations in 2011 and 2012[110];
- 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 7.7), different BEFs for coniferous and deciduous trees (Table 7.8 and Table 7.9).

The total gross biomass increment in forest land according to recalculation is shown in Figure 7.12.

Table 7.6 Average periodic gross increment of living trees (m^3 ha- 1 yr)[111]

Species	1990-1993	1994-1998	1999-2003	2004-2008	2009-2011
Aspen	15.96	16.33	14.72	11.97	10.39
Grey alder	7.04	7.6	7.84	8.29	8.86
Birch	8.64	8.81	8.69	8.08	7.77
Spruce	7.44	8.54	9.91	10.82	11.74
Black alder	10.77	11.84	12.12	12.13	9.88
Oak, ash	6.3	6.48	6.21	6.01	5.67
Other species	8.74	7.77	7.53	8.28	12.04
Pine	7	7.08	7.3	7.23	8.28
Average	8.42	8.8	8.97	8.79	9.06

Table 7.7 Wood density[112]

Species	Density, tons m^{-3}
Aspen	0.35
Grey alder	0.45
Birch	0.5
Spruce	0.4
Black alder	0.45
Oak, ash	0.58
Other species (mostly *Salix* sp.)	0.5
Pine	0.42

Table 7.8 Coefficients for calculation of above ground biomass from stem biomass[113]

Species	Coefficient for growing stock[114]	Coefficient for gross increment[115]
Coniferous	1.35	1.15
Deciduous	1.30	1.10

Table 7.9 Coefficients for calculation of below ground biomass from above ground biomass

Species	**< 50**	**50-150**	**> 150**
Coniferous	0.46	0.32	0.23

110 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*.

111 Lazdiņš, Donis, and Strūve, Latvijas Meža Apsaimniekošanas Radītās Ogļskābās Gāzes (CO_2) Piesaistes Un Siltumnīcefekta Gāzu (SEG) Emisiju References Līmeņa Aprēķina Modeļa Izstrāde.

112 Penman Ed., Good Practice Guidancefor Land Use, Land-Use Change and Forestry.

113 Penman Ed., Good Practice Guidancefor Land Use, Land-Use Change and Forestry.

114 Used in calculations of harvested biomass and mortality.

115 Used for calculations of the gross increment figures.

Species	< 50	50-150	> 150
Deciduous	0.43	0.26	0.24

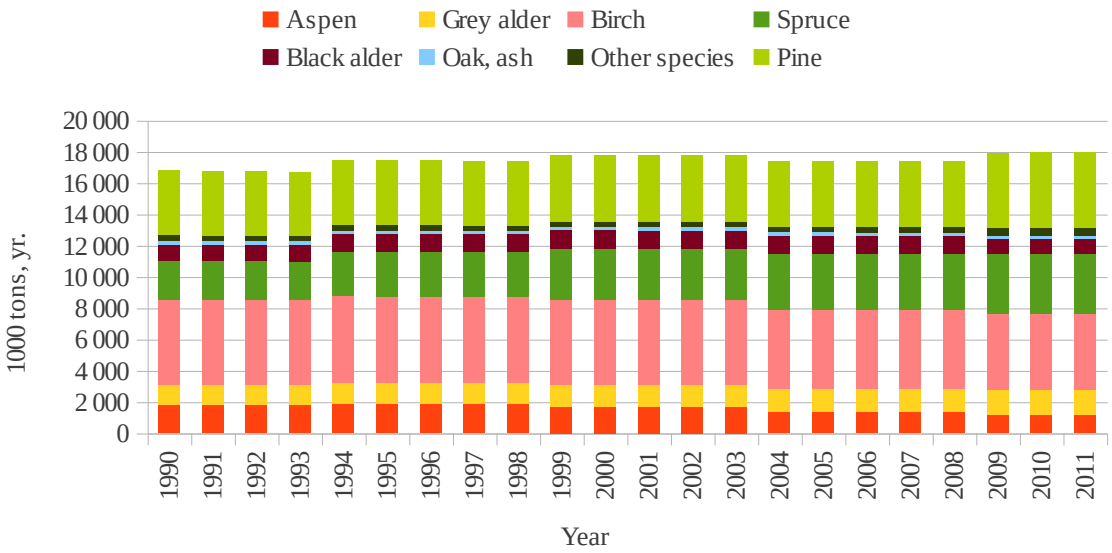


Figure 7.12 The total biomass increment in forest lands

Mortality and decay:

- species specific coefficients of mortality (Table 7.10), not dependant of size of tree (dominant or undergrowth trees), depends from 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 90^{ths};
- 20 years decomposition period (mortality since 1970 considered as emissions);
- constant mortality values considered for periods before 1990.

Table 7.10 Average periodic mortality (m^3 ha^{-1} $yr.$)[116]

Species	1990-1993	1994-1998	1999-2003	2004-2008	2009-2011
Aspen	1.64	1.95	1.97	1.92	1.92
Grey alder	0.3	0.33	0.36	0.48	0.48
Birch	1.59	1.67	1.58	1.43	1.43
Spruce	1.61	1.76	1.94	2.05	2.05
Black alder	1.3	1.42	1.47	1.64	1.64
Oak, ash	2.29	2.66	2.67	2.87	2.87
Other species	0.75	0.66	0.67	0.77	0.77
Pine	1.16	1.24	1.38	1.48	1.48
Average	1.33	1.44	1.49	1.52	1.52

Summary of annual mortality is shown in Figure 7.13, net annual emissions – in Figure 7.14.

[116] Lazdiņš, Donis, and Strūve, Latvijas Meža Apsaimniekošanas Radītās Ogļskābās Gāzes (CO_2) Piesaistes Un Siltumnīcefekta Gāzu (SEG) Emisiju References Līmeņa Aprēķina Modeļa Izstrāde.

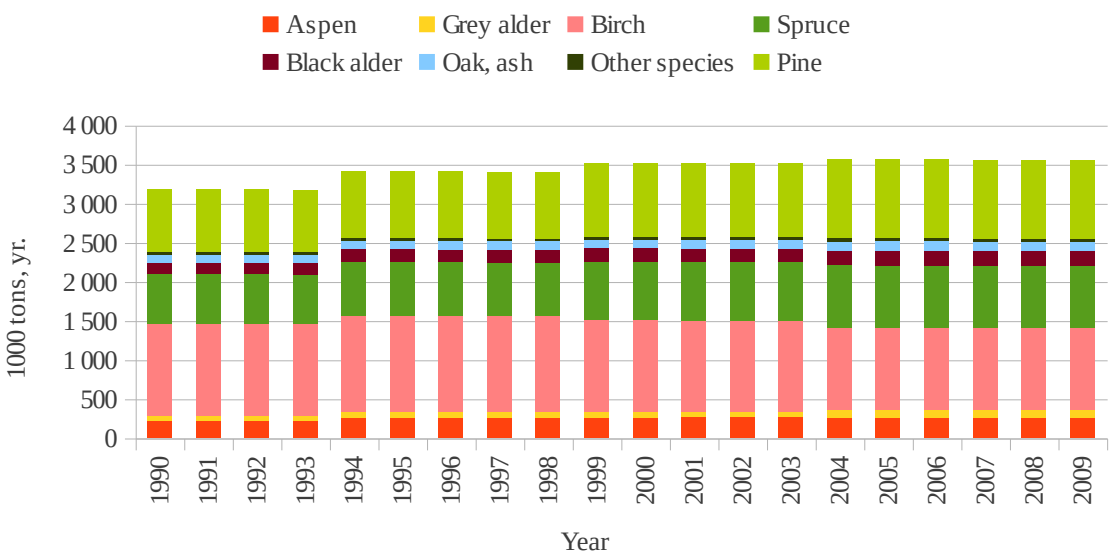


Figure 7.13 The total biomass losses due to natural mortality in forest lands.

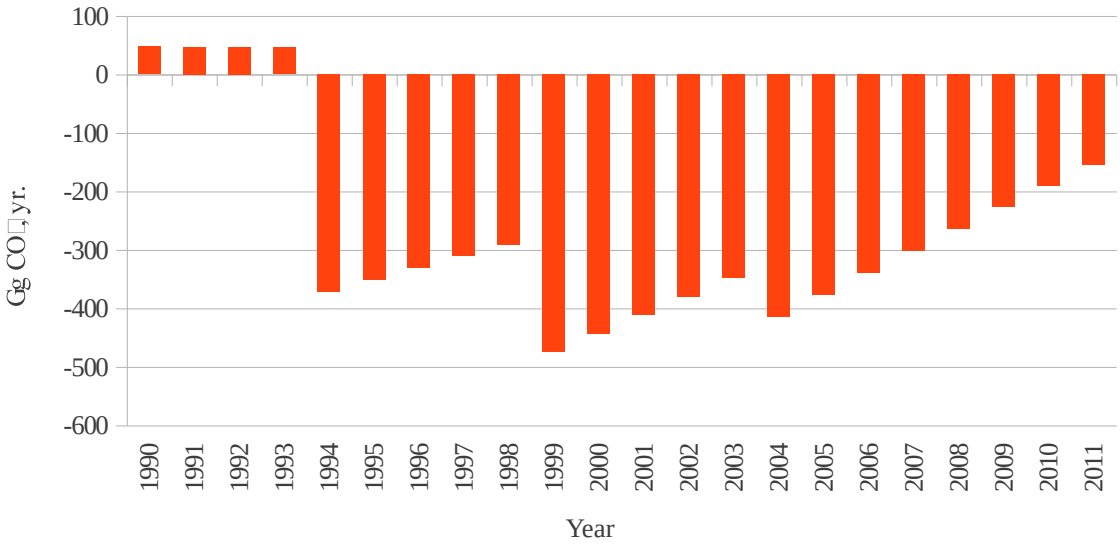


Figure 7.14 Net emissions from dead wood carbon pool.

Alternative evaluation of carbon stock changes in dead wood using the NFI data (comparison of situation in 2004-2007 and 2009-2012) shows significant increase of dead wood stock in forest lands and no changes in grassland (Figure 7.15). Average annual stock change in dead wood in fores land according to the NFI between 2004 and 2012 was 0.9 ± 0.4 m^3 ha^{-1}. This is close to the average modelled values presented in Table 7.10.

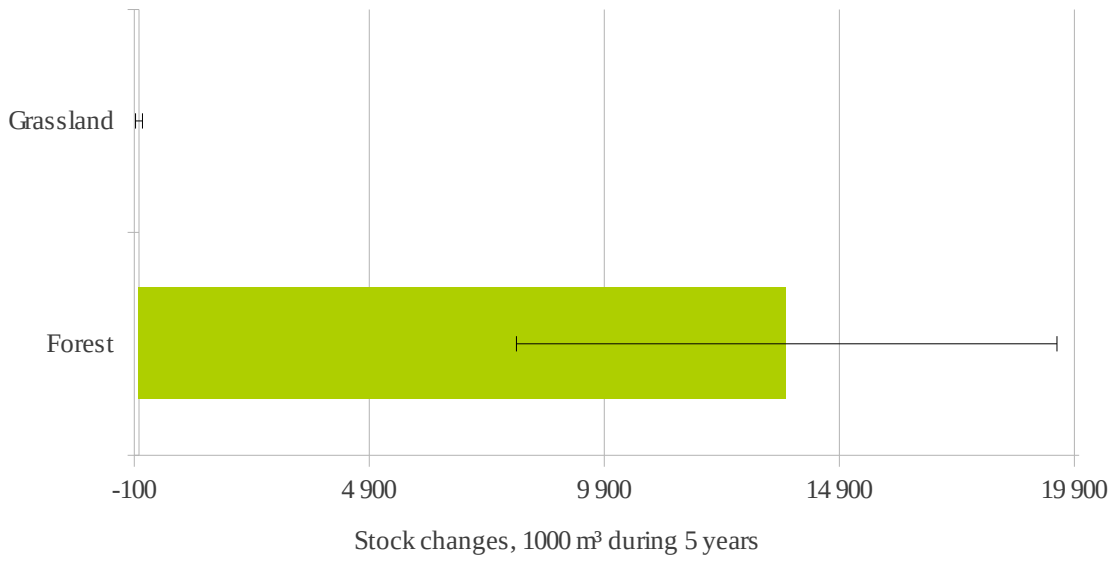


Figure 7.15 Stock changes of dead wood in forest land and grassland[117]

Commercial felling:

- dominant species specific harvesting data since 1970 (1990-2011 Central statistical bureau, 1970-1989 research papers[118]), summary in Figure 7.16;
- decomposition of crown and underground biomass – 20 years; species specific wood densities and different BEFs for coniferous and deciduous trees (Table 7.7, Table 7.8 and Table 7.9).

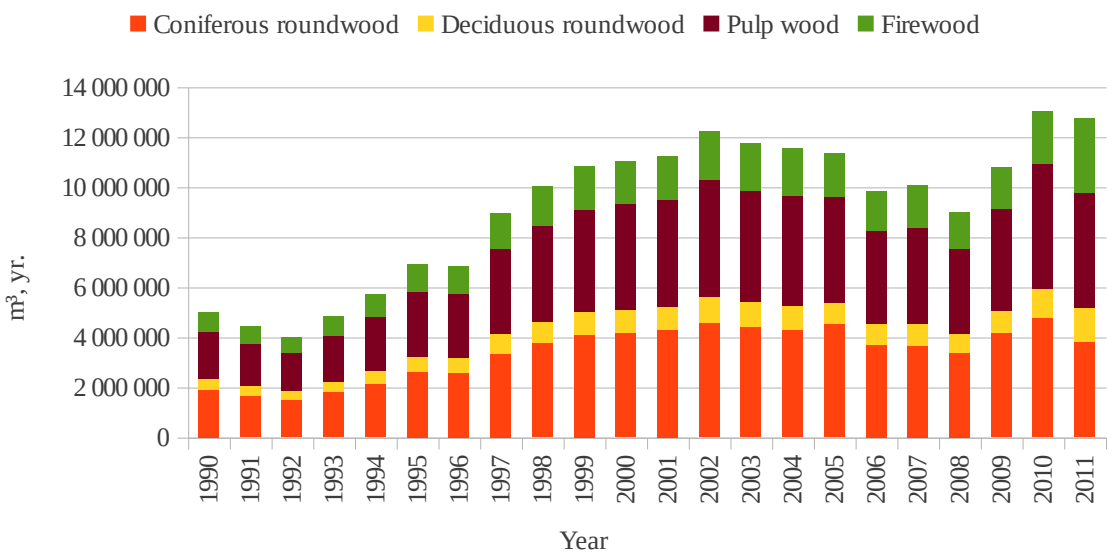


Figure 7.16 Assortments composition of annual harvesting stock

The methodology for harvested wood products is based on Rüter, S., 2011. Projection of Net Emissions from Harvested Wood Products in European Countries, Johann Heinrich von

117 Source – NFI, unpublished database snapshot, 14.01.2013.

118 Zigurds Saliņš, *Mežs - Latvijas Nacionālā Bagātība* (Jelgava: Jelgavas tipogrāfija, 2002); Zigurds Saliņš, *Meža izmantošana Latvijā: stāvoklis, perspektīvas* (Jelgava [Latvia]: LLU Meza izmantosanas katedra, 1999).

Thünen Institute, Hamburg. More detailed description follows in chapter 7.10.4 Methodological issues. CO_2 emissions in the controlled burning section (category – land remaining forest) are notated as IE because they are already accounted as losses in living biomass due to commercial harvesting.

Summary of emissions due to commercial harvesting is shown in figure 7.17.

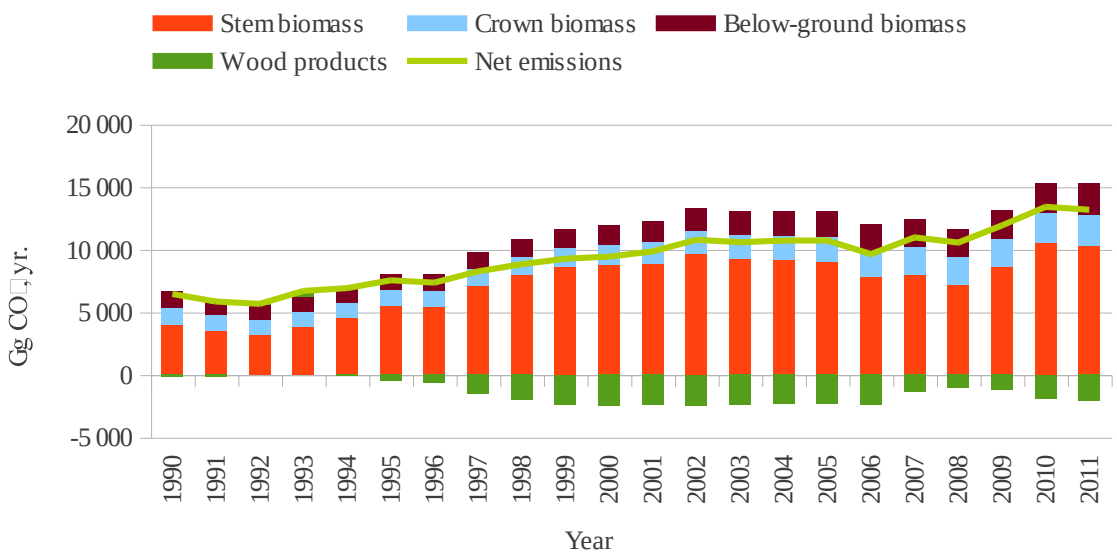


Figure 7.17 Summary of emissions due to commercial harvesting.

Only emissions from drained soils are accounted – 0.68 tons C ha^{-1} (Table 3.2.3 of the IPCC GPG LULUCF 2003) and 0.943 kg N_2O ha^{-1} annually from organic soils and 0.094 kg N_2O ha^{-1} annually from mineral soils. Emissions of CO_2 from drained soils are calculated according to Equation 3.2.15 of the IPCC GPG LULUF. Emissions of N_2O from drained organic forest soils were calculated according to Equation 3a.2.1 and Table 3a.2.1. Methodology on estimation and monitoring of carbon stock changes in naturally dry and drained mineral forest soils is under development.

Methodology for calculation of emissions due to wildfires and incineration of harvesting residues is described in chapter 7.8.4 Methodological issues; burnt biomass in forest fires 19.8 tons ha^{-1}, combustion factor 0.45. Incineration of harvesting residues is going down in Latvia and in 2012 LSFRI Silava has opportunity to collect information about incineration of harvesting residues in private forests; according to results of the questioonaire about 15 % of harvesting residues were left for incineration during last 3 years in private forests, in state forests no harvesting residues are left for incineration. Weighted average share of left for incineration residues is 7 %.

Total forest area was changed in the reporting 1990-2009[119] by separation forest lands being forest before 1990 and lands afforested after 1990. Deforested areas estimated using satellite image analysis is added to initial forest area. Therefore, area of forest land being forest before 1990 is constant, except changes caused by deforestation and due to completion of the transitional stage in afforested lands.

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 in

[119] LVĢMC, *Latvia's National Inventory Report Submitted under United Nations Convention on Climate Change and the Kyoto Protocol Common Reporting Formats (CRF) 1990 – 2009* (Rīga: Latvijas vides, ģeoloģijas un meteoroloģijas centrs, 2011).

already in 1990-2009 reporting according to research data on land use structure according to the NFI[120].

In section lands converted to forest land all categories except grasslands converted to forest land are notated 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 farmlands which afforested after 1990 and before 2004. Areas where trees did not reach 2 cm diameter at breast height were excluded from estimation and moved back to grasslands category. The year of afforestation of every single NFI plot selected for analysis were determined by subtraction of age of stand from a year when field measurements were done. The data about afforestation between 1990 and 2004 were used to extrapolate potentially afforested areas in 2004-2009. The regression equation used for extrapolation is shown in Figure 7.18. Regressions for calculation of drained soils is shown in Figure 7.19. No afforestation is considered for 2010 and 2011 to avoid potential overestimation of removals. In 2014 after processing of the NFI data from the second measurement cycle extrapolated figures will be replaced with actual land use change values.

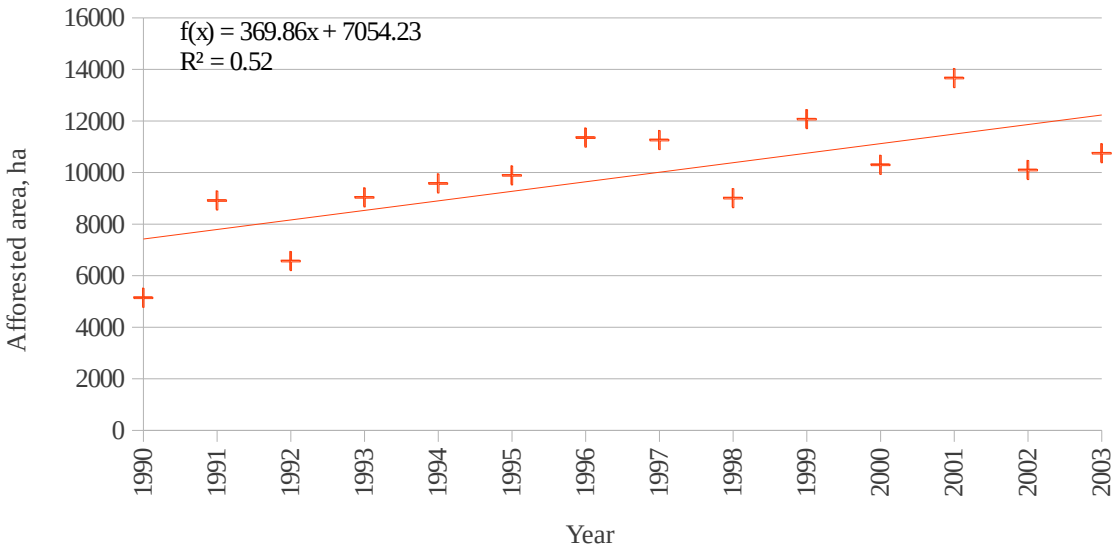


Figure 7.18 Logarithmic regression for extrapolation of areas afforested after 2004

[120] 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)."

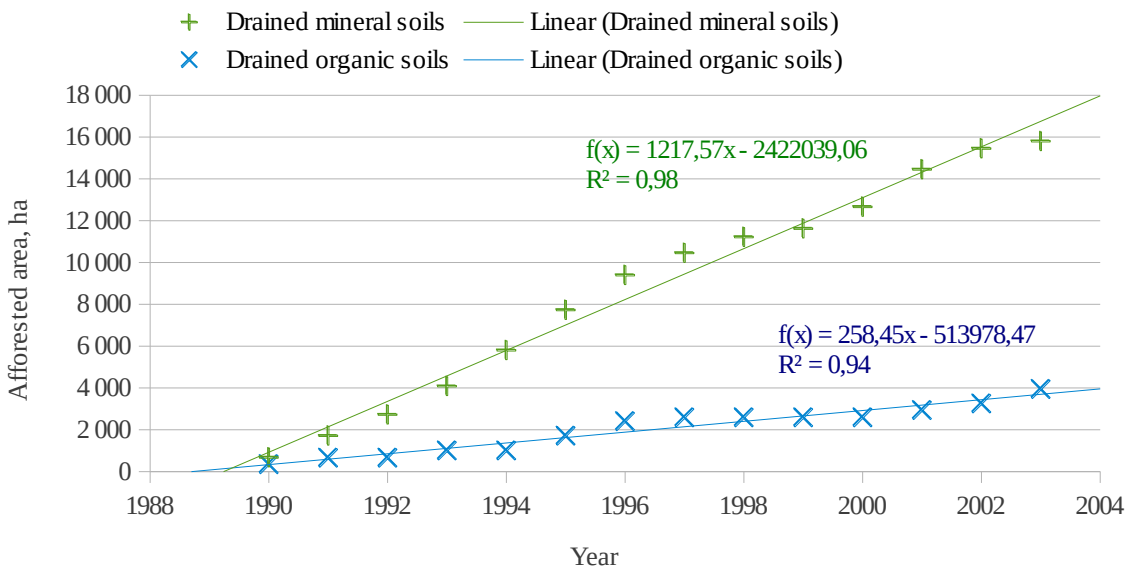


Figure 7.19 Linear regression for extrapolation of afforested area in the forest stand types on drained soils.

Gains in living biomass on afforested lands estimated using interpolation (stock change method assuming that the increment structure in areas afforested in different periods is similar)[121]. Weigted average wood density for a a particular year is used in calculations (0.44 kg L^{-1} in 2011) is used to covent stem volume to biomass. Default IPCC GPG LULUCF coefficients were used (1.3 to convert stem biomass into above ground biomass and 0.32 to convert above-ground biomass to below-ground biomass). Carbon content in biomass 50 %.

Losses of living biomass in afforested lands notated as NO because no commercial harvesting is taking 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 calculated using the same approach as for emissions from drained organic soils on lands remaining forest.

This is the first 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 45 years. This assumption will be corrected in the next inventory compiling actual figures of the dead wood stock change in afforested lands.

It is assumed in the calculation, that dead wood stock in afforested lands will reach 6.9 tons C ha^{-1} within 45 years, respectively, average annual stock changes in dead wood are 0.15 tons ha^{-1}. Values characteristic for fertile stand types on mineral soils typical for afforested lands are used in calculation. Wood density is considered according to average values of the living biomass in a particular year (0.44 kg L^{-1} in 2011). Similarly, weighted average above-ground and below-ground biomass expasion factors obtained in living biomass calculations are used to convert stem biomass to the total biomass. Carbon content in dead biomass 50 %.

[121] 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.

Average carbon stock in litter is 21.2 tons C ha^{-1} according to the BioSoil project forest soil inventory data[122]. Considering the same transformation period of 45 years, average increment of of carbon stock in the litter carbon pool is 0.5 tons C ha^{-1}.

Summary of carbon stock changes in dead wood and litter in afforested lands is shown in Figure 7.20. In 2010 and 2011 the increase of the carbon stock becomes smaller. This is because areas afforested in 1990 are now moved to the category forest land remaining forest and carbon stock changes in litter and dead wood in these afforested lands are accounted in this category. In the Kyoto protocol Article 3.3 and 3.4 reporting afforested as well as deforested areas are not changing land use category after completion of 20 years completion period, respectively carbon stock changes in dead biomass are accounted under these categories until they reach point of equilibrium with average stock in forest lands.

The methodology of estimation of the transition period is going to be improved during 2013 and updated calculations will be provided to the GHG inventory at the beginning of 2014.

No removals in soil are accounted due to afforestation, because there are no scientific evidences of carbon stock changes 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)[123]; however, there are evidences of statistically significant carbon stock changes in deeper soils layers after afforestation[124]. The information on carbon stock change in soil due to afforestation will be updated in the next inventory.

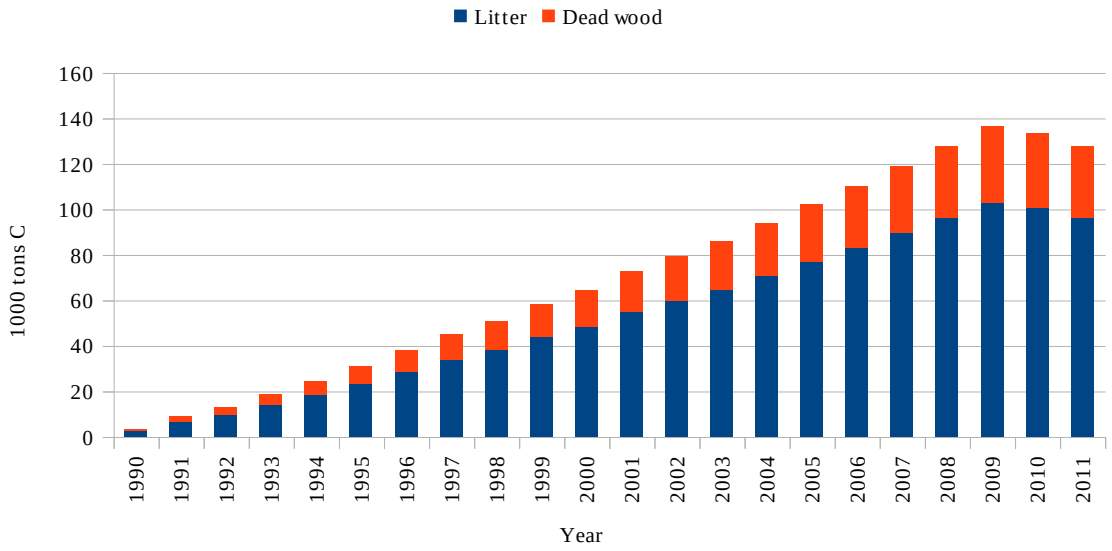


Figure 7.20 Carbon stock changes in dead wood and litter in afforested lands.

Information on carbon stock changes in mineral and organic soils in historical forest lands will be added to the inventory in the next submissiom. The information on mineral soil will be based on difference between carbon stock in soil in 2006 (the first BioSoil inventory) and

122 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)."

123 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.

124 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.

2012 (second forest soil inventory cycle)[125]. New project will be implemented in 2013 to estimate carbon stock change in organic forest soil due to establishment of drainage system. The empiric material will be collected in experimental trials established in early 60^{ths}.

7.2.5 Uncertainties and time-series consistency

Uncertainties are estimated on the base the NFI and expert judgement. Uncertainty of soil carbon (CO_2) and 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 IPCC GPG LULUCF 2003. Total level of uncertainty of emissions from organic soil is 90 %.

Uncertainty level (standard error of mean) of the forest area is 0.3 %, uncertainty of afforested area is 1.7 %, uncertainty of annual increment of growing stock of trees in forest lands is 0.9 %, uncertainty of increment on afforested lands 16 %. Uncertainty of area of drained organic soils in forest lands remaining forests is 0.8 %, uncertainty of area of drained organic soils in afforested lands 3.4 %. Uncertainties calculated as standard error of means. A standard error of mean of harvesting stock according to forest regulations is 10 %. BEFs utilized in calculations according to expert judgement have uncertainty level of 30 % according to the expert judgement.

7.2.6 Category-specific QA/QC and verification

Quality control procedures named in IPCC GPG LULUCF 2003, Table 5.5.1 were done for all calculations. Calculations concerning forest land were compared with similar calculations made for elaboration of the forest management decision making models and information provided by the State forest service.

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 that the guidelines and instructions are understood correctly;
- verification measurements were carried out during field seasons;
- from field data it was checked that all sample plots are measured that no required information is missing to find errors (if found, they were corrected) the compatibility with different data variables the compatibility with sample plot, tally tree and sample tree data;
- calculated results were compared with the results of previous inventories. If big or unexpected changes were found, reasons for them 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 a 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[126].

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125 Andis Lazdiņš et al., *Mežsaimniecisko Darbību Ietekmes Uz Siltumnīcefekta Gāzu Emisijām Un CO_2 Piesaisti Novērtējums (pārskats Par 2012. Gada Darba Uzdevumu Izpildi)* (Salaspils: LVMI Silava & Meža nozares kompetences centrs, 2012).

126 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),

The data based on forest statistics were produced by the LSFRI Silava[127]. Data descriptions are available (at the moment in Latvian) 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.

7.2.7 Category-specific recalculations

Significant updates are done in this category applying coefficients and equations elaborated within the scope of the calculation of the forest management reference level (FMRL) in 2012; particularly, updated figures on gross increment for the whole time series using average values for 5 years period, species specific mortality factors, wood density coefficients and decay factors, which are applied to living and dead biomass. Respectively, carbon stock changes in living biomass (gains and losses) and dead organic matter are recalculated. Estimations of annual increment and mortality were done down to 1970 to consider in calculations carbon stock changes in dead wood.

In subcategory land converted to forest land carbon stock changes in living biomass (gains) and carbon stock changes in dead organic matter are recalculated, assuming that average values of carbon stock in dead wood and litter characteristic for the forest lands will be reached within 45 years following to linear regression estimated in the NFI sample plots.

More detailed description of the applied methodologies is provided in chapter 7.2.4 Methodological issues.

7.2.8 Category-specific planned improvements

The most important planned improvements:

- elaboration of country specific biomass expansion factors, wood density and carbon content coefficients for the most common tree species (until report 1990-2013);
- elaboration of dead wood expansion factors (density, carbon content and decay factor depending from quality class) for the most common stand types (until report 1990-2013);
- estimation of decay period for dead wood (harvesting residues and below-ground biomass, planned to complete until report 1990-2013);
- estimation of temporary carbon stock change in forest soil using the first level forest monitoring plots (2013);
- estimation of carbon stock reference level in croplands and grasslands using selected network of the NFI plots which did not change land use category since 1990 to be used in estimation of impact of land use change (2013, preliminary results in 2012);
- estimation of carbon stock changes in drained organic soils in forest lands (2013);
- update of afforested areas according to empiric data from the second round of the NFI (report 1990-2013);
- estimation of transition period for dead wood and litter carbon stock in afforested lands (2013).

7.3 CROPLAND (CRF 5.B)

7.3.1 Source category description

Two key source categories are accounted under this category: CO_2 emissions from land converted to cropland and CO_2 emissions from cropland remaining cropland.

Under the cropland's category emissions from organic soils, lime applications and due to conversion to cropland (living and dead biomass, soil and N_2O emissions) are reported (Figure 7.21). Net aggregated emissions from cropland were 381 Gg of CO_2 eq. in 2011.

https://sites.google.com/site/lvlulucf/literature/Recalculationsofhystoricalremovals2007.pdf?attredirects=0&d=1.

[127] http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls

Lime applications were quite constant during the reporting period[128], except 2002 and 2003, when due to regulatory reasons (support for liming of farmlands) use of liming material considerably increased (Figure 7.22). Use of liming material strongly correlates with implementation of subsidiary schemas supporting liming of farmlands.

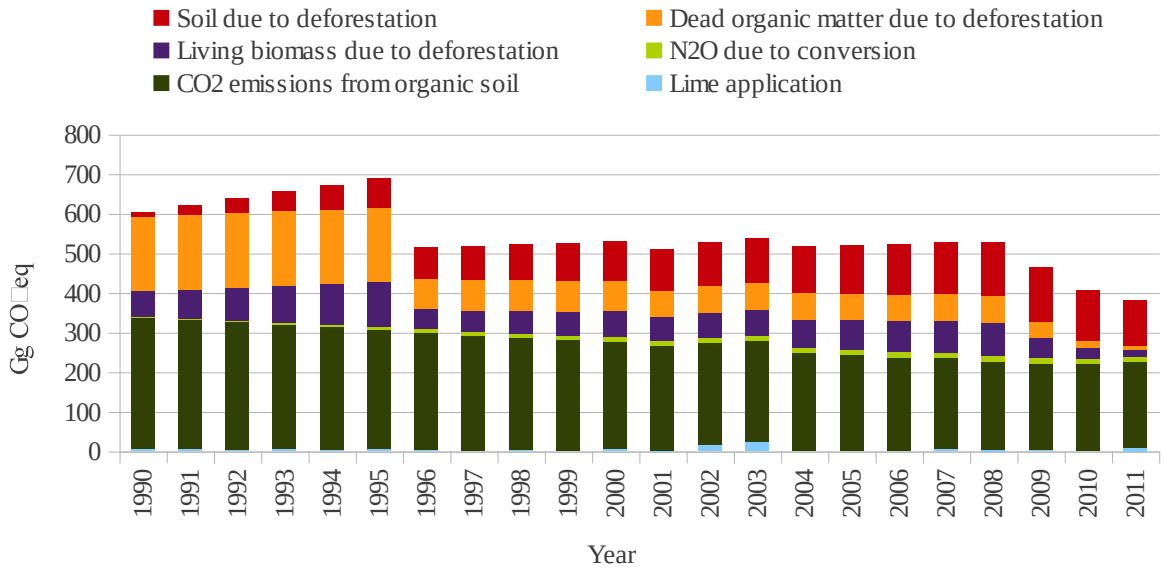

Figure 7.21 Aggregate GHGs in croplands

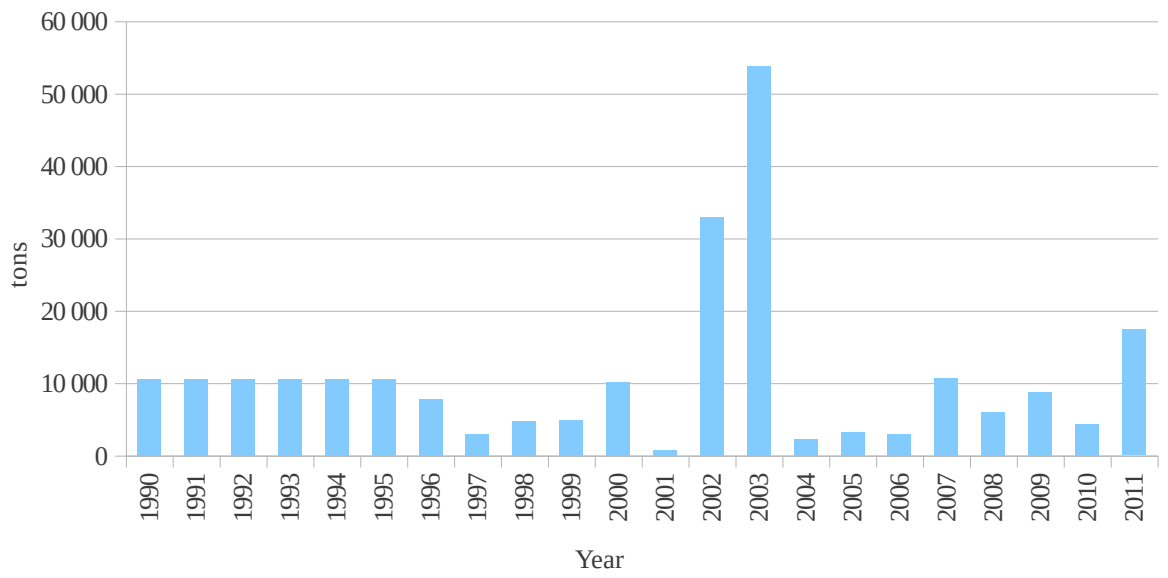

Figure 7.22 Application of liming material in croplands

The total area of croplands is estimated to the approach described further in chapter 7.3.7 Category-specific recalculations.

No removals in living biomass are reported in this category to avoid overestimations due to a high uncertainty level of negligible amount of removals in compare to a total carbon stock change, particularly in living biomass on forest lands. There is statistically significant increase

[128] https://sites.google.com/site/lvlulucf/activity/nir-1990-2010/Augsneskalkosana1995-2010.html?attredirects=0&d=1

of volume of growing stock of trees in cropland; however, uncertainty level is 60 %, therefore these figures are not used in calculations. Completion of the second round of the NFI in 2013 will provide information with considerably smaller level of uncertainty of increment of growing stock on the base of calculation of stock changes in 5 years period.

7.3.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Spatial approach is used to estimate deforested areas converted to croplands, interpolation of national statistics is used to determine changes in area of croplands since 1990[129]. Extrapolation of national statistics is used to determine area of croplands in 2009; combined approach – validation of interpolated data against national statistics is the NFI data about the land use structure is used to check correctness of estimations. Land use data will be recalculated in the beginning of 2014, when at least 80 % of the data obtained in the second cycle of the NFI will be processed.

7.3.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

The cropland refer to the official area of arable land, including orchards. The area is reported by the Central statistical bureau. According to the NFI data, which were used to estimate deforested areas converted to cropland and which will be used in further submissions to estimate land use conversions to and from cropland. The cropland also includes animal feeding glades.

7.3.4 Methodological issues

Emissions from organic soils in croplands were calculated using equation 3.3.5 of the IPCC GPG LULUCF 2003. CO_2 emissions from liming have been calculated using equation 3.3.6 of the IPCC GPG LULUCF 2003.

For calculation of emission from organic soils emission factor is taken from Table 3.3.5[130] of the IPCC GPG LULUCF 2003, emission factor for Cold temperate climate 1.0 ton C ha^{-1} yearly. For agricultural lime application overall emission factor of 0.12 was used to estimate CO_2 emissions, without differentiating between variable compositions of lime material.

Emissions of N_2O due to disturbances from conversion of forest land to cropland calculated using equations 3.3.13, 3.3.14 and 3.3.15 of the IPCC GPG LULUCF 2003. Carbon stock changes for calculation of the emission's factor are estimated using the Equation 3.3.3 of the IPCC GPG LULUCF 2003. Initial carbon stock in deforested areas was considered according to results of the BioSoil project – 124 tons C ha^{-1} at 0-30 cm depth (average carbon stock in mineral forest soil with standard deviation of 43 %). Coefficients for the carbon stock change calculations were taken from Table 3.3.4 – FLU 0.71 (Long-term cultivated, Temperate wet); FMG 1.00 (Full tillage, Temperate dry and wet); FI 1.00 (Medium input, Temperate dry and wet). The carbon stock in cropland after transition period of 20 years according to the Equation 3.3.3 is 88 tons C ha^{-1} at 0-30 cm depth; respectively net reduction of carbon stock in mineral soils is 36 tons ha^{-1} or 1.8 tons ha^{-1} annually. For organic soils in forest lands converted to croplands the default factor for cropland remaining cropland (1 ton C ha^{-1} annually) from Table 3.3.5 of the IPCC GPG LULUCF 2003 was used to estimate carbon stock changes. The data on emissions from mineral soils will be improved as soon as better information on carbon stock in cropland soil will be available. The project aimed to obtain missing data is initiated in 2012 and will provide statistically reliable information in 2013.

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129 Central statistical bureau, table LIG014. LAUKSAIMNIECĪBĀ IZMANTOJAMĀS ZEMES IZMANTOŠANA (Use of agricultural lands, 2000-2011); Statistical Yearbook of Latvia, 2012, Central statistical bureau, ISBN 978-9984-06-420-4, p 500 (use of agricultural lands, 1990-2011).

130 Annual emission factors (EF) for cultivated organic soils.

Activity data for calculations is taken from national statistics[131] (amount of liming material applied) and according to the national research data[132] (area of organic soils).

Area of land remaining cropland was estimated using interpolation method from data provided by CSB[133] and results of satellite image analysis[134]. Area of the cropland was calculated backwards from 2008 assuming[135] that statistical information about cropland area in 1990-1994 and 2006-2009 is correct and can be used to estimate starting and ending points of area of cropland. Remote sensing analysis of satellite images was used to estimate deforested area converted to cropland[136].

Only changes related to transition of land use from land converted to cropland to category cropland remaining cropland after completion of 20 years transition period are done after 2009, as well as deforestation to cropland according to a linear regression for the period before 1990. Data will be updated at the beginning of 2014, when the NFI will provide information on actual deforestation rate during the second NFI cycle.

Linear regression used for calculations of historical transition of cropland into grassland category is shown in Figure 7.2.

According to the study data[137] area of organic soils in farmlands is 5.18 ± 0.5 %. This value characerizes 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 proportion of organic soils in lands remaining croplands, lands converted to croplands and croplands converted to grasslands is equal until better data will be available. Therefore, the area of organic soils in cropland is linearly correlating in calculations with the total area of cropland. In 2011 according to this estimation there was 59 kha of organic soils in cropland remaining cropland and 0.9 kha in land converted to cropland. This assumption significantly is overestimated because the NFI shows that only about 3 % of afforested areas are on organic soils. The project started in 2012 on the base of the NFI demonstrates that 0.3 % of cropland, 1.4 % of cropland and 3.0 % of naturally afforested grassland is on organic soil; however, these, data should be considered as very preliminary, because only 20 % of the NFI plots on non-forest land are evaluated. (about 2000 plots). The rationale of the project is estimation of carbon content and texture of soil (where necessary) in the NFI plots fitting to the cropland or grassland category and being located on wetlands according to topographic maps developed at the beginning of the last century (50 % of cropland and grassland). Statistically verifiable results will be available at the end of 2013.

Area of organic soils in cropland used to calculate emissions from soil in this report is shown in Figure 7.23.

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131 https://sites.google.com/site/lvlulucf/activity/nir-1990-2010/Augsneskalkosana1995-2010.html?attredirects=0&d=1

132 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)."

133 http://data.csb.gov.lv/Dialog/varval.asp?ma=LI0140&ti=LI014%2E+LAUKSAIMNIEC%CEB%C2+IZMANTOJAM%C2S+ZEMES+IZMANTO%D0ANA+%28t%FBkst%2E+hekt%E2ru%29&path=../DATABASE/lauks/Ikgad%E7jie%20statistikas%20dati/01Lauks_visp/&lang=16

134 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)."

135 Agriculture and statistics experts were involved in consultations to identify if these data can be used.

136 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)."

137 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)."

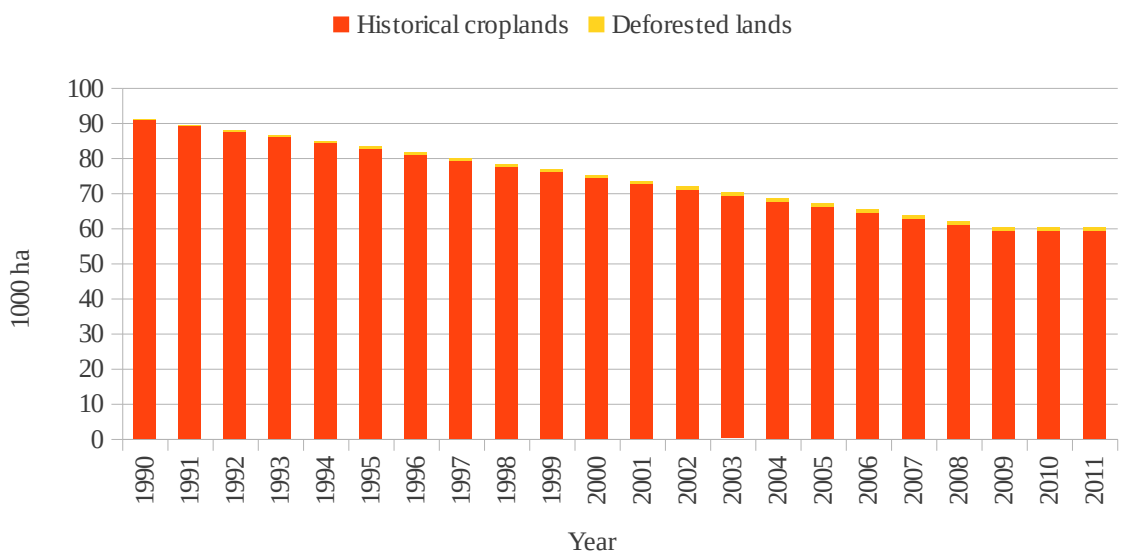

Figure 7.23 Total area of drained organic soils in croplands

Notation keys characterizing carbon stock change in living biomass and dead biomass in cropland remaining cropland is set to NO because carbon stock in these pools in cropland is negligible and do not result in actual emissions or removals. Exception is forest lands converted to cropland where losses in living biomass are calculated as proportion of the total harvesting rate (average harvesting rate per ha in particular year was multiplied with deforested area). Standard biomass expansion factors and wood density utilized previously in calculation of carbon stock change due to commercial felling in forest land was used in calculations losses in living biomass due to deforestation.

Net carbon stock changes in mineral soils in cropland are reported as not occurring because according to IPCC GPG LULUCF 2003[138] these emissions should be reported in case of changes in land management practice. Exception is forest land converted to cropland, where carbon stock changes in mineral soil are calculated using the Equation 3.3.3 of the IPCC GPG LULUCF 2003 as described above. Instant oxidation method is applied to living biomass (37 tons C ha^{-1}), dead wood (6 tons C ha^{-1}) and litter layer (20.9 tons C ha^{-1}).

Emissions from dolomite applications are notated as included elsewhere because they already accounted under the dolomite category using conversion factor 12 % (carbon per mass unit of liming material).

The notation key NO is used for other categories of land conversion to cropland because there are no evidences of such changes in the country. The area of cropland is reduced by 35 % in compare to 1990, which means that land use changes takes place mostly in opposite direction due to long-drawn reduction of activity in agriculture sector.

7.3.5 Uncertainties and time-series consistency

Uncertainty in the total area of cropland in 2011 according to the NFI was 0.3 %, uncertainty of area of organic soils in cropland in 2011 was 11 % expressed as standard error of mean of share of organic soils in Latvian municipalities. The uncertainty estimate for the CO_2 emission factor for organic soils is 90 % according to the IPCC GPG LULUCF 2003. For emissions associated with the lime application uncertainty was estimated at 10 % according to CSB.

Uncertainty of deforested area converted to croplands is 35 % expressed as standard error of mean of remote sensing results. Uncertainty of average carbon stock in litter in forests is 6 %,

[138] Section 3.3.1.2.1.1 Choice of Method.

uncertainty of carbon stock in mineral soil in forest land at 0-30 cm is 43 %, uncertainty of dead wood stock in forests is 2 %, uncertainty of carbon stock in dead wood according to the expert judgement is 30 % (as standard error of mean of density of dead wood depending from decomposition rate); and therefore, the total uncertainty of carbon stock in dead wood is 31 %.

Uncertainty of N_2O emissions due to disturbance of land following to transformation to cropland according to expert estimation is 90 % summarizing standard error of mean of carbon stock in soil and area of forest land converted to cropland.

Consistency of time series of calculations is considerably improved due to implementation of empirically based data about area of organic soils before 1990 and because of switching to interpolation of cropland area instead of usage of statistical data which fluctuated a lot due to changing methods and definitions without actual changes of the cropland area. Recent figures of cropland area is validated against actual figures provided by the NFI which will be used as the main source of information starting with 2014 when second round of the NFI will be completed (end of 2013).

7.3.6 Category-specific QA/QC and verification

The QA/QC plans for the cropland category includes the QC measures based on the IPCC (IPCC 2000, Table 8.1, p. 8.8-8.9). 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.

7.3.7 Category-specific recalculations

Major changes were introduced into the calculations of emissions in the land converted to cropland category:

- carbon stock changes in living biomass (losses) is recalculated considering average harvesting rate in particular year and biomass conversion factors used in the forest management activities to calculate carbon stock change in living biomass due to harvesting losses;
- net carbon stock changes in mineral soils are updated using correct value of initial carbon stock in mineral soils (previously used value was average carbon stock in forest soils).

7.3.8 Category-specific planned improvements

There are several major issues, which will be solved until the next inventory:

- updated area of organic soil in cropland according to the NFI study started in 2012[139]; the same values of share of organic soil will be used for land converted to cropland. Linear regression will be used in time series to reduce share of organic soil in cropland before 1990 (5.18 %) to the actual value;
- updated information about land use change according to the NFI data; particularly, from grassland to cropland;
- updated carbon stock in cropland remaining cropland to estimate carbon losses in soil due to deforestation as well as carbon stock changes in soil due to conversion to grassland and vice versa;
- updated CO_2 emissions from organic soils considering area changes and recent findings in Nordic and Baltic countries, particularly, doctoral thesis by Jüri-Ott Salm

[139] Lazdiņš, A., 2012. Atbalsts klimata pētījumu programmai (starpziņojums par 2012. gada darba uzdevumu izpildi) (No. 020512/S68). LVMI Silava, Salaspils.

"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"[140].

- updated N_2O emissions due to disturbances using new data on carbon stock changes in soil;
- carbon stock changes in living biomass and dead wood using updated conversion factors for density and carbon stock, as well as biomass expansion factors.

7.4 GRASSLAND (CRF 5.C)

7.4.1 Source category description

The grassland's category is a key source of CO_2 emissions from organic soil. Total area of grassland in Latvia in 2011 was 1 260 kha, including 665 kha of grasslands remaining grasslands and 595 kha of lands converted to grassland[141]. Emissions from organic soils and biomass burning are reported under the grassland category (Figure 7.24). The net emissions from grasslands were 65 Gg in Latvia in 2011. Extraordinary pikes of emissions associated with burning of grass (for instance, in 2006) are associated with considerably larger area of fires initiated by favourable climatic conditions in 2006 (Figure 7.25). No removals are reported in this category to avoid an overestimation. According to comparison of the results from 1st and 2nd NFI cycle there are no statistically significant changes in growing stock of woody biomass in grasslands according to the preliminary data of the NFI.

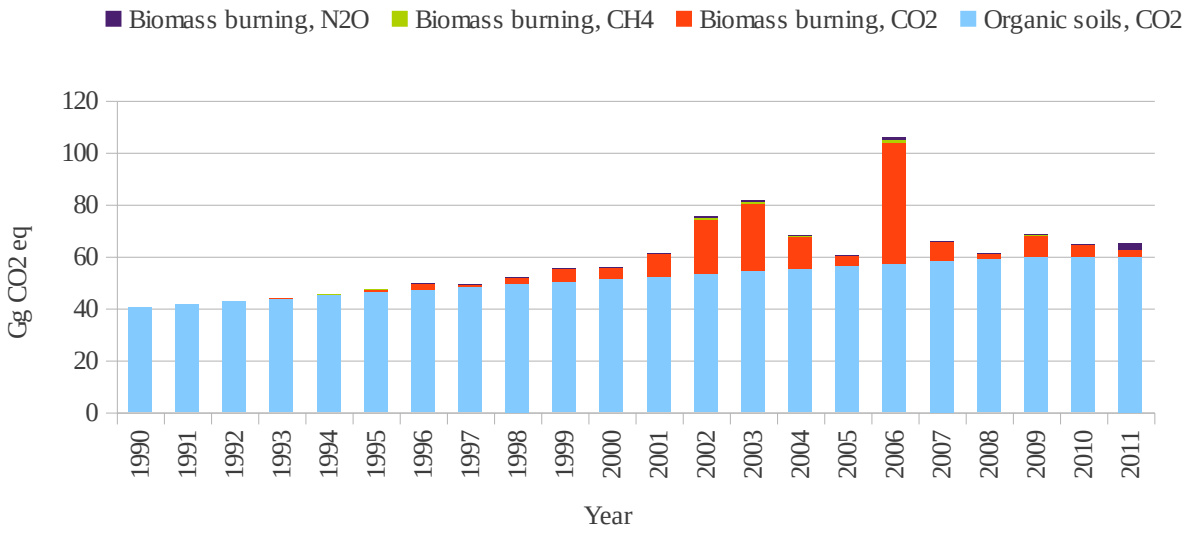

Figure 7.24 Aggregate GHGs (CO_2, CH_4, N_2O) in grasslands

140 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.

141 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."

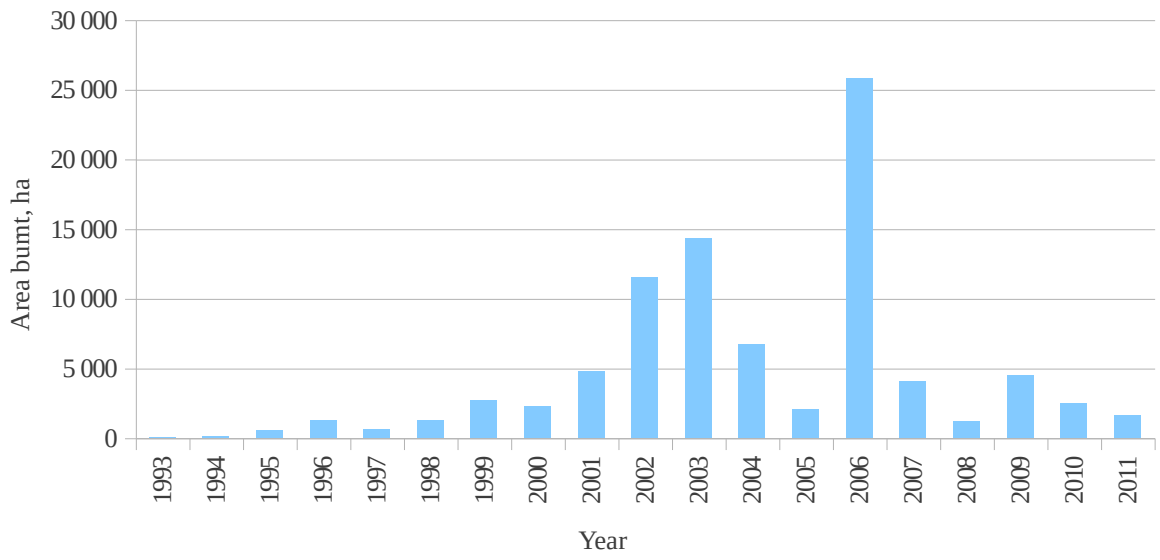

Figure 7.25 Statistics of artificial biomass burning in grasslands

Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Area of the grassland is estimated using combined approach – total area of grasslands and croplands for the whole time series estimated according to official statistics (CSB)[142] and the NFI field measurement data[143]. The latest data corresponds to actual area of grasslands determined by the NFI, historical data are recalculated backwards using this formula:

$$G_{-1} = G_0 - G_{gf} + G_{cg}\ ;\ where$$

G_{-1} - area of grasslands in previous year;
G_0 - area of grasslands in current year;
G_{gf} - area of grasslands converted to forest in current year;
G_{cg} - area of croplands converted to grasslands in current year.

The applied approach secures that different land use types are not overlapping and since 2008 it is fully consistent with marks of land use categories in the NFI database. It will be possible to account land use changes in this category using field measurement data of second round of the NFI.

Information about area of organic agricultural soils is provided by the MOA (5.18 ± 11 % of total area of farmlands)[144]. These figures are based on soil mapping data and characterizes situation before 1990 (data utilized in calculation were obtained from 60^{ths} to early 80^{ths}); therefore, there is no risk of underestimation of emissions in 2011 and previous years due to underestimation of area of organic soils. Dynamics of area of organic soils in grassland's used in calculations is shown in Figure 7.26. Increase of the area of organic soils is associated with

[142] http://data.csb.gov.lv/Dialog/varval.asp?ma=LI0140&ti=LI014%2E+LAUKSAIMNIEC%CEB%C2+IZMANTOJAM%C2S+ZEMES+IZMANTO%D0ANA+%28t%FBkst%2E+hekt%E2ru%29&path=../DATABASE/lauks/Ikgad%E7jie%20statistikas%20dati/01Lauks_visp/&lang=16

[143] 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)."

[144] 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)."

massive conversion of cropland to grassland during 90ths of the previous century and during the last decade.

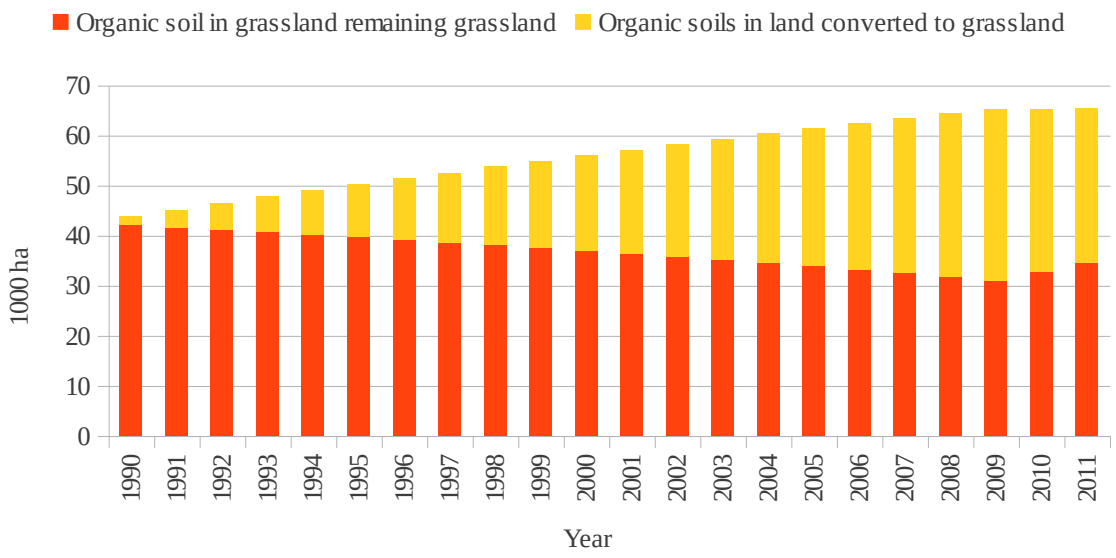

Figure 7.26 Area of organic soils in grasslands

A net carbon stock change in dead biomass in grasslands is reported as NO, taking in account that there is no dead biomass stock on grasslands. Gains and losses in living biomass are kept NE as these categories contributes to negligible carbon stock changes (growing stock of woody biomass on grasslands is less than 1 % of total growing stock[145]; therefore, considerably smaller than the uncertainty level), consequently, changes in terms of losses and gains are very small).

Emissions from wildfires are noted as IE for all GHGs and reported under controlled burning. Technically it is not possible to separate artificial and "natural" grassland fires; therefore, they are reported together.

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. Total area of cropland converted to grasslands in 2011 was 595 kha (34 % of croplands' area in 1990), excluding area of cropland converted to grassland in 1990 and 1991, which is moved to grassland remaining grassland category, because of completion of 20 years transition period. The NFI do not provide information about historical changes between grassland and cropland categories; therefore, interpolation method is used to calculate reduction of area of cropland due to conversion to grassland. The project on evaluation of historical area of cropland implemented within the scope of the NFI approved that actual area of cropland in 1990 was considerably smaller than it follows from official statistics (1487 kha in compare to 1685 kha)[146]. Calculated area of cropland in 2008 was evaluated according to actual measurement data provided by the NFI and official statistics. Difference from official statistics in 2008 was 0.4 %, but from the NFI – 20 %. This might happen because the NFI might consider fallows as grasslands. During last decade area of fallows according official

145 http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls

146 Andis Lazdiņš and Juris Zariņš, *Vēsturiskās (1990. Gada) Apsaimniekoto Aramzemju Platības Noteikšana Un Līdz 2009. Gadam Notikušo Aramzemju Platības Izmaiņu Novērtēšana* (Salaspils: LVMI Silava, 2012).

statistics was 6-11 %[147], therefore difference between the NFI and interpolated data is about 10 %.

Carbon stock changes in mineral soils in croplands converted to grasslands is reported as not occurring, because there are research evidences, that carbon stock in grasslands in average at 0-30 cm depth is by 29 % figher than in cropland, respectively 86.8 ± 6.5 tons ha^{-1} and 61.8 ± 1.7 tons ha^{-1}.[148] These data are based on comparison of 40 NFI sample plots and will be updated in future by continuous monitoring of carbon stock change in soil.

No land use changes in this category are reported in 2011. These values will be recalculated in the beginning of 2014 after receiving the report of results of the second round of the NFI (at least 80 % of data).

7.4.2 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

The category consists of lands used as pastures, for a forage production and growing of grass as well as glades and bush land which do not fit to forest definition, including vegetated areas on non-forest lands complying to forest definition where land use type can be easily switched back to grassland without legal requirement of transformation of the land use. In the Latvia's GHG accounting non-forest lands with average diameter of trees at the breast height less than 2 cm are reported under grassland's category. No removals or emissions associated with living biomass are reported for these lands to avoid overestimation of removals due to a high uncertainty level of the increment data of biomass.

7.4.3 Methodological issues

Quantity of fuel burnt during incineration of grass was calculated according to the IPCC GPG LULUCF 2003 Table 3.4.2[149] (a value for cold temperate wet climate is used, 2 400 kg ha^{-1}). Information about fires on the Grassland was obtained from the State Fire and Rescue Service[150]. Emission factors corresponding to moist-infertile grassland from IPCC GPG LULUCF 2003 Table 3A.1.16[151] were used to calculate emissions (Table 7.11).

Table 7.11 Emission factors for moist-infertile grasslands

No	GHG	Emission factor
1	CO_2	1 498
2	CO	59
3	CH_4	2
4	NO_2	4
5	N_2O	0.1

Fraction of the biomass combusted during grass burning was taken from the IPCC GPG LULUCF 2003 Table 3A.1.12[152]. Factor for peat-lands (0.5) was applied in the calculations.

[147] http://data.csb.gov.lv/Dialog/varval.asp?ma=009_zemes_izmant_LV&ti=LSS09%2E+Lauksaimniec%EEb%E2+izmantojam%E2s+zemes+izmanto%F0ana+statistiskajos+re%ECionos+%28t%FBkst%2E+ha%29++&path=../DATABASE/lauks/Ikgad%E7jie%20statistikas%20dati/Lauksaimniec%EEbas%20strukt%FBra/&lang=16

[148] Lazdiņš, A., 2012. Atbalsts klimata pētījumu programmai. Starpziņojums par 2012. gada darba uzdevumu izpildi, No. 020512/S68 (Climate research program supporting studies, progress report 2012). LVMI Silava, Salaspils, p 75.

[149] Default estimates for standing biomass grassland (as dry matter) and aboveground net primary production, classified by IPCC climate zones.

[150] https://sites.google.com/site/lvlulucf/activity/nir-1990-2011/Kulas%20ugunsgreki.pdf?attredirects=0&d=1

[151] Emission factors (g kg^{-1} dry matter combusted) applicable to fuels combusted in various types of vegetation fires.

[152] Combustion factor values (proportion of prefire biomass consumed) for fires in a range of vegetation types, dimensionless.

CO_2 emissions from drained organic soils were estimated according to the IPCC GPG LULUCF 2003 Table 3.4.6[153]. Emission factor for cold temperate climate (0.25 tonnes C ha^{-1} yearly) was used.

7.4.4 Uncertainties and time-series consistency

Uncertainty in the area of organic grassland was estimated at 11 % as standard error of proportion. The uncertainty estimate for the CO_2 emission factor for organic soils is 90 % according to the IPCC GPG LULUCF 2003. For biomass burned uncertainty was estimated at 100 % based on expert judgement (variation of growing stock of wild grasses harvested for pellet production).

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 %[154]; however more accurate information will be available at the end of 2013. Area of organic soils in afforested grasslands is about 3 % of total area of grasslands converted to forests according to the NFI[155]. This number seems to be more realistic than 5.15 % obtained from historical data.

7.4.5 Category-specific QA/QC and verification

The QA/QC plans for the Grassland's category includes the QC measures based on the IPCC (IPCC 2000, Table 8.1, p. 8.8-8.9). 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.

7.4.6 Category-specific recalculations

Minor changes are done in this category. More accurate figures on organic soils and total area of historical grassland (being grassland before 1990) are applied to 2010. The same is done for land converted to grassland – more accurate figure for cropland converted to grassland in 2010 is entered. These changes are related to mathematical mistakes in calculations during previous reporting.

7.4.7 Category-specific planned improvements

Grassland is significant potential source or sink category; therefore, the most of attention will be paid to improve knowladge about carbon stock change in grassland; particularly, in historical grasslands due to different management of grasslands as well as due to land use conversion from and to grassland. The most important improvements proposed for the future inventories are:

- update of land use information (conversion of cropland to grassland, afforestation of grassland and deforestation to grassland);
- evaluation of carbon stock in historical grassland, cropland and forest land representing similar growth condition to estimate carbon stock changes in soil due to land use change;
- recalculation of carbon stock changes in living and dead biomass and soil carbon pools due to land use changes;
- calculation of carbon stock changes in all carbon pools in grassland areas covered by woody vegetation.

153 Annual emission factors (EF) for managed grassland organic soils.

154 Lazdiņš, *Atbalsts Klimata Pētījumu Programmai (starpziņojums Par 2012. Gada Darba Uzdevumu Izpildi).*

155 http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls

7.5 WETLANDS (CRF 5.D)

7.5.1 Source category description

Wetlands remaining wetlands is a key source category of CO_2 emissions due to commercial peat extraction. According to the IPCC GPG LULUCF 2003 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 (448 kha) is reported according to the research results.

Latvia reports CO_2 emissions associated with industrial peat extraction in this category. Default activity data (area of industrial peatlands) provided in Table 3a.3.3 of the IPCC GPG LULUCF 2003 is used in calculation of emissions. This method allow to avoid underestimation of emissions raised by alternative approach – calculation of are of industrial peatlands assuming that the peat extraction rate is 0.016 mill. tons km^{-2}. According to the Table 3a.3.3 of the IPCC GPG LULUCF 2003 the default value for area of industrial peatlands in Latvia is 27 kha every year; using extraction rate method calculations results in 3 kha in 2009. Taking into account considerable annual fluctuations in peat production, more conservative default method is used in calculations. Emissions of CO_2 from drained industrial peatlands are reported under Table 5.D.1 Wetlands remaining wetlands as carbon stock changes. Emissions of N_2O are reported under Table 5(II) Non-CO_2 emissions from drainage of soils and wetlands. No emissions of CH_4 are reported in this category as there are no input data as well as default methodology in the IPCC GPG LULUCF 2003.

Aggregated emissions from industrial peatlands are equal for the whole time series due to lack of data about status of industrial peatlands prepared for extraction 20-40 years ago. However there is no evidence of new industrial peatlands prepared for peat extraction after 1990, therefore risk of underestimation of emissions do not exist. N_2O contributes to about 7 % of net emissions from peatlands.No removals are reported in this category according to requirement of the IPCC GPG LULUCF 2003, however wetlands is a considerable source of removals. Net removals in living biomass on wetlands in calculation to CO_2 are provided by the NFI are shown in Figure 7.27.

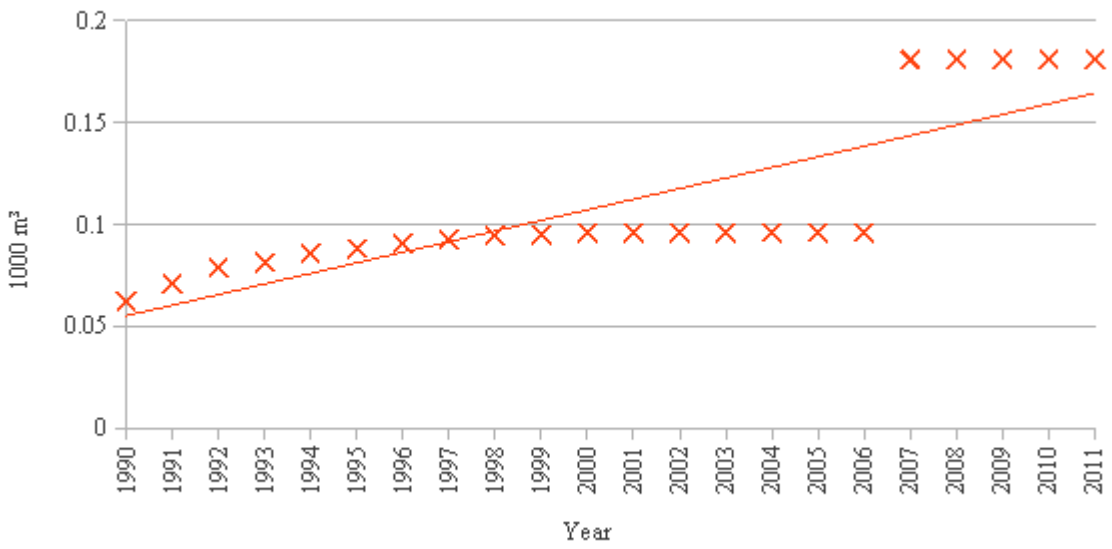

Figure 7.27 Increment of growing stock of trees on the wetland

7.5.2 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 wetlands. Activity data are provided by the NFI[156]. No changes in land use are considered since 1990.

7.5.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Wetlands category includes all inland water bodies (rivers, ponds, lakes, and ditches), swamps (constantly wet areas where height of trees cannot reach more than 5 m in height and ground vegetation consists mostly of sphagnum and different sword grasses), flood-lands (small areas) and alluvial lands (larger flood-lands).

7.5.4 Methodological issues

Activity data – area of peatlands prepared for extraction – is taken from TABLE 3a.3.3[157] of the IPCC GPG LULUCF 2003. Emission factor for carbon stock changes due to drainage is taken from Table 3A.3.2[158] of the IPCC GPG LULUCF 2003. Emission factor for N_2O emissions due to drainage is taken from Table 3A.3.4[159] of the IPCC GPG LULUCF 2003. Coefficients for poor sites are considered because mostly poor sphagnum bogs are prepared for extraction historically.

7.5.5 Uncertainties and time-series consistency

Uncertainty level of CO_2 and N_2O emission factors assumed 95 %[160] according to the IPCC GPG LULUCF 2003. Uncertainty level of area estimations assumed 90 % according to the expert judgement. Uncertainty level of area of wetlands according to the NFI is 1.4 % (6.3 kha) expressed as standard error of mean.

Complete consistency of the time-series is secured by use of single source of data for estimation of area and emissions for the whole time period. Emissions associated with peat extraction might be considerably overestimated because this industry is considerably reduced during last decades[161] and area of peatlands prepared for extraction is reduced as well. 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.

7.5.6 Category-specific QA/QC and verification

Quality control procedures named in IPCC GPG LULUCF 2003 were done, particularly, data about peat extraction were compiled from different sources as well as emission factors provided by different authors were compared.

7.5.7 Category-specific recalculations

There are no recalculations done in the wetland's category.

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156 Lazdiņš, "Harmonization of land use matrix in Latvia according to requirements of international greenhouse gas reporting system - extending outputs of National Forest inventory program."

157 Estimates of peatland areas and use for tier 1 in 1000 hectares

158 Emission factors for CO_2-C and associated uncertainty for organic soils after drainage, coefficient for nutrient poor soils – 0.2 tons C ha^{-1} yearly.

159 Default emission factors for N_2O emissions from wetlands, coefficient for nutrient poor soils – 0.2 tons N_2O-N ha^{-1} yearly.

160 According to log-normal distribution.

161 http://data.csb.gov.lv/Dialog/varval.asp?ma=DR0060&ti=DR06%2E+SVAR%CEG%C2KO+DER%CEGO+IZRAKTE%D2U+KR%C2JUMI+GADA+BEIG%C2S+&path=../DATABASE/visp/Ikgad%E7jie%20statistikas%20dati/Dabas%20resursi/&lang=16

7.5.8 Category-specific planned improvements

Land-use changes for the period 2009-2012 will be reported on the base of empirical data provided by the second round of the NFI. Changes in 5 years period (between the both measurement cycles in a single plot) will be divided equally between years. Emissions will be calculated in case of conversion of land use from wetlands to other land use categories. Default Tier 1 methods and emissions factors from the IPCC GPG LULUCF 2003 will be used in calculations until better data will be available. The discussion on improvement of reporting, particularly, development of map (dedicated GIS layer) of peat extraction areas is initiated with non governmental organization "Latvia's national peat society"; however, funding sources are not yet identified. The map of peat extraction areas will consist of information about peat production, qualitative and quantitative characteristics of peat extraction areas.

The increment in living biomass will reported for managed wetlands, like drainage ditches, riversides and lakes. The activity data will be obtained from the NFI. An example of managed wetlands is shown on Figure 7 .34. Trees and bushes growing on ditces are not accounted under grassland, cropland or forest land category, because they are not fulfilling threshold criteria for these land use categories, therefore all vegetation on ditchsides is accounted under wetlands. Only in state forest length of drainage ditches is about 48000 km, which means about 48 kha area[162]. The same could be accounted in private forests and even more – in farmlands.

7.6 SETTLEMENTS (CRF 5.D)

7.6.1 Source category description

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 than any new constructions are always associated with deforestation. Afforestation of abandoned farmlands at the same time is more intensive; however, young forests on farmlands cannot fully compensate emissions due to the deforestation.

Under the settlements category emissions from soils, litter, living and dead biomass due to conversion of land use type are reported. Summary of emissions due to conversion of forest lands to settlements are shown in Figure 7.28. Net emissions from settlements in 2011 were 883 Gg CO2 eq. Total area of settlements in 2011 was 254 kha, including 15 kha of land converted to settlements after 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 lands and not other land use types where area of settlements reduced due abandonment. 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 belongs to forest

[162] Accoding to the Joint stock company "Latvia state forests".

land.

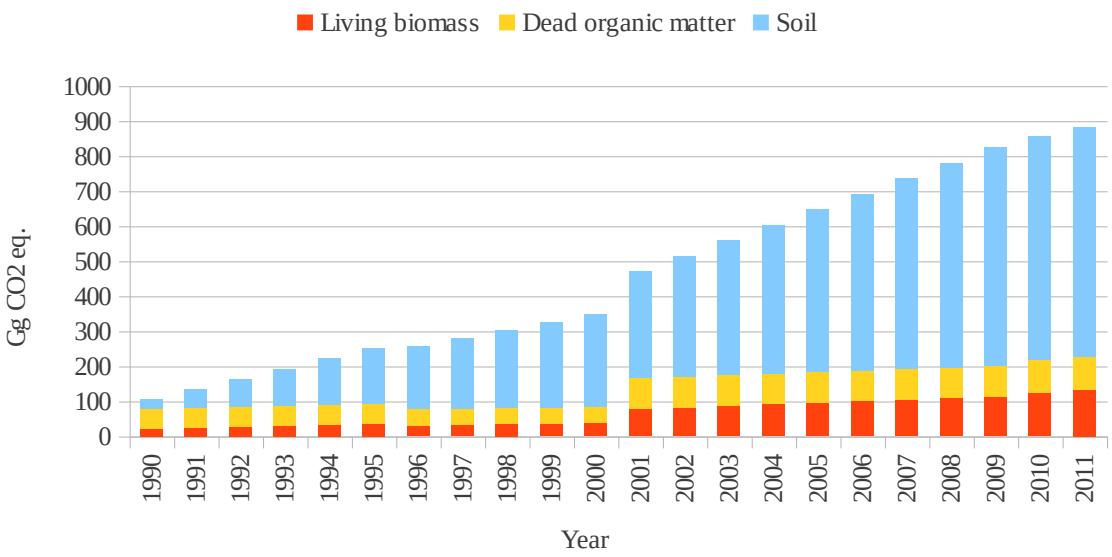

Figure 7.28 Net carbon stock changes in settlements

7.6.2 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 settlements. Activity data are provided by the NFI. Area of lands converted to settlements presented 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"[163].

7.6.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

According to the IPCC GPG LULUCF 2003 settlements includes land under buildings including infrastructure necessary to maintain those buildings, like industrial networks, roads and other types if land use if they are not already accounted under other land use categories, for instance, in forest lands (parks and green parts of forests). According to national definitions updated for the GHG reporting settlements means:

- 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 excluding ditches and other wetlands, but including seed orchards, forest nurseries and fire-breaks;
- other infrastructure – buffer zones of industrial networks, quarries etc.

7.6.4 Methodological issues

Area of lands converted to settlements is estimated by evaluation of vegetation index of the NFI points (23 thousands of 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. Points where the vegetation index changed from forest to non-forest lands were marked as potentially deforested. Then logical selection were used to separate those

[163] 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)."

points where removal of woody vegetation is not associated with land use change (for instance, cleaning of roadsides outsides 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 was used to elaborate prognosis for deforestation in 2010 (Figure 7.29). Obtained data (1.0 kha) were validated according to actual statistics of forest road construction in state forests and other deforestation activities planned for 2010.

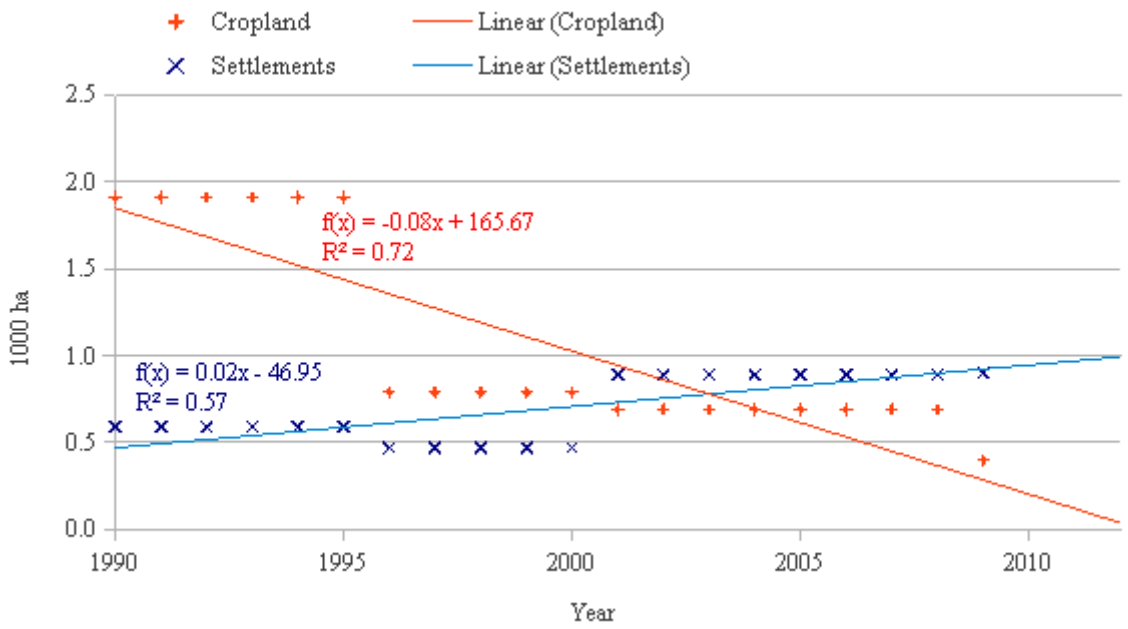

Figure 7.29 Linear regression used to elaborate prognosis of deforestation

Area of land remaining settlements is assumed constant until 2009 (239 kha) according to the NFI data. In 2010 and in 2011 areas converted to settlements in 1990 and 1991 are moved from the temporary land use subcategory to the settlements remaining settlements. Area of land converted to settlement since 1990 is estimated using satellite image analysis . Total area of land converted to settlements in 2011 is 14.7 kha. The category will be updated in 2014, when the NFI field measurement data characterizing land use changes between 2009 and 2013 will be available. Dynamics of area of settlements is shown in Figure 7.30.

No carbon stock changes are reported in the category – settlements remaining settlements. 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 already accounted under losses of living biomass under land remaining forest[164]. Net carbon stock changes in dead biomass on land remaining settlement is noted as not occurring because there is no dead biomass on these lands normally or values are negligible. A net carbon stock change in soil in lands remaining settlements is noted as not applicable because they are not resulting in emissions or removals.

There are only evidences in national statistics about conversion of forest land to settlements, and not of other land use types; therefore, the rest of categories of land converted to settlements are reported as not occurring. Losses in living biomass due to commercial felling

[164] In the Kyoto protocol reporting they are moved to the deforestation category, a splitting method is based on assumption that losses in living biomass due to deforestation are equal to average losses in living biomass due to clear-felling in the specific year.

are noted as included elsewhere, because they are already accounted under losses due to commercial harvesting on land remaining forest. Forest harvesting is a part of deforestation due to national legislation, it can also be separated in time (harvesting takes place several years before actual deforestation – implementation of the measures prohibiting forest regeneration); therefore, it is not possible to identify, how much wood is harvested due to deforestation. Carbon stock changes in dead biomass are accounted using instant oxidation method considering that all dead biomass converts to emissions in the year of conversion.

Carbon stock changes in soil due to deforestation were calculated using Equation 3.3.3 of the IPCC GPG LULUCF 2003. Initial carbon stock in deforested areas was considered according to results of the BioSoil project -244 tons C ha^{-1} at 0-30 cm depth (average carbon stock in mineral forest soil with standard deviation of 70 %). Coefficients for the carbon stock change calculations were taken from Table 3.3.4 –FLU 0.83 (Set aside (< 20 yrs) Temperate and Tropical, wet); FMG 1.16 (No tillage, Temperate wet); FI 0.91 (No input, Temperate wet). The carbon stock in cropland after transition period of 20 years according to the Equation 3.3.3 is 214 tons C ha^{-1} at 0-30 cm depth; respectively net reduction of carbon stock in mineral soils is 30.3 tons ha^{-1} or 1.5 tons ha^{-1} annually.

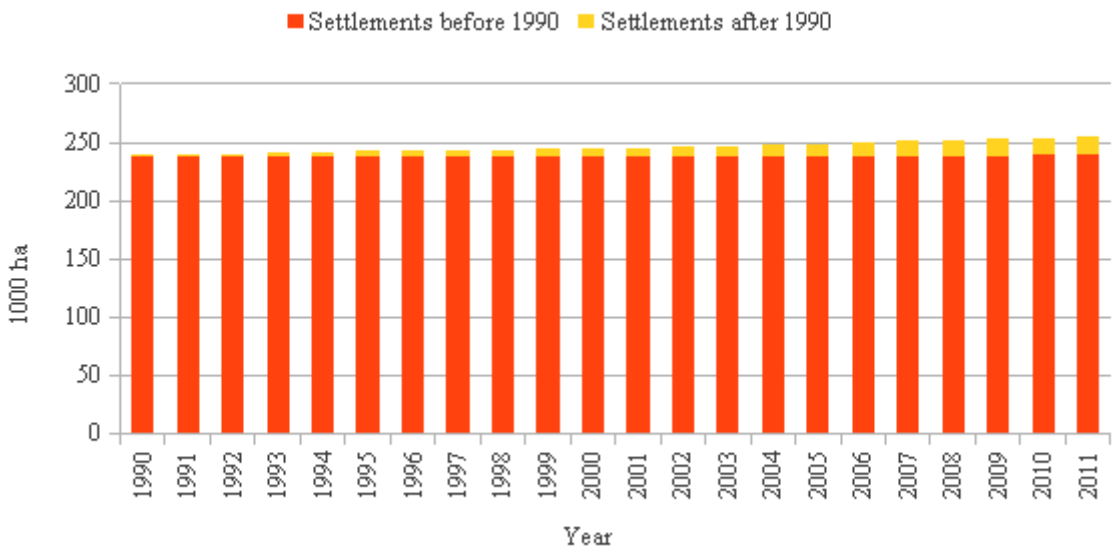

Figure 7.30 Area of settlements

No carbon stock changes are reported in the category – settlements remaining settlements. The emissions (losses in all 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 reported as average values of carbon losses acording to a harvesting stock in particular year. Linear regression is used to equalize average carbon losses (Figure 7.31). Carbon stock changes in dead biomass are accounted using instant oxidation method considering that all dead biomass converts to emissions in the year of conversion. Average carbon stock in dead biomass (20.9 tons C ha^{-1} in litter and 6.0 tons C ha^{-1} in dead wood) is used in calculations. Soil emissions are calculated considering average carbon stock in forest soils (mineral and organic) at 0-30 cm depth (244 tons ha^{-1}) according to earlier publications considering that all carbon in 0-30 cm deep soil layer will converts to CO_2 emissions within 20 years.

The conversion factors for dead wood were borrowed from the forest land remaining forest category assuming that average wood density, share of crown and below ground biomass and carbon content corresponds to the figures in particular year, when deforestation takes place; respectively, in 2011 wood density was 0.44 kg L^{-1}, average carbon content 500 g kg^{-1}, share

of crown biomass 30 % of stem biomass and share of below ground biomass 32 % of aboveground biomass

Representation of land use changes from 2010 to 2012 will be updated according to actual figures obtained in the NFI plots – difference in land use between the first (2004-2008) and second (2009-2013) round of the NFI.

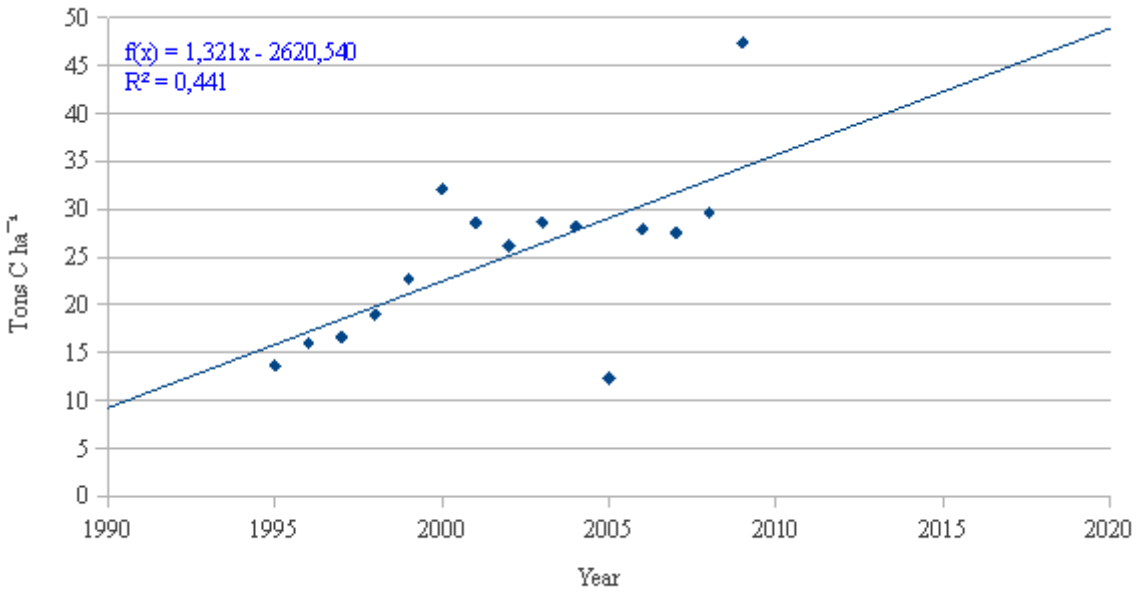

Figure 7.31 Losses in living biomass due to deforestation

7.6.5 Category-specific planned improvements

Settlements particularly forest infrastructure is carbon sink due to increment in living biomass (Figure 7.32); however, uncertainty level is very high (3 % for vegetated area and 15 % for the annual increment in recent data and up to 35 % and 45 %, respectively, in calculation of historical data). Methods to calculate the prognosis of annual increment is not validated on settlements therefore we need to verify them against actual stock change figures. After completion of second round of the NFI (in 2014) equations for calculation of carbon stock changes in living biomass on settlements will be updated and gains in living biomass as well as net change in dead biomass will be estimated.

It is planned to separate in future area of settlements covered by vegetation (like buffer zones below the electrical lines) and areas without vegetation (like asphalted part of roads) to calculate losses of carbon stock in soil in these areas separately. The approach proposed in the IPCC GPG LULUCF Equation 3.3.3 will be developed.

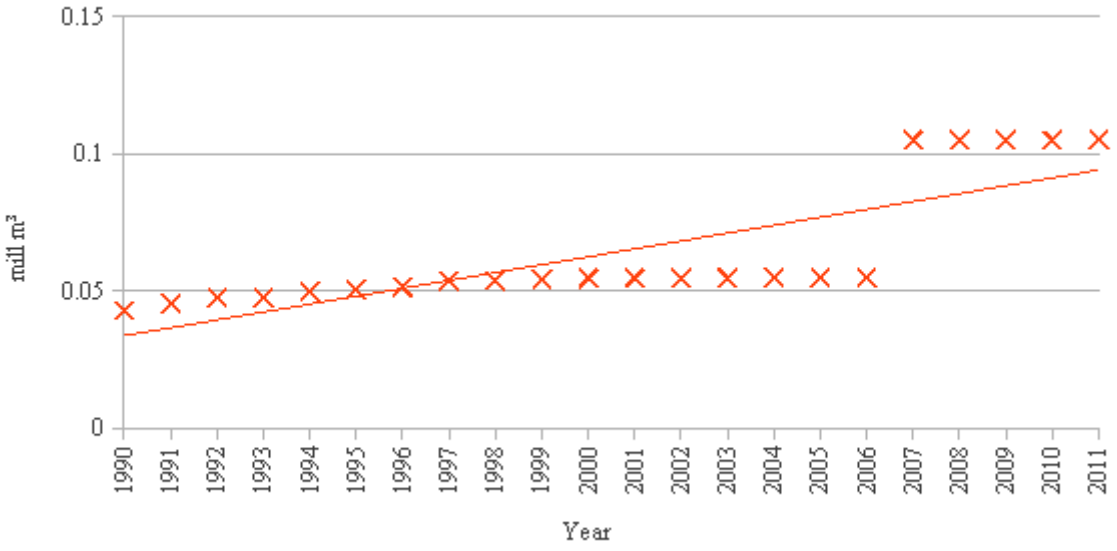

Figure 7.32 Increment of living biomass in settlements

7.6.6 Uncertainties and time-series consistency

The uncertainty of area of settlements is 4 % (10 kha). Uncertainty of deforested area converted to settlements is 19 % expressed as standard error of mean of remote sensing results. Uncertainty of average carbon stock in litter in forests is 6.1 %, uncertainty of carbon stock in soil layer 0-10 cm is 15.6 %, uncertainty of dead wood stock in forests is 1.7 %, uncertainty of carbon stock in dead wood according to the expert judgement is 30 %, and therefore total uncertainty of carbon stock in dead wood is 30 %. All values are expressed as standard error of mean. Total 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.

7.6.7 Category-specific QA/QC and verification

The QA/QC plans for the settlements' category includes the QC measures based on the IPCC (IPCC 2000, Table 8.1, p. 8.8-8.9). These measures are implemented first time during this 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.

7.6.8 Category-specific recalculations

Major recalculations was done in this category by adding losses in living biomass due to deforestation, updating figures of carbon losses in dead wood due to deforestation using updated values of wood density and biomass expansion factors, and carbon stock changes in soil by increasing of depth of calculation – from 0-10 cm to 0-30 cm and by applying transformation period of 20 years instead of instant oxidation.

7.7 OTHER LANDS (CRF 5.F)

7.7.1 Source category description

According to the IPCC GPG LULUCF 2003 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 includes unmanaged lands, wetlands and settlements (1 459.3 mill. ha in 2008). Instead of the official statistics since 2009 the NFI is used to estimate area of other lands. It is assumed that other lands are moorlands, dunes and recultivated lands where land use type cannot be determined yet (categories of the NFI No 33, 34 and 542, Table 7.1). Total area of these lands is considered constant for the whole reporting period (4.3 kha).

No emissions or removals are reported in this category.

7.7.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Spatial approach is used to represent land areas. Activity data are provided by the NFI. Area of other lands presented in this report is estimated 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"[165].

7.7.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

The NFI land use classification system is used to identify other lands. The other lands are moorlands, dunes and recultivated lands where land use type cannot be determined yet (Table 7.1). No emissions or removals are reported in this category.

7.7.4 Methodological issues

No emissions or removals are calculated treating the other lands as the unmanaged areas.

7.7.5 Uncertainties and time-series consistency

The uncertainty of activity data calculated as standard deviation of mean according to the NFI is 8.3 % (0.4 kha).

7.7.6 Category-specific QA/QC and verification

Category other lands remaining other lands is reorganized in this submission. The total area reported under this category is considerably reduced and moved to grassland's category; however, it does not affect GHG balances because no emissions or removals are reported just like in previous report.

7.7.7 Category-specific recalculations

No recalculations were done for this category.

7.7.8 Category-specific planned improvements

No improvements are planned for this category. Changes in land use will be reported according to empirical data provided by the NFI every 5th year, respectively, land use changes will be recalculated every 5th year applying average figures to every year in the period.

7.8 BIOMASS BURNING (CRF 5 (V))

7.8.1 Source category description

This source category includes greenhouse gas emissions (CO_2, CH_4, N_2O) and other air emissions (NO_x and CO) from biomass burning on forest land comprising wildfires and controlled burning as well as biomass burning (grassland fires) in the grassland's category.

[165] 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 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)."

The area statistics on forest wildfires are compiled by the State forest service and they are based on information given the local units. In the statistics all wildfires are classified as forest fires and for this reason it is not possible to separate wildfires on wetlands and other land from fires on forest land. Classifying land area by IPCC land-use category, forest fires can happen on Forest land, Wetlands and Other land. All wildfires taking place in forests are reported under the category forest land remaining forest.

Figure 7.33 shows that the most of forest fires are located in 2 regions, which are actually 2 the largest cities in Latvia. The situation is about the same every year.

Figure 7.33 Forest *fires (red spots) in Latvia in 2011*

Emissions from biomass burning are represented by incineration of harvesting residues during forest logging operations. The information until 2010 was based on the study and for the 2011 the information source is changed to questionnaire of private forest owners and state forest management company. This switch lead to reduction of emissions in 2011.

Total aggregated emissions from biomass burning in 2011 were 19 Gg of CO_2 equivalents (Figure 7.34).

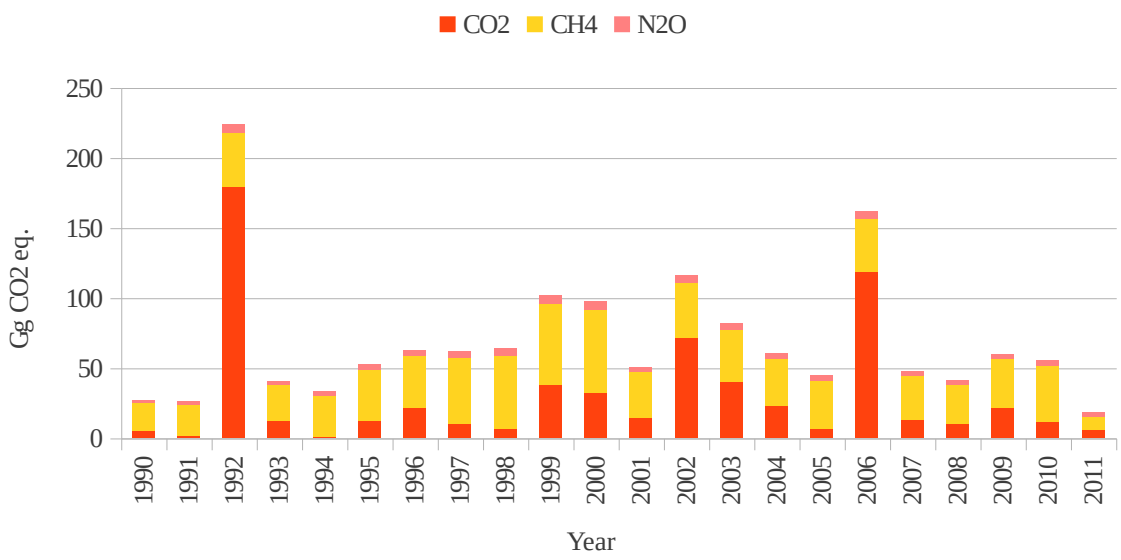

Figure 7.34 Aggregated emissions from biomass burning

Significant linear regression found between area of forest wildfires and grassland burning ($R^2 = 0.59$, Figure 7.35), which indirectly shows that both data collected by independent institutions are trustful.

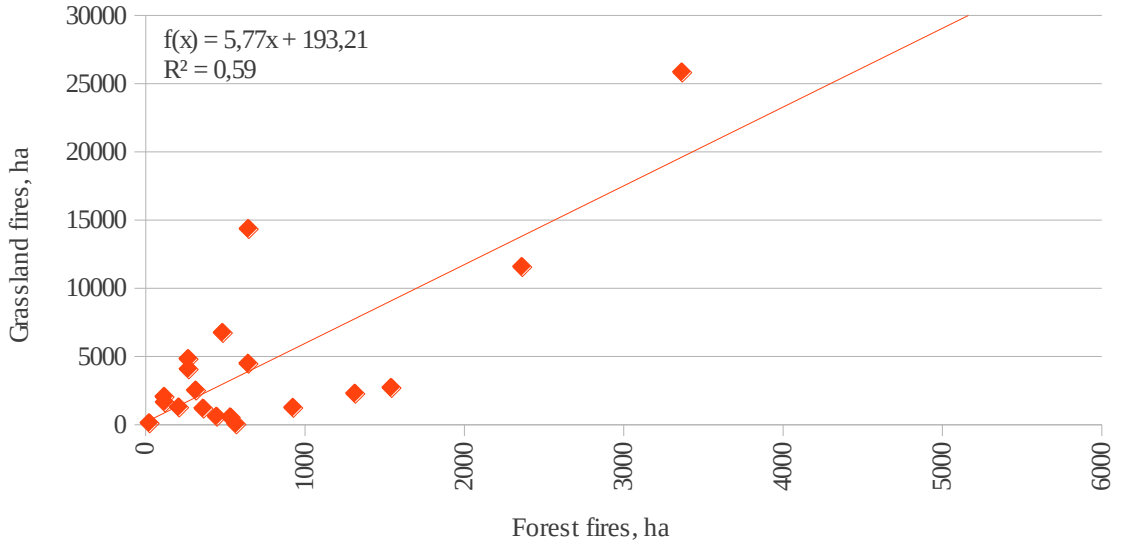

Figure 7.35 Correlation between areas of forest wildfires and areas of grassland burning.

7.8.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Area of forest wildfires in time period between 1990 and 2011 is provided by the SFS , area of grassland burning is provided by the State fire safety service (SFSS) . Future reporting of grasslands fires will be updated by adding georeferenced information on location of fires.

7.8.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Biomass burning occurs on forest land and grassland. Taking in account that wetlands (swamps) belongs 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. Wildfires on lands converted to forests can be reported in national statistics under forest land remaining forest or grassland depending from legal status of land use. The approach used in the Latvia's NIR (reporting emissions under land use categories according to national statistics) secures that emissions from biomass burning are not overlapping.

7.8.4 Methodological issues

Tier 1 and 2 methods of calculation provided in the IPCC GPG LULUCF 2003 were utilized. Emissions from wildfires were calculated using equation 3.2.20 of the IPCC GPG LULUCF 2003[166].
Amount of burned biomass is considered according to – 41 tons ha^{-1} in forest wildfires[167].
Emissions from controlled burning were calculated using equation 3.2.19 and emission ratios were taken from Table 3A.1.15 of the IPCC GPG LULUCF 2003.

For emission calculation from controlled burning of harvesting residues in forest default emission factors according IPCC GPG LULUCF 2003 are used (Table 7.12).

Table 7.12 Emission factors and ratios for burning

Emission factors for open burning of cleared forests	
CH_4	0.012
CO	0.06
N_2O	0.007
NO_x	0.121
Fractions, factors, ratios	
Biomass Oxidised On Site	0.9
Carbon fraction	0.5
Nitrogen Carbon Ratio of Biomass burned	0.01

Amount of harvesting residues was assumed as 20.2 % from annual cutting volume according national research[168]. The following assumptions have been made for harvesting residues calculation, which was burned:

- harvesting residues on-site burning 50 % in period from 1990 to 1999, the rest 50% left to decay;
- starting from 2001 – harvesting residues burning 30 % and 70 % left to decay.

From the harvesting residues burned on-site, 2/3 is actually burned on-site, and 1/3 is gathered by population and used as fuel wood. Assumptions that have been made for calculation are shown in Table 7.13.

Table 7.13 Factors and parameters used for calculations of change in carbon stock in living biomass

Coefficient	Numeric value
Weighted average wood density	0.5 (td.m. m^{-3})

166 Ed. Penman et al. (2003) *Good Practice Guidancefor Land Use, Land-Use Change and Forestry (*IPCC GPG LULUCF).

167 IPCC GPG LULUCF 2003 – TABLE 3A.1.13 Biomass consumption *(t ha^{-1})* values for fires in a range of vegetation types.

168 Līpiņš, "Assessment of wood resources and efficiency of wood utilization (Koksnes izejvielu resersu un to izmantošanas efektivitātes novērtējums)."

Coefficient	Numeric value
Biomass expansion factor for conversion of merchantable volume to aboveground tree biomass	1.30 (dimensionless)
Root-to-shoot ratio appropriate to increments	0.32 (dimensionless)
Carbon fraction of dry matter	0.5 (t C td.m^{-1})

For wildfires default factor (for all boreal forest – 0.34) from Table 3A.1.12 of the IPCC GPG LULUCF 2003[169]. Emission factors for CH_4, CO, N_2O, NOx and CO_2 are taken from TABLE 3A.1.16 of the IPCC GPG LULUCF 2003[170] (Table 7.14).

Table 7.14 Emission factor for each GHG (g kgd.m^{-1})

CO_2	CH_4	CO	N_2O	NO_x
1532	7.1	112	0.11	0.7

CO_2 emissions are calculated only from wildfires taking in account that carbon located in harvesting residues is already accounted as emissions using instant oxidation approach.

7.8.5 Uncertainties and time-series consistency

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 (± 70 %) are based on the IPCC GPG LULUCF 2003 default values.

7.8.6 Category-specific QA/QC and verification

Quality control procedures named in IPCC GPG LULUCF 2003 Table 5.5.1 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.

7.8.7 Category-specific recalculations

No recalculations were done for this category.

7.8.8 Category-specific planned improvements

A new methodology on estimation of biomass stock in areas suffering from forest fires is under development in the LSFRI Silava. Information provided by the State forest service will be used for quality assurance. Harvesting residues burning will be evaluated within the scope of NFI by remarking harvesting sites where harvesting residues burning will take place and by land owners questionnaires securing double and independent accounting.
Amount of incinerated harvesting residues will be calculated as a function from extracted timber biomass using regionally verified biomass expansion factors which also are going to be elaborated until 2014.

7.9 NON – CO_2 EMISSIONS (CRF 5 (I-III))

7.9.1 Source category description

Direct N_2O emissions from fertilization of forest land are reported as not occurring because no forest fertilization takes place in Latvia. It is forbidden by the FSC and PEFC forest certification systems as well it is economically non-feasible in forests with ordinary rotation

[169] Combustion factor values (proportion of prefire biomass consumed) for fires in a range of vegetation types were used to calculate the amount of burned biomass.

[170] Emission Factors (g kg^{-1} dry matter combusted) applicable to fuels combusted in various types of vegetation fires.

period. Emissions from applications of fertilizers on farmlands in reported in the agriculture's section. The category includes N_2O emissions from drained soils in forest lands and wetlands as well as N_2O emissions associated with land use change to croplands.

7.9.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The land area currently used as cropland is estimated according to empirical data provided by the NFI, historical areas of the new croplands (land converted to cropland) is estimated using interpolation on the base of research data[171]. Area of constructed wetlands (areas prepared for peat extraction) is taken from the default values of the IPCC GPG LULUCF 2003. Area of drained forest soils is estimated using spatial approach on the base of information about distribution of forest stand types characteristic for drained mineral and organic soils.

7.9.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

The NFI land use definitions are merged into the LULUCF categories of land use. Harmonized approach (single source of information) is used in all of the LULUCF categories to represent current land use data with exception of croplands which is extrapolated according to the national statistics of the managed croplands area.

7.9.4 Methodological issues

Methods utilized to estimate N_2O emissions due to conversion of land use to croplands are described in Chapter 7.3.4.

7.9.5 Uncertainties and time-series consistency

Uncertainties described in Chapter 7.3.4.

7.9.6 Category-specific QA/QC and verification

Procedures relevant to specific land use categories are applied.

7.9.7 Category-specific recalculations

No recalculations done.

7.9.8 Category-specific planned improvements

The research is started in 2011 to evaluate carbon stock in grasslands to elaborate methodology for estimation of net emissions from conversion between forest lands and grasslands. Similar study is initiated in 2012 to estimate carbon stock in croplands. These data will be used to evaluate emissions of CO_2 and N_2O due to conversion of forest lands to cropland. As soon as the results will be implemented into the GHG accounting (in 2013) land use change relevant non-CO_2 emissions will be accounted using country specific activity data.

7.10 HARVESTED WOOD PRODUCTS (CRF 5.G)

7.10.1 Source category description

Harvested wood products is a key source of CO_2 emisssions. Increase of removals in the harvested wood products during the last decade is associates with increase of harvesting rate and development of more advanced wood processing technologies.

[171] Lazdiņš, "Harmonization of land use matrix in Latvia according to requirements of international greenhouse gas reporting system - extending outputs of National Forest inventory program."

Net emissions due to production of the harvested wood products are calculated on the base of the methodology elaborated in 2011 by S. Rüter for estimation of the forest management reference level for the 2013-2020 reporting period of the Kyoto protocol[172].

The net emissions in harvested wood category in 2011 was -2434 Gg CO_2. The net emissions during the reporting period are shown in Figure 7.36.

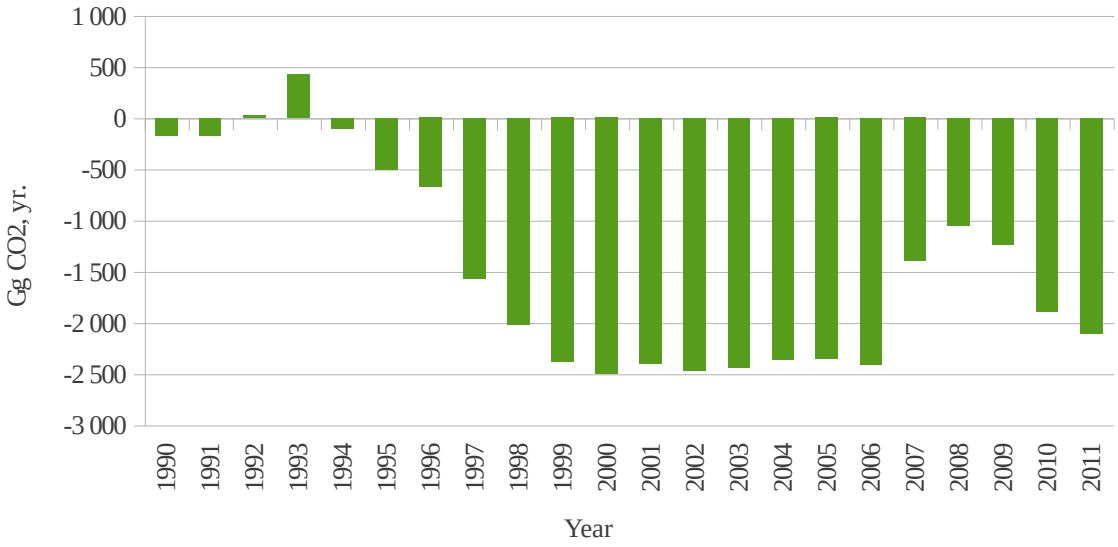

Figure 7.36 Net emissions from harvested wood products

7.10.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The calculation is based on harvesting statistics collected by the State forest service and production statistics by the Forest industry association and FAO. Linkage to land area extracted 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 originated and consumed (including primary processing) wood is accounted.

7.10.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

Not applicable.

7.10.4 Methodological issues

The net emissions from the harvested wood products are calculated according to the methodology elaborated by S. Rüter, 2011.

Historical data on production, import and export of harvested wood products as well as share of different types of the products are used in calculation. The coefficients and numeric values used in calculation are provided in Table 7.15 and Table 7.16. Input data in calculation are counted down 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.

[172] Rüter, S., 2011. Projection of Net-Emissions from Harvested Wood Products in European Countries (No. Work Report No. 2011/x of the Institute of Wood Technology and Wood Biology). Johann Heinrich von Thünen Institute (vTI), Hamburg.

Table 7.15 Assumptions for estimation of carbon stock in harvested wood products

ID	Assortment	Density, g cm^{-3}	Gg C 1000 m^{-3}
1.2.C	Industrial rdw - Coniferous	0.45	0.23
1.2.NC	Industrial rdw Non-Coniferous	0.67	0.34
5.C	Sawnwood -Coniferous	0.45	0.23
5.NC	Sawnwood - Non-Coniferous	0.67	0.34
6 1	Veneer sheets	0.59	0.30
6 2	Plywood	0.48	0.24
6 3	PARTICLE BOARD (including OSB)	0.63	0.29
6.4.1	HARDBOARD	0.85	0.42
6.4.2	MDF (MEDIUM DENSITY)	0.73	0.32
6.4.x	Fibreboard compressed	0.79	0.34
6.4.3	INSULATING BOARD	0.27	0.11
10	PAPER AND PAPERBOARD	0.90	0.45

Share of locally originated wood in harvested wood products is calculated using equation No. 1.

$$ratio_{INDRW\ consumption\ from\ dom\ harvest} = \frac{(Production_{INDRW} - Export_{INDRW})}{(Production_{INDRW} + Import_{INDRW} - Export_{INDRW})} \quad (1)$$

Organic carbon in harvested wood products originated from local wood is calculated using equation No. 2.

$$Production_{HWP\ from\ dom\ harvest} = Production_{HWP} \bullet ratio_{INDRW\ consumption\ from\ domestic\ harvest} \quad (2)$$

The rate of the CO_2 emissions and removals in harvested wood products is calculated using equations No. 3 and 4.

$$(1) \qquad C(i+1) = e^{-k} \bullet C(i) + \left[\frac{(1-e^{-k})}{k}\right] \bullet Inflow(i) \qquad \text{with } C(1900) = 0.0$$

$$(2) \qquad \Delta C(i) = C(i+1) - C(i)$$

(3)

$$k = \frac{\ln(2)}{HL} \quad (4)$$

Table 7.16 Common coefficients to estimate balance between CO_2 emissions and removals in harvested wood products

Coefficients	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
$\frac{1-e^{-k}}{k}$	0,99	0,99	0.85

The methodology is still under development to represent more accurate impact of species distribution in the harvesting stock as well as to simplify representation of different products (to reduce them to sawn products, plate wood and pulp wood).

The equtions of calculation of the harvested wood products are included into the National model for calculation of the net emissions due to forest management as separate module.

The instant oxidation method is used to estimate emissions from HWP as losses in the living biomass. Emissions are reported in the Forest land remaining forest section.

7.10.5 Uncertainties and time-series consistency

Uncertainty level for the whole time series is assumed 15 % (212 Gg CO_2) expressed as standard error of mean of of the net removals in the harvested wood products in 1990-2011.

7.10.6 Category-specific QA/QC and verification

Harwesting rate and production of harvested wood products used in the calculations is compared with other data sources, particularly statistics collected by the Latvia Forest indistry federation.

7.10.7 Category-specific recalculations, if applicable, including changes made in response to the review process

No recalculations were done, 2011 is the first year, when Latvia reports harvested wood products.

7.10.8 Category-specific planned improvements

Major changes will we applied to activity data, when country specific values for wood density will be eladorated (in 2014). Impact factors of species composition on structure of assortments will be included into the calculations in the next inventory.

CHAPTER 8: WASTE (CRF 6)

8.1 OVERVIEW OF SECTOR

8.1.1 Quantitative overview

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 permit according to IPPC directive. Biogas collection and use for energy production from biodegradable wastes and sludge is set as one of priorities in Latvia.

Main activity data sources for GHG emissions calculations in Waste sector are databases "3-Wastes"[173], "2-Water"[174] 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 wastes are combined in one database "3-Wastes". Data in this database are taken from State Statistical survey about wastes, which occurs annually.

Statistical survey about wastes must fill 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 is developed by LEGMC also. Data of wastewater treatment and discharge have been collected since 1991 in the frame of state statistical survey "2 – Water". State statistical survey "2-Water" must be filled by all enterprises which have permits on water use, water resources use or mineral deposits quarry use, or else A and B category polluting activity permit or C category acknowledgment. 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 N_2O emission from industrial waste water handling, and CSB for CH_4 emission from industrial waste water handling and N_2O from domestic waste water handling.

8.1.2 Description

GHG emissions from Waste sector have been fluctuated from 1990-2011. In 2011, emissions were approximately 3.1 % higher than in 1990. In 2011, emissions from the Waste sector were 535.52 Gg CO_2 equivalents; it contributes about 4.8% of total GHG emissions (excluding LULUCF).

[173] http://oas.vdc.lv:7779/la/atkr/red/mar$www_atkr.atkr_la
[174] http://oas.vdc.lv:7779/la/udens/skat/pls

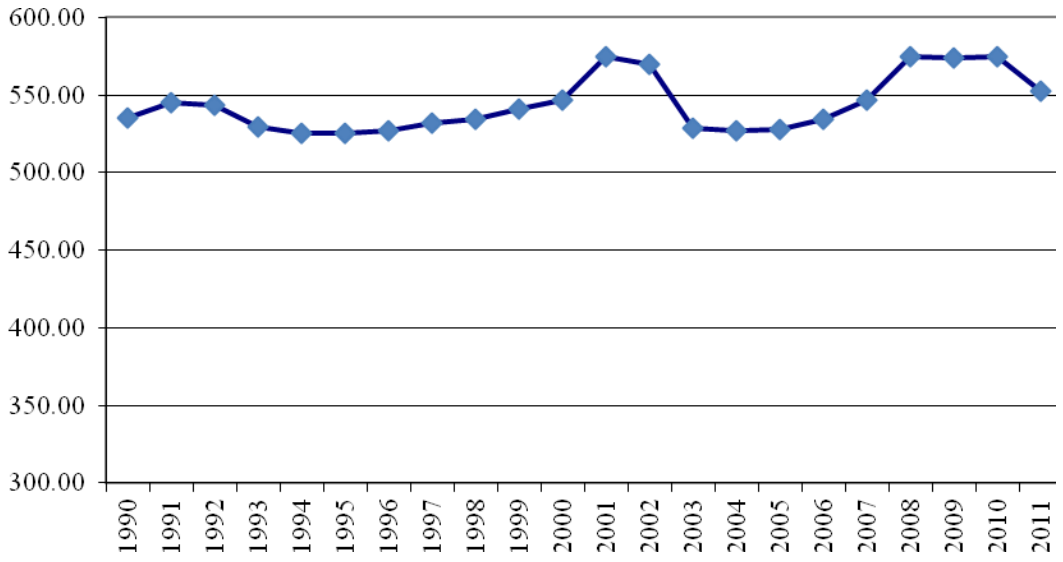

Figure 8.1 Total emissions from Waste sector in CO_2 equivalent (Gg)

Fluctuations in total GHG emissions in waste sectors could be explained with changes of economical situation in last 20 years (Figure 8.1). Some industry sectors were almost closed in the middle of 90-ties.

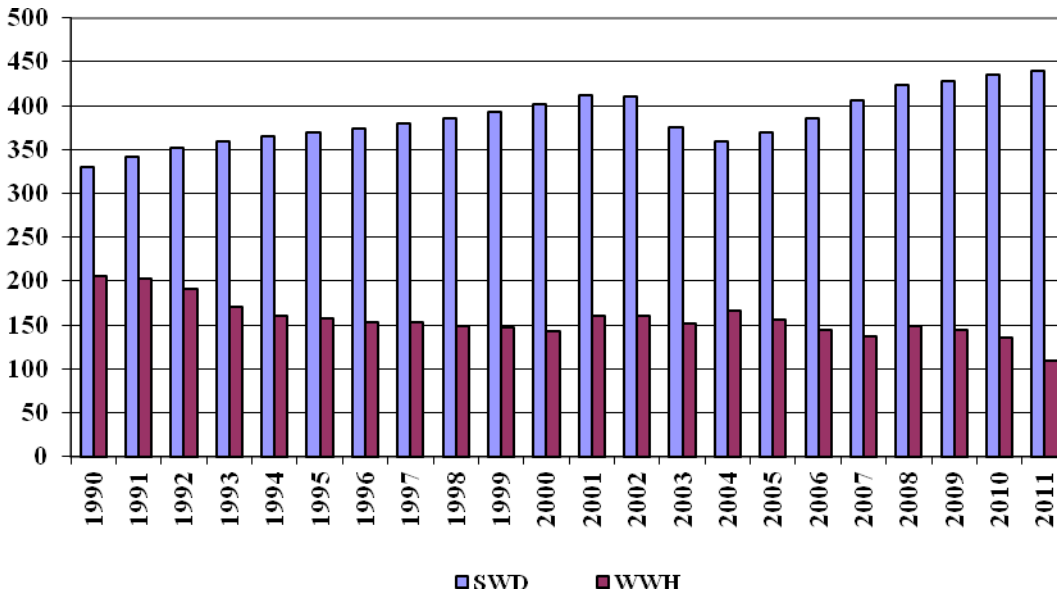

Figure 8.2 Emissions from SWD and WWH sectors in CO_2 equivalent (Gg)

Emissions from Waste Incineration (WI) and Composting (Comp.) in last year's, when emissions from these sectors were calculated, are very small in comparison with other sectors – Solid waste disposal (SWD) and Waste water handling (WWH) (Figure 8.2, Figure 8.3).

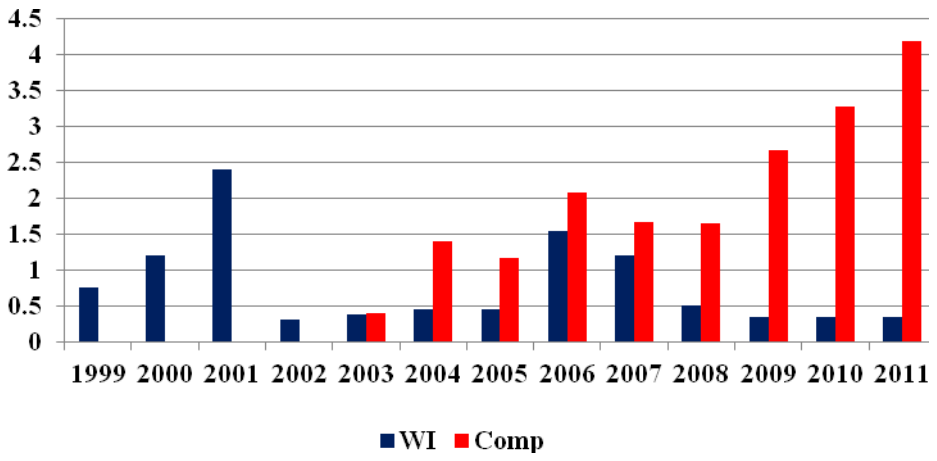

Figure 8.3 Emissions from WI and composting sectors in CO_2 equivalent (Gg)

According to the information from LEGMC[175] the total generated amount of waste are shown in Table 8.1.

Table 8.1 Generated wastes in Latvia (Gg)

Year	Municipal (all non-hazardous) wastes	Hazardous wastes	Total
2006	1420.46	54.372	**1474.832**
2007	1386.57	41.605	**1428.175**
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**

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, for earlier years no information available about incinerated waste amounts without energy recovery. Calculation of indirect GHG emissions from cremation is shown in Section 8.4.4. Emissions from waste incineration with energy recovery are counted under energy sector.

CH_4 and N_2O are emitted from waste composting. Data available only from 2003, when composting facilities start to report within state statistical survey about wastes composting. For emission calculations IPCC 2006 guidelines and default factors were used.

8.2 SOLID WASTE DISPOSAL ON LAND (CRF 6.A)

8.2.1 Source category description

Methane emission is calculated from SWD (Table 8.2). It is main GHG source from waste sector in Latvia.

Table 8.2 Reported emissions under subcategory Solid Waste Disposal on Land

CRF	Source	Emissions reported
6.A 1	Managed Waste Disposal on Land	CH_4, NMVOC
6.A 2	Unmanaged Waste disposal Sites	CH_4, NMVOC
6.A 3	Other	Not occurring

[175] http://www.meteo.lv/public/28759.html

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[176] 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 wastes is going to landfills. Amount of disposed tons are calculated - 2 379 829 m^3*0.2 = 475 965 tons. Waste amounts 1997 – 2001 was estimated like equal growth between 1996 and 2002 amount. Amounts 1970 – 1995 were estimated according to GDP and population changes.

Table 8.3 Estimated Disposed amounts from 1970 – 2002

Year	Population	Disposed solid waste amount (Gg)	GDP/inhabitant (LVL - 2000 prices)	Disposed wastes from urban areas (Gg)	Disposed wastes from rural areas (Gg)
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
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[177] (Table 8.3). All other years are estimated according to these figures. Disposed amount are estimated according to GDP and

[176] "Research about solid waste management in Latvia", 1998, Ltd GEO Consultants
[177] Statistical Yearbook of Latvia 2004, CSB, 2005

population changes. Population amounts for year 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 estimated as unmanaged[178]. Disposed amount are divided between rural and urban areas, according population proportion 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.

Data about waste disposal on land for 2002 - 2011 are taken from database "3-Wastes" (Table 8.4). Starting from year 2002, according to data base information, biggest sites could be estimated as managed sites (polygons) and MCF-1 is starting to use. For each year (2002-2011) in polygons disposed amount are determine according to disposing site profile from "3-Wastes" data base.

Table 8.4 Disposed solid waste amounts from 2002-2011 (Gg)

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

According to information in landfill research, number of active waste disposal sites decreased from 558 in 1997 to 21 in 2011. All calculations are done for unsorted wastes, because 95% of disposed wastes are reported as unsorted.

According to Waste management plan 2006 – 2012, in Latvia operates 11 waste disposing polygons, all other waste disposal sites are planned to close. In 2011 – 11 solid waste polygons operates, all these sites are estimated as managed. When this plan will be realized, data collection about disposed municipal wastes amounts and its composition will become more accurate. Disposed solid waste amounts in Latvia are shown in Figure 8.4.

[178] "Degradable organic carbon in disposed wastes", 2011, Ltd Virsma

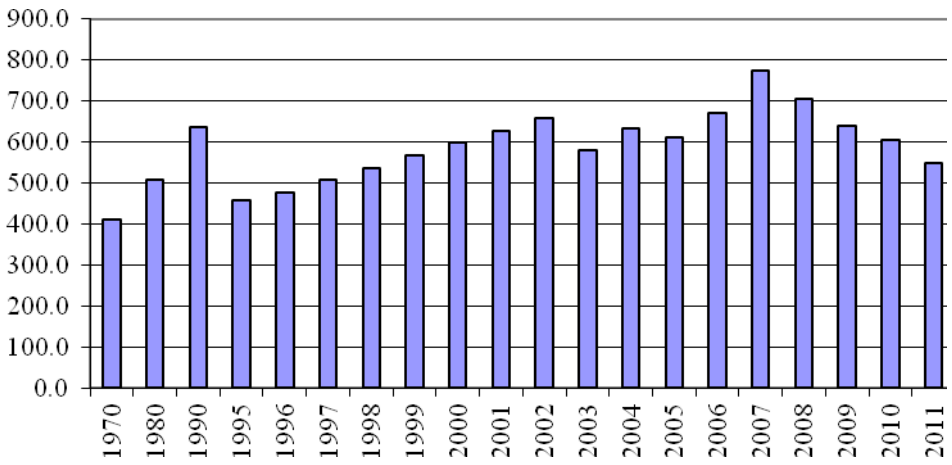

Figure 8.4 Disposed waste amounts in Latvia (Gg)

Since October 2002 CH_4 recovery from landfills are in progress. For 2010 only in three waste facilities (SIA Getlini EKO, SIA Liepajas RAS, SIA ZAAO Daibe) 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 build 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 total 6.499 Gg of CH_4 was collected and recovered in 2011. Recovered methane amount is presented in Figure 8.5.

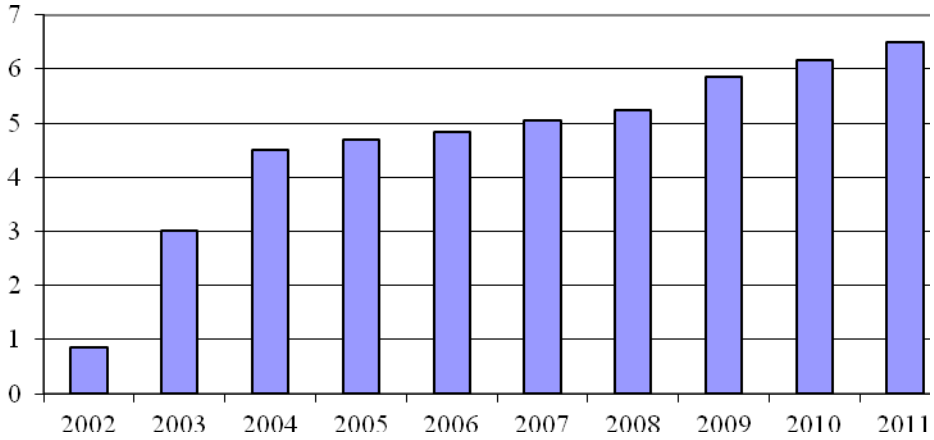

Figure 8.5 Recovered CH_4 from waste disposing (Gg)

According to Latvia's Waste Management plan 2006-2012, 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 8.6.

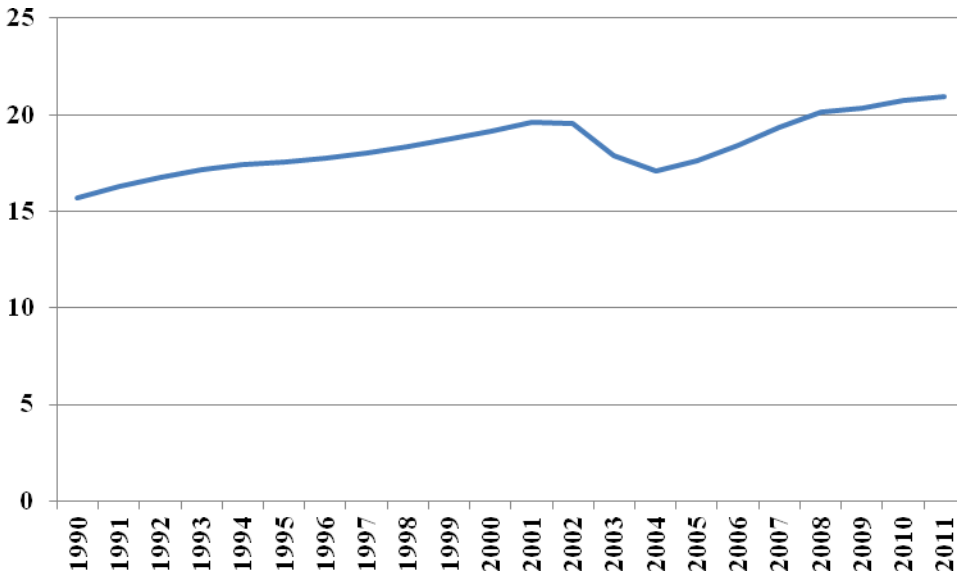

Figure 8.6 CH_4 emissions from waste disposing (Gg)

8.2.2 Methodological issues

IPCC GPG 2000 (Tier 2) method is used for CH_4 emissions calculation and is based on equations:

$$L_o\ CH_4 \text{ potential emission} = MSW_L * MCF * DOC * DOC_F * F * 16/12$$

$$CH_4 \text{ generated in year t (Gg/yr)} = \sum_x [\ (A*k*MSW_{L(x)}*Lo(x))*e^{-k(t-x)}]$$

$$CH_4 \text{ year emission (t)} = [CH_{4\ (t)} - R_{(t)}] * (1 - OX)$$

where:
L_o *– potential annual methane emission (Gg);*
MSW_L *- annual MSW landfilled (Gg);*
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);*
DOC_F *– fraction of DOC dissimilated (0.6);*
F *– fraction of CH_4 landfill gas (0.5);*
R *– recovered CH_4 (Gg);*
CH_4 *– methane real emission;*
A *– normalisation factor $A=(1-e^{-k})/k$*
k*- methane generation coefficient (1/y) (0.05);*
x *– calculation starting year;*
t *– inventory year;*
R (t) *– methane recovery in year t;*
OX *– oxidation factor (default 0)*

3 separate calculations are done for 3 types of landfills:

1. polygons (MCF-1),
2. deep unmanaged sites (MCF-0.8)
3. shallow unmanaged sites (MCF-0.4)

Total methane emission is counted together from 3 values.

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 is used as 0.17, according to research what is carried out in Latvia ("Degradable organic carbon in disposed wastes", 2011, Ltd Virsma). All other factors are default from IPCC guidelines.

8.2.3 Uncertainties and times series consistency

To calculate CH_4 emissions from SWD many emission factors are used. According to IPCC GPG 2000 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 estimate as 20 %. For all years same methodology and coefficients for calculation are used (Tier 2). Amount of disposed wastes are estimated in different ways for time period since 1970. There are no other possibilities for Latvia, because waste statistics are available only from 2002.

8.2.4 Source-specific QA/QC and verification

QA/QC procedure for waste disposing is done. Mistakes, found in emission calculation during QA/QC procedure, were corrected within this submission. Time series consistency check for IEF on 10% changes was done.

Disposed waste amount from year 2002 is taken from waste data base "3-Wastes". Data in this data base before entering are checked by Regional Environmental Boards.

8.2.5 Source-specific recalculation

No recalculations are done.

8.2.6 Source specific planned improvements

For waste polygons is planned to start calculate emissions with specific DOC values for each of them according to disposed waste content.

8.3 WASTEWATER HANDLING (CRF 6.B)

8.4.1 Source category description

The emission sources cover handling of collected and uncollected domestic waste water for CH_4 and N_2O emissions, as well as industrial waste water for CH_4 and N_2O emissions (Table 8.5).

Table 8.5 Reported emissions under the subcategory Waste Water Handling in the Latvian Inventory

CRF	Source	Emission reported
6.B 1	Industrial waste water	CH_4, N_2O, NMVOC
6.B 2	Domestic and commercial waste water	CH_4, N_2O
6.B 3	Other	Not occurring

LEGMC data show that 241 million m³ of wastewater in 2011 was discharged, from which 174 million m³ were treated by different wastewater treatment plants, ~78% from which were biological plants (Figure 8.7).

Fluctuation of amount of discharged waste water is due to change in national statistics – the procedure of data collecting was changed and it could be a reason for some inaccuracies in data.

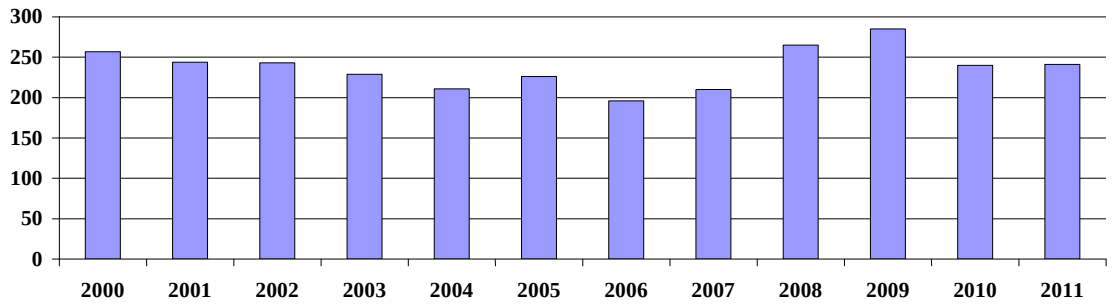

Figure 8.7 Amount of discharged waste water in last ten years (mio m^3)

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 is distributed by their type and level of treatment.

Due to change of calculation approach, there is no longer recovery of methane considered to have a place in Latvia for Domestic Waste Water Handling. Instead, some amount of methane is recovered from Sewage Sludge.

Domestic Waste Water Handling is the main source of the CH_4 emissions from Wastewater Handling sector, reaching 68 % (2011) from total CH_4 emission from Waste Water Handling sector (Figure 8.8). CH_4 emissions from Industrial Waste Water Handling and Sewage Sludge are lower, contributing accordingly 18 un 14 % from total emission.

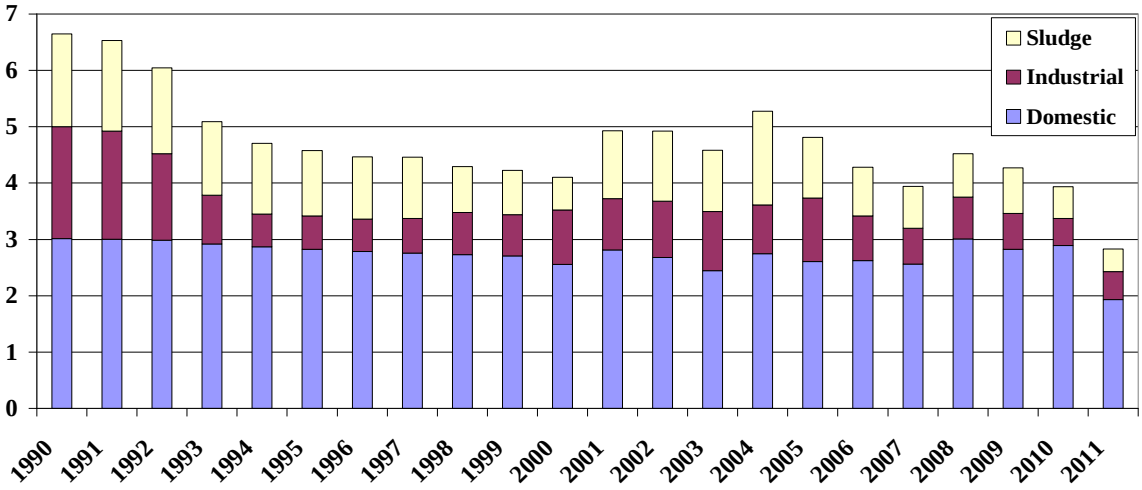

Figure 8.8 Emissions of methane from Waste Water Handling (total), Gg

Fluctuations of methane emission from Industrial Waste Water Handling are connected with fluctuations of amount of production produced. Significant decrease in methane emission in period 1993 – 1999 is due to decrease of economic activity after collapse of Soviet Union.

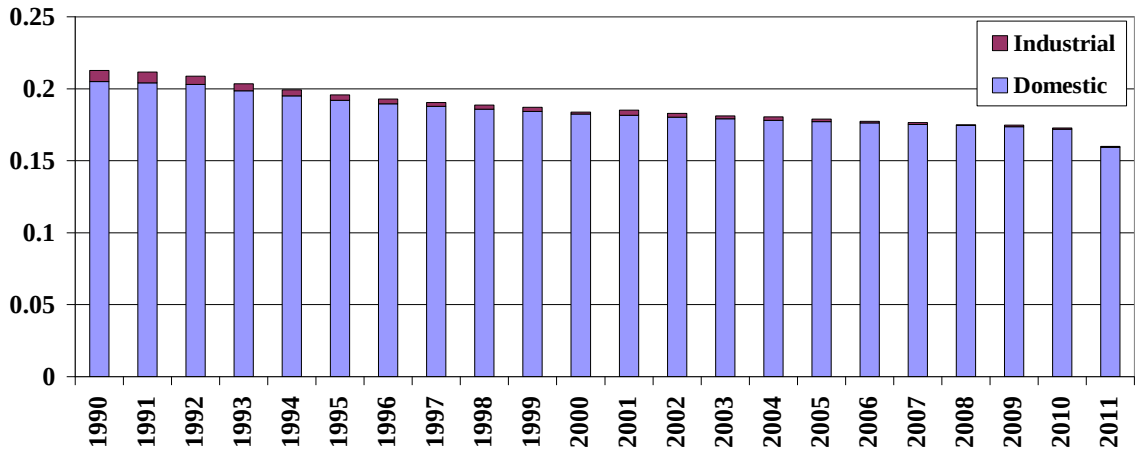

Figure 8.9 Emissions of N_2O from Waste Water Handling (total), Gg

8.4.2 Methodological issues

Calculation of methane 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. Mechanically treated load are calculated, using maximum value of MCF. 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", 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).

IPCC default formula („Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual"; chapter 6.3.5 „Methodology for Estimating Emissions from Wastewater Handling") report was used for calculation of CH_4 emission from Domestic Waste Water Handling sector:

$$\boxed{WM = \sum_i P_i \bullet D \bullet SBF \bullet EF \bullet MCF_i \bullet 365 \bullet 10^{-9}} \text{ Gg of } CH_4,$$

where:
P_i *– number of population, served by certain type of treatment;*
D *– organic load of BOD_5 (60 g/pers/day);*
SBF *– easy degradable part of BOD_5, SBF = 0.5;*
EF *– emission factor, EF = 0.6 kg CH_4/kg BOD_5;*
MCF_i *– anaerobically degradable part of BOD_5 for certain type of treatment*.

However, since activity data is distributed by type and level of treatment, method is considered as Tier 2 method.

Table 8.6 Activity data for Domestic Waste Water Handling – number of population served by certain type or level of treatment

Year	Well-managed, biological treatment	Poor-managed, biological treatment	Non-biological treatment	Not connected and not treated
Criteria for identification of treatment type	Biological treatment with secondary or higher treatment level	Biological treatment with treatment level lower than secondary	Mechanical and chemical treatment; treatment level does not matter	No treatment
1990	1755610	51996	43022	817258
1991	1748912	51178	42858	814140
1992	1738809	51499	42610	809437
1993	1700929	50377	41682	791804
1994	1671330	49500	40957	778025
1995	1644689	48711	40304	765623
1996	1624171	48104	39801	756072
1997	1607895	47621	39402	748495
1998	1591958	47149	39012	741076
1999	1577719	46728	38663	734448
2000	1610665	72328	71693	620653
2001	1509397	53122	38318	763417
2002	1537912	42886	40176	724794
2003	1585042	32937	18181	695320
2004	1481646	32017	18602	786938
2005	1519684	40155	37360	709235
2006	1502517	43111	38452	710510
2007	1505448	46965	38135	690757
2008	1322213	139886	39197	769498
2009	1364440	125855	21500	749499
2010	1327806	126379	31253	753570
2011	1465768	91448	26025	491364
MCF applied	**0**	**0.3**	**0.8**	**0.5**

Methane Conversion Factors (MCFs) were applied depending of treatment type and level (Table 8.6). IPCC Guidelines 2006 were used as source of MCF values; however, expert judgement was performed to choose values applicable for Latvian conditions.

Organic load – 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)).

Emissions from Industrial Waste Water Handling are based on load of COD (chemical oxygen demand) in industrial waste water. Assumptions from IPCC Guidelines 2006 are used to estimate amount of waste water generated per unit of certain production type as well as load of COD in it. Amount of certain industrial production is available from Latvian Central Statistical Bureau (CSB).

Methane emission from Industrial Waste Water Handling is calculated using Tier 1 method from „Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual"; Chapter 6.3.5 „Methodology for Estimating Emissions from Wastewater Handling":

$$\boxed{WM = \sum_i P_i \bullet V_i \bullet C_i \bullet PFM \bullet 10^{-6}} \text{ Gg } CH_4,$$

where:
P_i *– amount of certain industry production, t;*
V_i *– amount of waste water generated per certain unit of industry production, m^3/t;*
C_i *– organic load in waste water of certain industry sector (COD), g/l or kg/m^3;*
PFM *– emission factor of CH_4, kg CH_4/kg COD*.

Activity data (amount of certain industrial production) was taken from national statistics – data base of Latvian Central Statistics Bureau.

Default IPCC emission factor (*PFM*) – 0.25 kg CH_4/kg COD was used.

Table 8.7 Current assumptions used for calculation of CH_4 emission from Industrial Waste Water Handling

Production type	Assumptions used from IPCC Guidelines 2006	
	Generation of waste water, m^3 per tone of production	Organic load of waste water, COD g/l (or kg/m^3)
Milk	7	2.7
Meat	13	4.1
Fish	13	2.5
Beer	6.3	2.9
Fruits and vegetables	20	5
Sugar	11	3.2
Plastics	0.6	3.7
Organic chemicals	67	3

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). Results are shown if the Table 8.8.

Table 8.8 MCF values for calculation of CH4 emission from Industrial Waste Water Handling

Industry type	Weighted MCF value (rounded to 2 decimal positions)
Milk	0.10
Meat	0.15
Fish	0.05
Beer	0.04
Fruits and vegetables	0.13
Sugar	0.50
Plastics	0.14
Organic chemicals	0.03

Emissions from Industrial Waste Water Handling are calculated as follows in Table 8.9.

Table 8.9 Calculation example for 2010 of emission of CH_4 from Industrial Waste Water Handling (3 types of production) – activity data, assumptions, emission factors and results

Product name	Amount of production, th.t/a	Amount of waste water per production unit, m^3/t	Amount of waste water, th.m^3/a	Conc.of COD in waste water, g/l	Load of COD, t/a	Emission factor, kg CH_4/ kg COD	MCF	Emission of CH_4, t/a
	a	b	c = a*b	d	e = c*d	f	g	h = e*f*g
Milk	183	7	1281	2.7	3459	0.25	0.10	87
Meat	121	13	1573	4.1	6449	0.25	0.15	240
Fish	60	13	781	2.5	1953	0.25	0.05	24

Some amount of sewage sludge is treated or stored in anaerobic conditions in Latvia, causing formation of CH_4. Methane emission from sewage sludge is calculated using following formula from „Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual"; chapter 6.3.5 „Methodology for Estimating Emissions from Wastewater Handling":

$$\boxed{WM = TOS \bullet EF \bullet 10^{-6} - MR} \text{ Gg } CH_4,$$

where:
TOS *– Total organic content in sludge (COD), kg;*
EF *– emission factor, kg CH_4/kg COD;*
MR *– amount of methane recovered, Gg.*

Assumptions regarding sewage sludge are shown in Table 8.10.

Table 8.10 Characteristics of sewage sludge in Latvia

Characteristic	Value
Average content of dry solids in sludge, %*	14**
Average content of COD in dry solids, %	43***

**Is used to estimate content of dry solids for years where statistic data are not available (1998-2002)*
***"Notekūdeņu dūņas un to izmantošana" („Sewage Sludge and Disposal"), Gemste I., Vucāns A., Jelgava, 2002.*
****Average data of 1996*

Extrapolation was used to estimate amount of sewage sludge produced and treated anaerobically for period 1990-1997, where statistic data is not available. Based on statistics available (1998-2008), assumption was made the part of anaerobically treated sludge is 53%.

Data on recovery of CH_4 from sewage sludge are plant specific data from treatment plant "Daugavgrīva", operated by largest Latvian water supply and waste water Treatment Company "Rīgas ūdens". 2.235 Gg of methane was recovered from sewage sludge in 2009.

Amount of N_2O emission from Domestic Waste Water Handling is calculated, using IPCC default equation from „Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual"; chapter 6.4. „Nitrous Oxide from Human Sewage". It 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 value of protein consumption (83.7 g/pers/day or 30.551 kg/pers/y) is obtained from national food consumption research[179], accessible on Web address http://www.lvaei.lv/?lang=1&menu=51&itemid=94.

When compared with similar data from Latvian neighbour countries (Lithuania and Estonia), Latvian data shows consistent value (Table 8.11).

[179] Latvian State Institute of Agrarian Economy

Table 8.11 Comparison of Latvian protein consumption data with data from neighbour countries (Lithuania and Estonia)

Country	g/pers/day	kg/pers/year
Latvia	83.7	30.551
Lithuania	77.4…78.1*	28.251…28.507**
Estonia	101*	36.865**

**Data taken from Lithuanian and Estonian NIRs (2010)*
***Recalculated for comparison*

$$WM = P \bullet O \bullet EF \bullet Frac_{Nprot} \bullet \frac{44}{28} \bullet 10^{-6} \text{ Gg } N_2O,$$

where:
P *– national population;*
O *– amount of protein, produced by population, kg protein/person/year;*
EF *– emission factor, kg N_2O-N/kg N;*
$Frac_{Nprot}$ *– nitrogen fraction in protein, kg N/kg protein.*

Default value for nitrogen fraction in protein – 0.16 kg N/kg protein – is used in calculation. Default IPCC value for emission factor – 0.01 kg N_2O-N/kg N – was used as well. Both values were taken from 1996 IPCC Guidelines.

A small amount of N_2O is emitted during the release from the sewage system. The calculations gives emission 0.159 Gg of N_2O (2011).

N_2O emission from Industrial Waste Water Handling was calculated, using Tier 1 method from "2006 IPCC Guidelines for National Greenhouse Gas Inventories", chapter 6.3.1 "Nitrous Oxide Emissions from Wastewater. Choice of Method". Calculation is based on load of nitrogen in the industrial waste water:

$$WM = N_{ef} \bullet EF \bullet \frac{44}{28} \bullet 10^{-6} \text{ Gg } N_2O,$$

where:
N_{ef} *– load of nitrogen, kg/year;*
EF *– emission factor, kg N_2O-N/kg N.*

IPCC default value (0.005 kg N_2O-N/kg N) from IPCC 2006 Guidelines was used for calculation.

N_2O emission from Industrial Waste Water Handling is negligible – 0.0007 Gg/a (i.e. 0.722 Mg/a (2011)).

Emission of NMVOC was calculated and using default EMEP emission factor from „EEA Emission Inventory Guidebook 2009" was used for this calculation – 15 mg of NMVOC per m^3 of waste water produced, what gives 3.62 Mg/a of NMVOC (2011).

8.4.3 Uncertainties and times series consistency

The following uncertainties were used for Wastewater Handling sector for activity data and emission factors (Table 8.12).

Table 8.12 Uncertainties for Waste Water Handling sector

Emission	Activity data	Emission factor
CH_4	2%* for Industrial Waste Water Handling; 10% for Domestic Waste Water Handling	30%**
N_2O	10% for Industrial Waste Water Handling; 10% for Domestic Waste Water Handling	30%**

** 2% - frame uncertainty of CSB;*
***30% - default uncertainty from IPCC guidelines 2006.*

Time series of emissions are inconsistent, since main source of emissions is Industrial Waste Water Handling and amount of production, which is activity data, 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.

Emissions from Domestic Waste Water Handling (both CH_4 and N_2O) are more consistent, since there are no large fluctuations in activity data as in case of Industrial Waste Water Handling.

8.4.4 Source-specific QA/QC and verification

Following procedures of quality assurance and quality control were carried out:

- 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;
- Comments in CRF tables were checked in process of entering data of calculation and recalculation results in CRF tables;
- External expert assessment was carried out for entire Waste sector and certain findings regarding Wastewater Handling sector were taken into consideration.

Mistakes, found in emission calculation during QA/QC procedure, were corrected within this submission.

Consistency check regarding differences of IEFs larger than 10% was carried out using according function of CRF Reporter. In total, 20 differences were found, mostly regarding CH_4 emission from Industrial Waste Water Handling sector. The differences are caused by fluctuations of activity data (amount of certain types of production).

8.4.5 Source specific recalculations

Amount of methane emissions was recalculated due to following factors:

- Methane emission from Industrial Waste Water Handling was recalculated for entire period due to update of MCFs.
- Data on recovery of CH_4 from Sewage Sludge was recalculated for certain years due to update of activity data.

8.4.6 Source specific planned Improvements

The main improvements planned for next inventory is aimed mainly on improvement of precision on existing calculations, since consistency and quality of some time series of activity data is still quite low, as well as further recalculations due to updating of assumptions and applying more accurate factors.

8.5 WASTE INCINERATION (CRF 6.C)

8.6.1 Source 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 starting 1999. In the hazardous waste data base there is a separate entry for 1997-2001 on the amount of

incinerated waste. Starting 2002 the database also contains entries for recovery (R) and disposal (D) of waste, which is consistent with the EU legislation.

Table 8.13 Reported emissions under subcategory Waste Incineration

CRF	Source	Emissions reported
6.C 1	Biogenic (cremation)	SO_2, NMVOC, CO, NOx
6.C 2	Other – non biogenic (industrial and hospital wastes)	CO_2, N_2O, SO_2, NMVOC, CO, NOx

Currently there are no large amounts of waste being incinerated in Latvia without energy recovery (Table 8.13). The main source of emissions is attributed 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*. The rest of the incinerated waste from hazardous waste database is considered as hazardous (industrial) wastes.

In 2001 large increase of emissions are shown, because one enterprise reported huge amount of incinerated wastes, but another year's amount is much smaller.

In last years incinerated amount of waste decrease due to hazardous waste incineration facility do not work in full capacity and some of them are closed. CO_2 emissions from Waste Incineration are presented in Figure 8.10

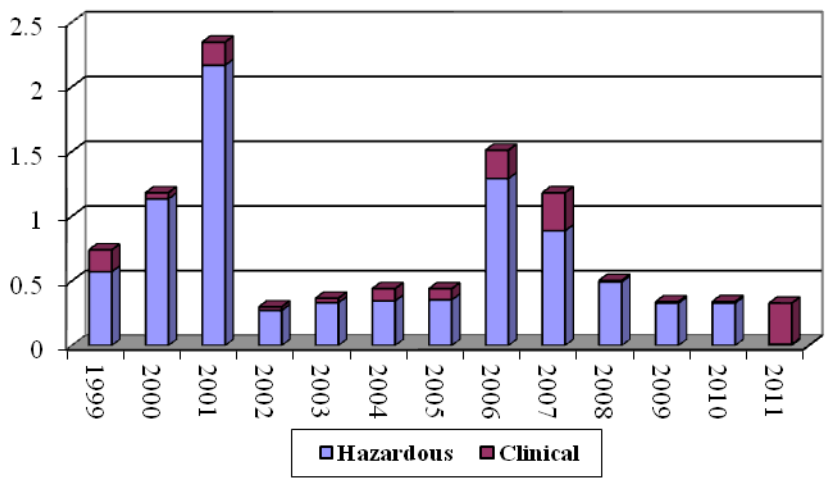

Figure 8.10 CO_2 emissions from Waste Incineration by waste type (Gg)

Data about burned bodies available from Riga crematorium since 1994, and calculations of its emissions are being made in accordance with the EMEP/EEA guidebook 2009 methodology. The crematorium is being under operation since December 22nd, 1994. The main gases emitted during cremation are SO_x, NO_x, CO, and NMVOC, and all of them have to be reported in the IPCC inventory as indirect GHG. These amounts are counted in Incinerated Biogenic Waste sector (Table 8.14).

Table 8.14 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

Year	Burned bodies
2003	1389
2004	1391
2005	1529
2006	1630
2007	1959
2008	2227
2009	1977
2010	2102
2011	2000

8.6.2 Methodological issues

According to the IPCC GPG 2000 emissions of CO_2 and N_2O have to be calculated from the Waste Incineration. CH_4 emissions are negligible, and they are not calculated. 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.

CO_2 emissions were calculated using following IPCC GPG 2000 equation:

$$\mathbf{CO_2}\ \text{emissions} = \Sigma_i[\ IW_{ix} \times CCW_i \times FCF_i \times EF_i \times 44/12\ ]\ \text{Gg/year,}$$

where:
i = waste type (hazardous waste, clinical waste);
IW_i = amounts of type i waste incinerated. (Gg/year);
CCW_i = carbon contents in the type i waste;
FCF_i = fossil carbon contents in the type i waste;
EF_i = effectiveness of incineration 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 factors from the IPCC GPG 2000 were used (Table 8.15).

Table 8.15 Default emission factors for CO_2 emission calculation

	Clinical waste	Hazardous waste
C contents in waste (CCW)	0.6	0.5
Fossil C contents in waste (FCF)	0.4	0.9
Incineration effectiveness (EF)	0.95	0.995

N_2O emissions from Waste incineration are calculated according to IPCC Guidelines 2006 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 wastes are mostly used oils, solvents and other liquids. Clinical wastes are not dried before burning. The same factor also is used for clinical wastes N_2O emissions calculation.

Table 8.16 Incinerated waste amounts without energy recovery

Year	Hazardous waste (Gg)	Clinical waste (Gg)	Total (Gg)
1999	0.347210	0.201420	0.548630
2000	0.690280	0.056410	0.746690
2001	1.319270	0.213310	1.532580
2002	0.165643	0.032247	0.197890
2003	0.201813	0.040607	0.242420
2004	0.210125	0.112325	0.322450
2005	0.215127	0.102127	0.317254
2006	0.786160	0.261890	1.048050
2007	0.5405	0.350861	0.891361
2008	0.29975	0.012361	0.312111
2009	0.20000	0.011663	0.211663

Year	Hazardous waste (Gg)	Clinical waste (Gg)	Total (Gg)
2010	0.20000	0.012843	0.212843
2011	0.0063	0.37883	0.38513

Indirect gases (NMVOC, CO, SO_2, NOx) are calculated from waste incineration according to EMEP/EEA emission inventory guide book 2009 (Table 8.17).

Table 8.17 Emission factors for indirect gases

	Clinical wastes (kg/Mg)	Hazardous waste (kg/Mg)
NMVOC	0.7	7.4
CO	2.8	0.07
SO_2	1.4	0.047
NOx	1.4	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 by the EMEP/EEA emission inventory guide book 2009 (Table 8.18).

Table 8.18 Emission factors for indirect gases from cremation

Indirect GHG	Emission factor (kg/body)
NMVOC	0.013
CO	0.141
SO_2	0.544
NOx	0.309

8.6.3 Uncertainties and times series consistency

Emission factors uncertainty is estimated as 50 %, because no correct information on carbon content in incinerated wastes is known, Uncertainty for activity data is estimate as 20 %, Times series for incineration begins from 1999, For previous years data are not available, There is no any believable information available, that waste incineration without energy recovery occurs in Latvia before 1999.

8.6.4 Source-specific QA/QC and verification

QA/QC procedure for waste incineration is done. Mistakes, found in emission calculation during QA/QC procedure, were corrected within this submission. Time series consistency check for IEF on 10% changes was done. Inconsistencies between years were not found.

Incinerated wastes amounts are taken from waste data bases. Data in this data bases before entering are checked by Regional Environmental Boards.

8.6.5 Source-specific recalculations

No recalculations are done.

8.6.6 Source specific planned improvements

No planned improvements

8.7 OTHER (CRF 6.D) – COMPOST PRODUCTION

8.7.1 Source category description

Under Other 6.D sector emissions from waste composting are calculated, Composting is set as one of priorities in waste treatment in Latvia (Table 8.19). For composting biological degradable wastes are useful. In Latvia these are mostly "park - garden" and "food production" wastes. Composting in private households was very popular for many years, but about these activities no correct data or estimation about composted waste amounts. Data

become available since 2003, when waste treatment companies start waste composting and get IPPC permits on this activity.

Table 8.19 Reported emissions under subcategory Other (compost production)

CRF	Source	Emissions reported
6.D	Compost production	CH_4, N_2O

From composting CH_4 and N_2O emissions are calculated according IPCC Guidelines 2006. In previous IPCC Guidelines was not provided emission factors for composting. Data about composted amounts are taken from "3-Waste" database (

Figure 8.11).

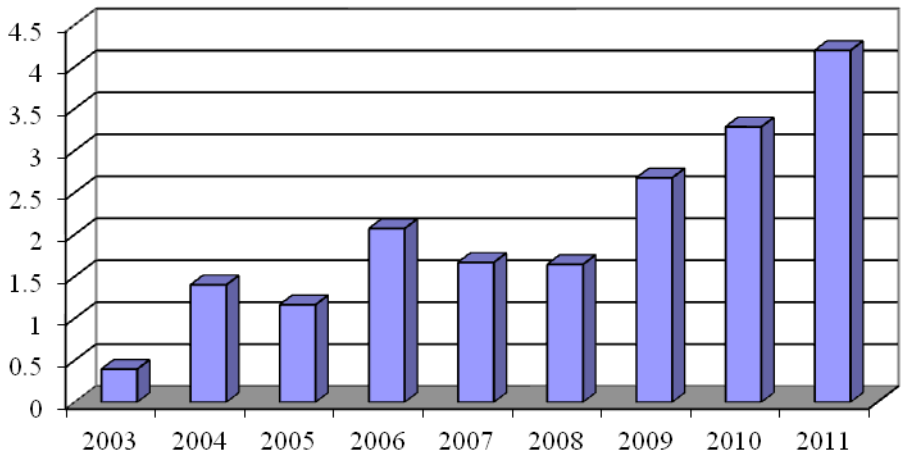

Figure 8.11 Total emissions from waste composting in CO_2 equivalent (Gg)

8.7.2 Methodological issues

IPCC Guidelines 2006 is used for composting calculations. Composted waste amount is multiplied by 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 (Table 8.20 Composted waste amounts and emissions). Not all amounts, which classified under recovery as R3, are composted. To determine composted amount, each enterprise, which reports with recovery operations R3, working profile must be taken in account.

Default emission factors for composting were used from IPCC Guidelines 2006:

1. 4 g CH_4/ kg composted wastes;
2. 0.3 g N_2O/ kg composted wastes,

Table 8.20 Composted waste amounts and emissions

Year	Composted amount (Gg)	CH_4 emission (Gg)	N_2O emission (Gg)
2003	2.224	0.008896	0.0006672
2004	7.905	0.031620	0.0023715
2005	6.564	0.026256	0.0019692
2006	11.698	0.046792	0.0035094
2007	9.416	0.037664	0.0028248
2008	9.282	0.037128	0.0027846
2009	15.11	0.06044	0.004533
2010	18.55	0.0742	0.005565
2011	23.699	0.094796	0.0071097

8.7.3 Uncertainties and times series consistency

Emission factor uncertainties are calculated according range, which is published in IPCC Guidelines 2006 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%, Activity data uncertainty is estimated as 20%, Time series for composting begins in 2003, for previous years data are not available, because industrial composting do not happening in Latvia, Composting in private garden occurs all time in Latvia, but there is no any estimation available on these amounts.

8.7.4 Source-specific QA/QC and verification

A QA/QC procedure for waste composting is done. Time series consistency check for IEF on 10% changes was done. Inconsistencies between years were not found.

Composted wastes amounts are taken from waste data bases. Data in this data bases before entering are checked by Regional Environmental Boards.

8.7.5 Source-specific recalculations

No recalculations.

8.7.6 Source specific planned improvements

No planned improvements.

CHAPTER 9: OTHER (CRF 7)

Latvia does not report any emissions under the Other sector.

CHAPTER 10: RECALCULATIONS AND IMPROVEMENTS

10.1. EXPLANATIONS AND JUSTIFICATIONS FOR RECALCULATIONS, INCLUDING KP-LULUCF INVENTORY

10.1.1 GHG inventory

The changes in the inventory since the previous submission to the UNFCCC were done according to:

- IPCC Good Practice Guidance's (IPCC 2000; IPCC 2003);
- recommendations by ERT during Centralized review (2011, partly 2012);
- corrections of activity data by CSB and corrections of input mistakes;
- EU QA/QC initial checks.

Table 10.1 Overall impacts of recalculations on national emissions

		Previous submission	Latest submission	Difference	Difference
		CO_2 equivalent (Gg)			(%)
1990	Total CO_2 Eq Emissions with LULUCF	10,593.32	4,017.36	-6,575.95	-62.08
	Total CO_2 Eq Emissions without LULUCF	26,604.71	26,323.42	-281.29	-1.06
1991	Total CO_2 Eq Emissions with LULUCF	7,019.70	1,382.03	-5,637.67	-80.31
	Total CO_2 Eq Emissions without LULUCF	24,663.22	24,420.65	-242.57	-0.98
1992	Total CO_2 Eq Emissions with LULUCF	1,094.89	-3,448.35	-4,543.24	-414.95
	Total CO_2 Eq Emissions without LULUCF	19,833.22	19,668.04	-165.19	-0.83
1993	Total CO_2 Eq Emissions with LULUCF	-2,348.05	-5,923.25	-3,575.20	152.26
	Total CO_2 Eq Emissions without LULUCF	15,996.92	15,888.95	-107.97	-0.67
1994	Total CO_2 Eq Emissions with LULUCF	-3,606.25	-8,926.31	-5,320.06	147.52
	Total CO_2 Eq Emissions without LULUCF	14,041.53	13,957.58	-83.95	-0.60
1995	Total CO_2 Eq Emissions with LULUCF	-4,266.66	-9,044.51	-4,777.84	111.98
	Total CO_2 Eq Emissions without LULUCF	12,655.94	12,573.95	-81.99	-0.65
1996	Total CO_2 Eq Emissions with LULUCF	-5,275.91	-9,488.82	-4,212.91	79.85
	Total CO_2 Eq Emissions without LULUCF	12,679.04	12,602.33	-76.71	-0.61
1997	Total CO_2 Eq Emissions with LULUCF	-3,225.68	-8,180.40	-4,954.73	153.60
	Total CO_2 Eq Emissions without LULUCF	12,122.02	12,040.54	-81.49	-0.67
1998	Total CO_2 Eq Emissions with LULUCF	-2,691.14	-7,695.00	-5,003.86	185.94
	Total CO_2 Eq Emissions without LULUCF	11,599.51	11,509.37	-90.14	-0.78
1999	Total CO_2 Eq Emissions with LULUCF	-2,950.26	-8,633.88	-5,683.62	192.65
	Total CO_2 Eq Emissions without LULUCF	10,813.44	10,714.02	-99.41	-0.92
2000	Total CO_2 Eq Emissions with LULUCF	-4,197.69	-9,180.79	-4,983.10	118.71
	Total CO_2 Eq Emissions without LULUCF	10,291.71	10,062.60	-229.11	-2.23
2001	Total CO_2 Eq Emissions with LULUCF	-3,938.22	-8,175.98	-4,237.75	107.61
	Total CO_2 Eq Emissions without	10,863.68	10,691.03	-172.65	-1.59

		Previous submission	Latest submission	Difference	Difference
		CO_2 equivalent (Gg)			(%)
	LULUCF				
2002	Total CO_2 Eq Emissions with LULUCF	-2,996.30	-6,849.53	-3,853.23	128.60
	Total CO_2 Eq Emissions without LULUCF	10,803.83	10,645.75	-158.08	-1.46
2003	Total CO_2 Eq Emissions with LULUCF	-4,270.91	-7,239.50	-2,968.58	69.51
	Total CO_2 Eq Emissions without LULUCF	11,008.19	10,871.64	-136.55	-1.24
2004	Total CO_2 Eq Emissions with LULUCF	-5,254.66	-6,743.03	-1,488.38	28.32
	Total CO_2 Eq Emissions without LULUCF	11,167.09	11,009.36	-157.73	-1.41
2005	Total CO_2 Eq Emissions with LULUCF	-6,102.00	-6,894.51	-792.51	12.99
	Total CO_2 Eq Emissions without LULUCF	11,265.59	11,097.74	-167.86	-1.49
2006	Total CO_2 Eq Emissions with LULUCF	-8,765.12	-8,225.56	539.56	-6.16
	Total CO_2 Eq Emissions without LULUCF	11,699.46	11,592.39	-107.07	-0.92
2007	Total CO_2 Eq Emissions with LULUCF	-9,673.54	-6,510.45	3,163.09	-32.70
	Total CO_2 Eq Emissions without LULUCF	12,208.32	12,085.43	-122.89	-1.01
2008	Total CO_2 Eq Emissions with LULUCF	-11,186.84	-8,098.06	3,088.78	-27.61
	Total CO_2 Eq Emissions without LULUCF	11,741.50	11,562.54	-178.96	-1.52
2009	Total CO_2 Eq Emissions with LULUCF	-9,604.12	-8,982.62	621.50	-6.47
	Total CO_2 Eq Emissions without LULUCF	10,984.62	10,882.19	-102.43	-0.93
2010	Total CO_2 Eq Emissions with LULUCF	-5,049.17	-4,376.24	672.93	-13.33
	Total CO_2 Eq Emissions without LULUCF	12,097.70	12,034.54	-63.16	-0.52

The following recalculations by sectors were made:

Energy sector:

Recalculations have been done because of the updated data received from CSB and changes in NCV for natural gas and other liquid fuels. During the QA/QC procedure also several input mistakes have been found and corrected, therefore there have been updated emissions in every subsector particularly in every year of the time series, mostly in 2008-2010, and the most significantly natural gas and other liquid fuel emissions have been changed.

During the centralised review in September 2012 there have been noted by experts that in 1.B.2.b iii – Transmission sector there have been a lack of CO_2 emissions and also were raised questions about the transparency of CH_4 calculating methodology in 1.B.2.b iii – Transmission sector therefore after ERT recommendations these emissions were calculated by Tier1 method according to Table 2.16 from IPCC 2000 GPG

CO_2 emissions for gasoline year 2009-2010 have been recalculated. Recalculations have been done due to an updated specific CO_2 EF. Instead 68.6 kg/GJ now 71.18 kg/GJ is implemented.

Transport

Considering that it was carried out study to get more precise activity data of road transport stock corresponding COPERT IV model format - subgroups (depending on engine volume) and layers (EURO classes), all emissions have been recalculated for year 2009 and 2010.

Taking into account that consumption of lubricants in road transport has been recalculated based on method proposed by EMEP Emission inventory Guidebook 2009; updated 2012, CO_2, CH_4 and N_2O emissions for lubricants in road transport have been recalculated for time period 1990 – 2010.

CO_2 emissions for gasoline year 2009-2010 have been recalculated. Recalculations have been done due to an updated specific CO2 EF. Instead 68.6 kg/GJ now 71.18 kg/GJ is implemented.

Considering that during the implementation of internal OA/QC procedure it was found that a new national Regulation determines using of diesel oil in railway with 0,1% sulphur content from year 2008, SOx emissions has been recalculated for time period 2008-2010.

Industrial proceses

Recalculations of HFC-134a from disposal of stationary and mobile air conditioning for years 1995-2010.

Recalculations of HFC-227ea from charging of fire extinguishing equipment.

Solvent and other product use

Detailed description on recalculations and information about planned improvements is described in the sectoral Chapters 5. The reasoning and impact of the recalculation for the years 1990-2011 can also be found in CRF tables 8(a) s1-8(a)s2 and 8(b) of the relevant years.

Agriculture

Recalculations of CH_4 emissions for period 2000-2010 are done based on the use of method Tier 2 instead of Tier 1.

Area of cultivated histosoils was corrected for 2000-2010. based on updating of numbers provided by Latvian State Forest Research Institute "Silava".

LULUCF, KP

Significant improvements are done in the Land Use, Land-Use Change and Forestry sector, using the methodologies and data elaborated for calculation of the national forest management reference level; therefore, the most of the changes are applied to the forest land remaining forest category.

Carbon stock changes in living biomass (gains and losses) are recalculated using more conservative wood density coefficients and biomass expansion factors for above ground and below ground biomass. For instance average wood density in the previous submission was 0.5 kg L^{-1}; now it is 0.44 kg L^{-1}. Future improvements are planned for the next inventory. Separate study was done in 2012 to review historical gross increment and mortality figures since 1970 to include dead wood into the calculation and to elaborate more realistic increment figures for living biomass. The study was base on the NFI data.

Net carbon stock changes in dead organic matter are included into the inventory using the species specific mortality figures. For litter no changes are applied since the preliminary data from repeated measurements of soil carbon stock in the Level I forest monitoring plots shows no significant difference in the litter layer, in spite in the soil layer there is significant growth.

In the land converted to forest land category carbon stock changes in living biomass (gains) are recalculated using average wood density figures and biomass expansion factors used in the historical forest lands. Dead organic matter, including litter layer and dead wood, is included into calculation as removals assuming that accumulation of dead wood and litter in afforested lands will follow to the linear regression and reach average level in forest lands within 45 years. These figures are going to be improved in future by empiric estimation of carbon stock in these pools in afforested lands.

In the cropland's category recalculations are done in the land converted to cropland subcategory by updating carbon stock changes (losses) in living biomass in forest land converted to cropland due to deforestation. Weighted average values of wood density and biomass expansion factors used in the calculation of carbon stock changes in living biomass in forest land are applied to the woody biomass in deforested areas. Carbon stock changes in mineral soils are recalculated using 20 years transition period instead of instant oxidation. N_2O emissions from disturbances associated with land use conversion to cropland are recalculated using values of the annual carbon stock changes in soil in deforested areas. A mathematical mistake was found in formula, which also affected the whole time series. Area of converted organic and mineral soils is updated using accumulated area instead of actual annual conversion figures.

In the grassland's category grassland remaining grassland subcategory figures on organic soils and total area of grasslands in 2010 are updated. In subcategory land converted to grassland accumulated area of cropland converted to grassland in 2010 is updated.

In settlements category land converted to settlements subcategory carbon stock change in living biomass (losses) are recalculated using weighted average values of wood density and biomass expansion factors used in the calculation of carbon stock changes in living biomass in forest land. Net carbon stock changes in dead organic matter using updated figures on wood density for dead wood (assuming that it corresponds to weighted average wood density in growing trees). Net carbon stock changes in soil due to deforestation to settlements considerably increased after recalculation assuming that all organic carbon in 0-30 cm deep soil layer converts to emissions within 20 years. Weighted average carbon stock (mineral and organic soils) is used in calculations.

In Other category harvested wood products are added using information elaborated by Joint research centre and VTi in 2012.

In the KP LULUCF reporting carbon stock change in litter and dead wood are accounted as sinks (assuming 45 years transition period to reach average values in forest), value of organic soils in 2010 in afforested areas is updated.

In deforestation more accurate area deforested in 2008, 2009, 2010 on mineral soils is entered. More accurate figures on carbon stock changes in above and below ground biomass are used (recalculation using weighted average wood density in living trees and updated biomass expansion factors). The information about carbon stock changes in litter and dead wood is recalculated according more accurate values of deforested area. Mineral and organic soils are now separated in calculation. N_2O emissions due to disturbances are corrected according updated information about deforested area and by correction of mathematical formula in the calculation model. Limestone application in land converted to cropland is corrected and relevant emissions recalculated. There were error in data of limestone application in deforested areas.

In the KP LULUCF Article 3.4 reporting area of organic soils is updated in 2010, recalculated figures about carbon stock changes in above and below ground biomass and dead wood, corrected value of carbon stock changes in organic soils (due to the area change). N_2O emissions due to drainage of soils are recalculated using corrected area of drained organic and mineral soils.

Waste

Emissions of CH_4 from Industrial Waste Water Handling were recalculated for entire reporting period (1990-2011) due to update of MCF values.

Amount of recovered CH_4 from Sewage Sludge was recalculated due to changes in activity data for certain years.

Detailed description on recalculations and information about planned improvements is described in the sectoral Chapters 3-9.

The reasoning and impact of the recalculation for the years 1990-2009 can also be found in CRF tables 8(a) s1-8(a)s2 and 8(b) of the relevant years.

Recalculations made for the 2012 inventory submission by CRF category and their implications to the emission level in 1990 and 2009 are shown in the Table 10.2.

Changes in methodological description are shown in the Table 10.3.

Table 10.2 Recalculations made for the 2013 inventory submission

CRF category		Recalculation	Reason for recalculation	Implication to the CRF category level		Implication to the total emission level without LULUCF %	
				1990	2010	1990	2010
1.	**Energy**			**-15.89**	**46.87**	**-0.06**	**0.39**
1.A.	Fuel Combustion Activities			-15.89	46.87	-0.06	0.39
1.A.1.	Energy Industries	1.A.1.a Public Electricity and Heat production, 1.A.1.c Manufacture of Solid Fuels and Other energy industries	Changes in NCV and activity data for other liquid products. Input mistakes in biomass activity data.	-0.92	0.13	0.00	0.00
1.A.2.	Manufacturing Industries and Construction	1.A.2.a, 1.A.2.c, 1.A.2.d, 1.A.2.e, 1.A.2.f	Changes in NCV and activity data for other liquid products and natural gas. Input mistakes for diesel, RFO, wood, other liquid biofuels, coal, gasoline.	-18.34	6	-0.07	0.05
1.A.3.	Transport	CRF A.3.b	Improvement and change in activity data for road transport time period 2009-2010. Implementation of new method for calculation of consumption of lubricants in road transport, time perio 1990 -2010.	3.37	37.57	0.01	0.31
1.A.4.	Other Sectors	1.A.4.a, 1.A.4.b, 1.A.4.c	Input mistakes in RFO, LPG, wood, biogas activity data. Changes in NCV and activity data for natural gas, other liquid products.		-3.49		-0.03
1.A.5.	Other	1.A.5.b	Precised activity data received from CSB.		6.67		0.06
2.	**Industrial Processes**				**-1.44**		**-0.01**
2.A.	Mineral Products		Update of activity data by CSB.		-1.44		-0.01
3.	**Solvent and Other Product Use**		Update of activity data.		**3.30**		**0.03**
4.	**Agriculture**				**-7.88**		**-0.07**
4.B.	Manure Management		Emissions for period 2000-2010 were updated, according to implementation of Tier 2 for CH4 emission calculation from non-dairy cattle manure management. 4.B(b) values are calculated by equations in IPCC Good Practice Guidance Chapter 4.		-7.23		-0.06
4.D.	Agricultural Soils	Area of cultivated histosoils	Area of cultivated histosoils was corrected for 2000-2010. based on updating of numbers provided by Latvian State Forest Research Institute "Silava"		-0.65		-0.01
5.	**Land Use, Land-Use Change and Forestry (net)**			**-6294.66**	**736.09**		

CRF category		Recalculation	Reason for recalculation	Implication to the CRF category level		Implication to the total emission level without LULUCF %	
5.A.	Forest Land	Carbon stock changes in living biomass, dead wood, litter and soil	Improvement of methodology, implementation of comments by the ERT during the previous review	-6144.13	2277.45		
5.B.	Cropland	Carbon stock changes in living biomass, dead wood, litter nd soil due to deforestation, updated values in organic soil related emissions	Improvement of the methodology, new coefficients for wood densities, biomass expansion factors and transition periods, implementationof comments by ERT during previous review	-20.09	-66.91		
5.E.	Settlements	Carbon stock changes in living biomass, dead wood, litter nd soil due to deforestation	Improvement of the methodology, new coefficients for wood densities, biomass expansion factors and transition periods, implementationof comments by ERT during previous review	42.55	682.55		
5.G.	Other	Harvested wood products	Development of new methodology	-173.00	-2157.		
6.	**Waste**			-265.40	-90.89	-1.01	-0.76
6.B.	Waste-water Handling		Update of MCF value for 6B.1.; update of activity data 6B.2.1.	-265.40	-90.89	-1.01	-0.76
	CO_2 Emissions from Biomass		Update of activity data.		**5.64**		**0.05**
2.F.	Consumption of Halocarbons and SF_6	2.F.1.6. Mobile AirConditioning:Recalculations of HFC-134a from disposal of stationary and mobile air conditioning for years 1995-2010.	According to suggestions of ERT during centralized review in 2012 there are made recalculations for all time series with 40% amount of f-gases remained in one MAC after the disposal instead of 75% that was assumed previously as to high and with 100% leakage at the disposal instead 90% that was assumed previously.		-13.19		-0.11
		2.F.3. Fire extinguishers:Recalculations of HFC-227ea from charging of fire extinguishing equipment	Latvia reports the same emission estimates for the entire time period 2007-2011 based on data from 2006. Furthermore, the emission estimate includes only emissions from stocks. Following by TERT recommendation assumed that the market situation for HFCs used in fire extinguishers might have changed, Latvia accepts to make data interpolation for years 2007-2011 in order to improve the accuracy of the estimates and avoid potential underestimation of emissions. Data for 2007-2011 was calculated assuming the average increase/decrease amount of HFC-227ae installed in fire extinguishers per year. There are calculated that activity data from years 2003-2006 increase/ decrease averagely about 0.486 tonnes per year.				

Table 10.3 Changes in methodological descriptions

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	**Please tick where this is also reflected in recalculations compared to the previous year CRF**	**If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc**
Total (Net Emissions)			
1. Energy			
A. Fuel Combustion (Sectoral Approach)			
1. Energy Industries			
2. Manufacturing Industries and Construction			
3. Transport	√		A new method for calculation of activity data for consumption of lubricants in road transport
4. Other Sectors			
5. Other			
B. Fugitive Emissions from Fuels			
1. Solid Fuels			
2. Oil and Natural Gas	√	√	Tier 1 method for calculation of emissions for natural gas leakages from 1.B.2.b iii – Transmission sector has been adopted instead of Tier2 which has been previously because of lack of transparency in emission calculating methodology. Tier1 method for CO_2 emissions from 1.B.2.b iii – Transmission sector have been adapted after centralised review.
2. Industrial Processes			
A. Mineral Products			
B. Chemical Industry			
C. Metal Production			
D. Other Production			
E. Production of Halocarbons and SF6			
F. Consumption of Halocarbons and SF6	√	√	– In Chapter 4, NIR 2013, 4.6.2.4.3. HFC-134a from disposal of stationary and mobile air conditioning. – In Chapter 4, NIR2013, 4.6.2.7.1 HFC-227ea from charging of fire extinguishing equipment.
G. Other			
3. Solvent and Other Product Use			
4. Agriculture			
A. Enteric Fermentation			
B. Manure Management	√		In Chapter 6.
C. Rice Cultivation			
D. Agricultural Soils		√	In Chapter 6.
E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	**Please tick where this is also reflected in recalculations compared to the previous year CRF**	**If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc**
5. Land Use, Land-Use Change and Forestry	√	√	Chapter 7.1.1 Overview of sector, recalculations are done for living biomass, dead wood, litter and soil. Harvested wood products are added to the report.
A. Forest Land	√	√	Explanation of recalculations and updated methodologies is provided in chapters 7.3.4, 7.8.4 and 7.3.7
B. Cropland	√	√	Explanation of recalculations and updated methodologies is provided in chapters 7.4.4 and 7.4.7
C. Grassland	√	√	Explanation of recalculations and updated methodologies is provided in chapters 7.5.4 and 7.5.7
D. Wetlands	√	√	Explanation of recalculations and updated methodologies is provided in chapters 7.6.4 and 7.6.7
E. Settlements	√	√	Explanation of recalculations and updated methodologies is provided in chapters 7.7.4 and 7.7.7
F. Other Land			
G. Other	√	√	Explanation of recalculations and updated methodologies is provided in chapter 7.11
6. Waste			
A. Solid Waste Disposal on Land			
B. Waste-water Handling			
C. Waste Incineration			
D. Other			
7. Other (as specified in Summary 1.A)			
Memo Items:			
International Bunkers			
Aviation			
Marine			
Multilateral Operations			
CO2 Emissions from Biomass			

NIR Chapter	DESCRIPTION		REFERENCE
	Please tick where the latest NIR includes major changes in descriptions compared to the previous year NIR		**If ticked please provide some more detailed information for example reference to pages in the NIR**
Chapter 1.2 Institutional arrangements			
Chapter 1.6 QA/QC plan	√		Page 40

10.1.2 KP-LULUCF inventory

See Section 10.1.

10.2. IMPLICATION FOR EMISSION LEVELS

10.2.1 GHG inventory

See Section 10.1.

10.2.2 KP-LULUCF inventory

See Section 10.1.

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 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; analyse bovine intestinal fermentation processes (methane release); evaluate agricultural fertilizer-related processes and activities; estimation of soil carbon stock in cropland and grassland);

-) ensuaring QA/QC evaluation for land use, land use change and forestry and industrial processes sectors;

-) conferences, training seminars and other experience-sharing events carried out to increase the capacity of Latvian inventory experts.

In the Table 10.4 are shown the sectoral improvement needs for the forthcoming inventories. More detailed information about planned improvements can be found under sectoral chapters.

Table 10.4 Sector – specific improvements needs of Latvia's national GHG inventory

CRF category	Planned improvement	Tentative time schedule	Progress

CRF category	Planned improvement	Tentative time schedule	Progress
Overview	Explore possibilities to develop national QA activities that would carried out by personnel not involved in the inventory	2013-2015	The air and climate monitoring program for is at developmental stage. There will be included responsibilities on QC/QA procedures
Overview	Improve QC/QA procedures to avoid inconsistencies	2013-2015	
Overview	Used key category analysis at a more disaggregated level (agriculture sector) and implement Tier 2 methods for key categories	2012 -2015	Railway: In cooperation with Latvian Railway administration, common working group is established to elaborate activity data collection system in railway in 2013.
1.A	Improving of activity data received from CSB to include in the emission estimation data smaller than EUROSTAT Annual Questionnaire's thresholds of 1kt	2013	
1.A	Country specific CO_2 emission factors for gasoline and diesel oil as well as country specific CH_4 EF will be determined for next inventories	2012-2013	For submission 2013, CO_2 emissions for gasoline 2009-2010 have been recalculated.
2.A, 2.C, 2.F	Verification for Industrial Processes sector and especially for the HFCs, SF_6 estimations as well as for 2.A Mineral Products and 2.C Iron & Steel sectors.	2013	For submission 2013, there was made recalculations for HFCs according to ERT recommendations in Centralized review week 2012. Detailed explanations are in Chapter 4. Detailed verification procedures will be done within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy ".
4D	To improve the accuracy of the inventory, conduct a specific research to identify exact histosol areas in the country.	2012-2013	Improvement is planned within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy.
5	Document the identification of lands, provide information on consistent representation of lands and check the areas of lands reported in the agriculture and LULUCF sectors	2011-2014	The activity is partially completed, deforested, afforested lands and historical land use structure is identified. The final stage of the project is identification of extensively used croplands and biologically valuable grasslands having special management requirements. Another continuing activity is identification of area of organic soils in cropland and grassland.
5	Elaborate country-specific methods for estimating annual removals from living biomass and other pools, where possible and considering national circumstances, in accordance with the IPCC good practice guidance for LULUCF	2011-2014	The activity is continuing and obtained results are implemented into the GHG inventory. Funding is secured for the most important activities.

CRF category	Planned improvement	Tentative time schedule	Progress
5	Develop country-specific parameters for the IPCC tier 2 method for key categories of the inventory, in accordance with the IPCC good practice guidance for LULUCF	2011-2014	The activity is closely related to the previous topic of the improvement plan, respectively, having similar progress. It is planned to implement recalculation results into the next inventory for all key categories.
6.B.1	Increasing accuracy of activity data for CH_4 emission from industrial waste water handling sector.	2011-2012	
6.A	Improve estimation about CH4 recovery. Make new distrubition about recovered CH4 amounts between managed and unmanages sites.	2012-2013	

Table 10.5 summarises Latvia's responses to the centralized review of 2012 inventory submission.

Table 10.5 Response to the review of the 2011 and partly 2012 inventory submission

CRF	Comment by ERT	Latvia's response	Where in NIR
Overview			
National system	Correct the information in the NIR so that it states that the key category analysis uses the tier 1 method.	Corrected.	Chapter 1.5
	Improve QC procedures to avoid inconsistencies such as the key category analysis being reported in the NIR differently from in CRF table 7 and the KP-LULUCF CRF tables with a view to avoiding errors, for example in the uncertainty analysis.	QC procedures were improved to avoid inconsistencies in the NIR differently from in CRF table 7 and the KP-LULUCF CRF tables	
	Include information in the NIR regarding the advice given to the experts regarding the prioritization of inventory improvements based in the uncertainty analysis.	Information is included.	Chapter 1.7.
	Provide additional information on the QA/QC plan in the next annual submission to improve transparency.	General Schedule for Implementation of QC/QA Activities are included in the Annex A.6.1 of NIR.	
	Improve transparency regarding the explanations of emission trends, in particular in the energy sector, and clarify in the NIR that agricultural areas smaller than 1 ha are included in the inventory.	Information is included in the NIR relevant chapters.	
	Include in the NIR the information provided to the ERT regarding the archiving system.	Information is included.	Chapter 1.6.3
Information on Kyoto Protocol units			

CRF	Comment by ERT	Latvia's response	Where in NIR
Calculation of the CPR	Include information on its commitment period reserve showing both figures to be compared one with the other, the one based on its most recently reviewed inventory and the one based on its assigned amount in next annual submission.	Information is included.	Chapter 12.5
	Report on changes from the previous year, whether or not there are any, in the information provided under Article 3, paragraph 14.	Information is included.	Chapter 15.
Energy			
	Comparison of the reference approach with the sectoral approach and international statistics 43. The ERT noted the improvement made in the difference between the reference and sectoral approaches for 2009 compared to that of earlier years of the time series, for which the difference is generally greater than 2 per cent. The ERT recommends that Latvia discuss, in the NIR of its next annual submission, the reasons leading to this improvement.	The reasons for different data are different NCVs. For example, NCV given in EUROSTAT table for Other oil products differ from ones used in emission calculation because of fuels taken into account for calculating NCV.	3.2.1 Comparison of the sectoral approach with the reference approach (CRF 1.A(b), 1.A(c))
	Feedstocks and non-energy use of fuels 47. The ERT encourages the Party to include data on all feedstocks in CRF table 1.A(d) and to report on the emissions when these occur.	Data from feedstocks are updated and described in chapter 3.2.3.	Chapter 3.2.3.
	Stationary combustion: all fuels – CO_2 49. …ERT recommends that Latvia work with CSB to update the coal characteristics for more recent years of the time series and use the revised data to recalculate the emission estimates for its next annual submission.	The NCV are updated according to values reported in EUROSTAT tables and verified with ones available at CSB on-line database. Therefore it is decided not to change these values in the current inventory.	Chapter 3
	50. ERT recommends that Latvia improve the transparency of its reporting by explaining the drivers behind the AD trends within this subcategory in its next annual submission.	Corrected.	1.A.c
Industrial processes and solvent and other product use			

CRF	Comment by ERT	Latvia's response	Where in NIR
	59. In accordance with the information included in the CRF tables, these changes resulted primarily from updated AD from the national statistics, but no updated information has been provided by the Party in the NIR: the discussion on recalculations in the 2011 NIR still reflects the recalculations made in the 2010 submission instead of the 2011 submission. The ERT recommends that Latvia ensure that it verifies that the information on the recalculations is updated in the NIR for the next annual submission;	For submission 2013 there are made recalculations of emissions from consumption of halocarbons and SF6 recommended by ERT in Centralized review 2012.	Chapter 4, 4.6.5 Source-specific recalculation
	Consumption of halocarbons and SF_6 – HFCs 66. …….ERT recommends that Latvia investigate whether additional AD could be gathered for this category either from country statistics, by considering alternative domestic or international data sources, or by interpolating data using indicator drivers.	For submission 2013, there are made recalculations of emissions from consumption of halocarbons and SF6.	Chapter 4, 4.6.5 Source-specific recalculation
Agriculture			
	75. The Party did not provide sufficient information in the NIR on the reason why field burning of agricultural residues is reported as "NO". The ERT recommends that Latvia include these explanations in the NIR in its next annual submission.	Legislative measures and agricultural residue management practices prohibit field burning of agricultural residues. This is explained by Latvijas Administratīvo pārkāpumu kodekss 179.pants. Ugunsdrošības prasību pārkāpšana. Available at http://www.likumi.lv/doc.php?id=89648	Chapter 6.5
	82. The ERT noted that Latvia reports in the NIR (page 234) that crop tables involve data from farms with an agricultural area larger than 1 ha of agricultural areas. The ERT recommends that the Party clarify this issue in the NIR of its next annual submission.	All crop areas are included in the inventory crop production data, also crop production on agricultural land smaller than 1 ha. CSB arrange surveys to largest farms, but data from smallest farms are incorporated in the official state statistics.	Chapter 6.4
	83. The ERT recommends that the Party continue its efforts to produce country-specific information and report on the advances made in its next annual submission.	Latvia already working on projects that will help to provide local research to fulfill requirement. It is planned to produce country-specific information within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy ".	Chapter 6.4
	84. The ERT recommends that Latvia develop national information on the use of sewage sludge applied to agricultural soils and prepare emission estimates in accordance with the IPCC good practice guidance in its next annual submission.	No appropriate statistical information available.	Chapter 6.4

CRF	Comment by ERT	Latvia's response	Where in NIR
	147. (h) Develop tier 2 estimates with country-specific EFs for non-dairy cattle and swine	Latvia already working on projects that will help to provide local research to fulfill requirement. It is planned to produce country-specific information within the project of EEA Financial Mechanism 2009-2014 Programme "National Climate Policy ".	Chapter 6
Land use, land-use change and forestry			
	88. In spite of the recalculations performed, Latvia reported an improvement plan in the NIR which is especially focused on the update of the land use and land-use change matrices using data from the second NFI as well as the improvement of some parameters. The ERT commends the Party for the improvement plan and recommends that Latvia, for future annual submissions, conduct a quantitative assessment of the recalculations performed in accordance with the IPCC good practice guidance for LULUCF.	Latvia's improvement plan is not completed yet and updates to the NIR and CRF tables are provided as soon as the new data are available from scientific studies and statistics.	All chapters of NIR
	89. However, the ERT noted that most of the emissions by sources and removals by sinks were estimated using a tier 1 method and IPCC default parameters. In addition, the carbon stock changes in dead organic matter and mineral soils for land remaining forest land were not estimated. Therefore, the ERT recommends that Latvia make efforts to develop higher-tier methods and country-specific parameters for the estimation of emissions from the LULUCF sector and complete the inventory by providing estimates of the carbon stock changes for all mandatory carbon pools in its future annual submissions.	Latvia is implementing the improvement plan according to the program and respecting available funding sources. In 2012 comparison of carbon stock in forest land, cropland and grassland is initiated and preliminary results shows that land use change from cropland to grassland and from grassland to forest land is not a source of emissions. Similarly it was estimated that mineral soils in forest lands are not a source of emissions (value of carbon stock change is positive). Latvia implemented in 2012 species specific increment factors for the most common tree species and mortality factors.	Annexes: Detailed information about Improvement plan for LULUCF sector

CRF	Comment by ERT	Latvia's response	Where in NIR
	90. As mentioned in paragraph 87 above, some land-use change data and parameters were based on expert judgement. However, the ERT noted that no transparent information was provided in NIR on how the experts derived the data and parameters. Also, although the NIR includes estimates of the uncertainties for all reported categories, the level of the uncertainties is based on expert judgement and statistical errors in AD, but no information is provided in the NIR to explain how the experts derived the uncertainty values. In response to questions raised by the ERT during the review week, Latvia informed the ERT that the reporting of the methodology used for the estimation of GHG emissions and removals, including the uncertainty of the biomass expansion factors and other values used in the inventory, is under preparation. The ERT welcomes the planned improvement and recommends that Latvia improve the transparency of its reporting by providing detailed explanations of the methodology used, in particular when expert judgement is used, in its next annual submission.	All land use changes are now calculated on the base of the NFI, however certain historical data, particularly identification of extensively used croplands is problematic and expert judgement is used to separate croplands and grasslands in the past. However, the same information base (NFI) is used in all cases and expert judgement is applied to a particular sample plot, therefore there is no overlapping of land use accounting.	Chapter 7.4.7 Category-specific planned improvements
	91. For all reported categories, Latvia uses category-specific QA/QC procedures as well as verification activities. However, the ERT still found some errors in the inventory (e.g. the different areas of cropland and grassland reported in NIR tables 7.1.2, 7.1.4, 7.1.5 and 11.1.1). Although these errors were clarified by Latvia in response to questions raised by the ERT during the review week, the ERT recommends that Latvia further improve the QA/QC procedures for the LULUCF sector in its next annual submission.	Improvement of the QA/QC procedures is planned in the 2014 inventory according to implementation plan of the Norwegian support scheme project on improvement of the GHG inventory in Latvia	-

CRF	Comment by ERT	Latvia's response	Where in NIR
	Forest land remaining forest land – CO2 93. The changes in carbon stocks in living biomass were estimated using country specific AD together with the default method and parameters from the IPCC good practice guidance for LULUCF. Although Latvia uses data from the NFI to estimate the time-series increments of growing stock, the biomass expansion factors are the IPCC default values for broadleaf forest while the root/shoot ratio was selected from an IPCC default value for coniferous forest, according to expert judgement. The methodology used for the elaboration of biomass functions for the most common tree species is under development at LSFRI Silava. Latvia states in the NIR that as soon as country-specific biomass functions have been elaborated and verified, the values for these parameters will be revised. The ERT commends Latvia for its planned improvements and reiterates the recommendation in the previous review report10 that Latvia develop country-specific parameters so that it can move to the use of IPCC tier 2 methods for the estimation of emissions and removals for this category. The ERT noted, based on the information provided by the Party, that the methodology used for the estimation and elaboration of the carbon stock changes in living biomass, mineral and organic forest soils and dead wood, which are under development, will be available only after 2012. The ERT recommends that the Party make efforts to obtain the results as soon as possible and report on the improvements made in the next annual submission.	The new methodology developed in conjunction with elaboration of the forest management reference level partially implemented in the inventory, which is continuously updated according to the research findings.	Chapter 7.2.4 Methodological issues
	94. Changes in the carbon stock in dead organic matter and mineral soils were reported as "NO" due to the lack of reliable information, but the ERT considers that the notation key used does not reflect the fact that the Party did not estimate the emissions. An IPCC tier 1 method and EF were used to estimate the carbon stock changes in drained organic forest soils. The ERT recommends that Latvia estimate and report the carbon stock changes for the missing pools in future annual submissions.	Carbon stock changes in dead organic matter are updated using newly developed mortality factors; however, the methodology, particularly decomposition period of dead wood and litter is still under development and will be updated in future inventories.	Chapter 7.2.4 Methodological issues

CRF	Comment by ERT	Latvia's response	Where in NIR
	Cropland remaining cropland – CO2 96. ….. ERT recommends that Latvia implement the described improvements and use a tier 2 method to estimate emissions from organic soils.	Latvia is investigating possibilities to adopt YASSO model to estimate carbon stock changes in mineral soils in cropland and grassland thus switching to Tier 2 method in mineral soil section. For organic soil we are investigating possibility to adopt emission factors from neighbouring countries (Sweden, Finland, Poland, Lithuania, Estonia), however, these factors are not similar or correlating with climatic conditions. Until the next inventory Latvia will evaluate possibility to use emisssions' factors elaborated in doctoral thesis by JÜRI-OTT SALM (2012)[180]	Chapter 7.3.8
	Land converted to cropland – CO2 97. Latvia reported the carbon stock changes for the dead organic matter and mineral soils pools for forest land converted to cropland, while the carbon stock changes in the living biomass and organic soils pools were reported under forest land remaining forest land and cropland remaining cropland. Latvia explains in the NIR that it is difficult to distinguish the loss of growing volume in this category from commercial harvesting stock, and no reliable information is available to separate organic soils under cropland remaining cropland from those under land converted to cropland. The ERT recommends that the Party make efforts to separate the estimates for these two categories in the next annual submission.	Latvia already split harvesting stock corresponding to deforested areas and conventional forest management using proportion according to average harvesting stock in all felling types. Area of organic soils is estimated in the NFI plots located on croplands and grasslands. The process, including physical sampling and analyses, is started in 2012 and up to now 20 % of sample plots are visited. Preliminary information shows, that organic soils are in 0.3 % of croplands, 1.4 % of grasslands and 3 % of naturally afforested lands. It is not yet included in the NFI, because of relatively small proportion of investigated NFI plots (about 2000 in 2012). All plots in croplands, including transformed ones are included into the study, therefore it will provide information about share of organic soils in historical and new croplands.	Chapters 7.3.8 and and 7.3.4
	Land converted to settlements – CO2 98. ….ERT recommends that the Party make efforts to separate the estimates for these two categories in the next annual submission.	Latvia already split harvesting stock corresponding to deforested areas and conventional forest management using proportion according to average harvesting stock in all felling types.	Chapter 7.6.4
	Grassland remaining grassland – CO2 99. … ERT recommends that Latvia estimate the carbon stock changes in living biomass and move to the use of a highertier method in line with the IPCC good practice guidance for LULUCF, in its next annual submission.	Carbon stock changes in living biomass will be updated in the beginning of 2104, when new database system of the NFI will complete testing phase. There is still work going on to estimate historical increment figures on grasslands.	Chapter 7.4.7 Category-specific planned improvements

[180] http://dspace.utlib.ee/dspace/handle/10062/25471?show=full

CRF	Comment by ERT	Latvia's response	Where in NIR
	Wetlands remaining wetlands – CO2 100. Latvia reports the CO2 emissions associated with industrial peat extraction in this category. IPCC default AD and EFs were used in the calculation of the emissions. The ERT encourages Latvia to implement its plan to use country-specific AD for industrial peat extraction and report the removals from living biomass as soon as NFI data for recent years are validated.	Wetlands remaining wetlands is a key source category of CO_2 due to commercial peat extraction. It is planned to evaluate actual activity in different peat extraction areas as well as to characterize vegetation on peatlands to separate areas, where natural status of peatlands (rewetting) took place in the past. These activities are not completed yet.	Chapter 7.5.8 Category-specific improvements
	147.(j) Develop higher-tier methods and country-specific parameters for the LULUCF sector and the KP-LULUCF activities, and complete the inventory by providing estimates of the carbon stock changes for all mandatory carbon pools (see paras. 89, 93, 94, 96, 97, 99, 100 and 118 above);	The work on elaboration of country specific parameters is continuing and results are implemented into the GHG inventory report as soon as they are available. The most of the problematic issues are already covered by ongoing projects and funding sources are already defined.	-
Waste			
	103. The inventory includes estimates for most gases and categories from the waste sector. However, the ERT notes that Latvia reports N2O emissions from biogenic waste incineration and CH4 emissions from non-biogenic incineration as not estimated ("NE"). Therefore, the ERT encourages Latvia to improve the completeness of its inventory by reporting emissions from this category in the next annual submission.	There are no emission factors available in UNFCCC guidelines.	Chapter 8
	104. The sector-specific QA/QC procedures are performed by the regional environmental board, but there is no information in the NIR on the sector-specific QC measures performed. The ERT reiterates the recommendations made in previous review reports that Latvia describe the sector-specific QC procedures in the NIR of its next annual submission and clarify which QC tier is used.	QA/QC for waste sector is realised as in QA/QC plan for GHG inventory.	Chapter 8
	Solid waste disposal on land – CH4 105. Latvia uses the IPCC tier 2, or first-order decay (FOD), methodology to estimate CH4 emissions from solid waste disposal on land, using country-specific AD and IPCC default values for the parameters. The ERT recommends that the Party conduct research in order to develop country-specific FOD parameters, instead of using IPCC defaults, so as to enhance the accuracy of this key category.	Latvia already uses country specific DOC – 0.17. It will be very difficult to implement other emission factors.	Chapter 8

CRF	Comment by ERT	Latvia's response	Where in NIR
	106. Latvia used the assumption that 50 per cent of solid waste disposal sites were managed and 50 per cent were uncategorized for the years 1980–1989. However, no justification for this assumption is provided in the NIR, and the ERT reiterates the recommendation from the previous review report11 that Latvia justify this assumption and further explain the expert elicitation methods used to arrive at this assumption, in its next annual submission.	For submission for 2012 this assumption is excluded. New assumption is in progress in Latvia's calculations.	Chapter 8
	107. The ERT noted that Latvia reports the amount of waste disposed in uncategorized landfill sites for the period 1970–1989, but does not provide transparent information on the emissions from the uncategorized landfill sites. The ERT recommends that Latvia provide information on how and where it estimates emissions from the uncategorized landfill sites in its next annual submission.	For submission for 2012 this assumption is excluded. New assumption is in progress in Latvia's calculations.	Chapter 8
	108. The ERT noted that Latvia used the waste density to calculate the amount of disposed waste in tonnes. During the review week, Latvia explained that the waste density value was changed from 0.3 t/m3 to 0.2 t/m3 according to recent research information. The ERT recommends that Latvia provide clear information in the NIR of its next annual submission on how the waste density values and their change were determined, in order to improve the transparency of the inventory.	0.2 t/m3 is taken from researches about waste density in Latvia.	Chapter 8
	Other (waste) – CH4 and N2O 113. The ERT notes that emissions from waste composting are not estimated prior to 2003. During the review, Latvia explained to the ERT that the emissions from industrial waste composting are not estimated because data are not available prior to 2003. The ERT recommends that Latvia report emissions from waste composting for the entire time series in its next annual submission.	Industrial composting did not occur in Latvia till 2003. In this year first permits on composting were issued and first data in "3-Wastes" survey were available.	Chapter 8
Supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol			
Information on activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol			

CRF	Comment by ERT	Latvia's response	Where in NIR
	118. In addition, the ERT noted that the methodology used for the estimation and elaboration of the carbon stock changes for all pools are under development and final recalculations will be available after the 2012 submission. The ERT commends the Party for its improvement plan but recommends that Latvia move to higher-tier methods and the use of country-specific parameters as soon as possible. The ERT also recommends that the Party report on the developments of the plan in the NIR of future annual submissions.	Latvia is updating information in the NIR and CRF as soon as the new data are available from scientific reports and national statistics. Funding of implementation of the improvement plan is based on annual agreements; therefore, it is hard to predict, which activities will be implemented in the first order and which will be postponed. Possibilities to use emissions' factors applied in neighbouring countries are studied for those pools, where national methodology will not be ready in 2014.	Chapter 11
	119. …. ERT recommends that Latvia conduct a tier 2 uncertainty analysis and improve the transparency of its reporting on the uncertainty analysis in its next annual submission.	The tier 2 uncertainty estimation will be elaborated for the whole NIR (all categories) until the next inventory. The implementation of the Tier 2 uncertainty estimation is subordinated to available funding to contract external experts.	Chapter 11
	120. The ERT found that the CO2 emissions and removals in CRF table 5.A.1 for forest land remaining forest land are different from the emissions and removals reported in CRF table 5(KP-I)B.1 for forest management. The ERT also found some inconsistencies, or potential errors, in several CRF tables; for example, the areas of afforestation/reforestation and deforestation activities in CRF table NIR-2 are different from the areas reported in CRF tables 5(KP-I)A.1.1 and 5(KP-I)A.2. Also, the areas of afforestation/reforestation and deforestation land areas at the end of the current year (line 15) in CRF table NIR-2 for 2008 are different from those at the start of the current year (column J) in CRF table NIR-2 for 2009. The ERT recommends that Latvia improve the QA/QC procedures in its next annual submission in order to enhance the consistency and transparency of its reporting.	The CO2 emissions and removals differed in convention reporting and KP reporting in the recent years, because certain area of afforested lands completed 20 years transition period and where moved to forest land remaining forest category in the forest management part, but remained in the afforested land category in the KP reporting. Mistakes of the reported area where caused by different rounding of numbers in different tables and during calculation process. It is important to note that the mentioned differences are second or third decimal sign.	Chapter 11
	Activities under Article 3, paragraph 4, of the Kyoto Protocol Forest management – CO2 and N2O 125. … The ERT reiterates the recommendations made above for forest land remaining forest land (see paras. 93 and 94 above), which also apply to forest management.	Carbon stock changes in dead organic matter are updated using newly developed mortality factors.	Chapter 7.2.4 Methodological issues

PART II: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

CHAPTER 11: KP-LULUCF

11.1 GENERAL INFORMATION

Under Article 3, paragraph 3, of the Kyoto Protocol (KP), Latvia reports emissions and removals from afforestation (A), reforestation (R) and deforestation (D), and under Article 3, paragraph 4 emissions and removals from forest management (FM). The estimates for emissions and removals under Articles 3.3 and 3.4 are consistent with the IPCC GPG LULUCF 2003 and Decisions 15/CMP.1 and 16/CMP.1 of the KP. The methodology for improved estimates of certain carbon pools (removals of CO_2 in dead wood, litter and soil) is under preparation; therefore, future reporting will contain more up-to-date information.

11.1.1 Definition of forest and any other criteria

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. The applied forest definition for the reporting is harmonized the definition used within the NFI. The forest definition is the same as used in chapter 7.2.3. Land-use definitions and the classification systems used and their correspondence to the LULUCF categories. The selected parameters are presented in Table 11.1. Additional criteria defined by the Latvia's Forest law[181] is width of rows of trees of artificial or natural origin – they should be at least 20 m wide to be accounted as the 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	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 are excluded from forest and are accounted under settlements; consequently, building of the forest infrastructure is accounted as deforestation.

11.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

For the commitment period 2008-2012 Latvia choose to account Forest Management as activity under Article 3.4 of the Kyoto Protocol in accordance with the Annex to the Decision 16/CMP.1., but did not elect Cropland management, Grazing land management and Revegetation. Following the Decision 8/CMP.2, the cap is equal to 6.23 Mt CO_2 for the whole commitment period.

Forest management areas are determined using spatial (statistical) approach within squares of 4 km grid according to the methodology of the NFI[182].

181 Latvijas Republikas Saeima, "Meža likums, 2000. (Forest law)", published in 24.02.2000.

182 Zemkopības ministrija, 2004. Meža statistiskās inventarizācijas veikšanas un mežaudzes sekundāro parametru aprēķināšanas metodika, instrukcija Nr. 10 no 17.03.2004. (Instruction for implementation of National forest inventory and calculations of secondary forest taxation parameters).

11.1.3 Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

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 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 are reported in 2010 under the forest land remaining forest land category. In the Kyoto protocol reporting transition period is not considered; therefore, deforested lands will be always deforested lands, even if they are covered by forests in future. The total areaof forest lands, however, is the same in the both reportings. All land use changes from and to forests takes place on managed lands and therefore are considered to be human induced. AR activities are reported together.

The information about ARD areas is based on results of the first round of the NFI and research results on deforestation obtained in 2010[183]. The first round of the NFI was carried out in 2004-2008 by the LSFRI Silava, therefore data on the land use changes are based on 5 years period. More detailed information on representation of the land use changes available in sections 7.6. Settlements (CRF 5.D), 7.3. Cropland (CRF 5.B) and 7.2. Forest Land (CRF 5.A). A second cycle of the NFI is started in 2009. After completion of at least 80 % of the second cycle (2013) data including land use changes and calculation models will be verified and updated according to actual figures. For the time interval 2009-2010 no land use change data are reported to avoid overestimations of removals. These data will be updated using linear regression after receiving the NFI data on land use structure in the second cycle.

Since the beginning the NFI uses a permanently marked hidden grid system. For this reason ARD activities will be assessed at the same grid points and sample plots at each inventory period.

11.1.4 Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified

Latvia has elected only forest management under Article 3.4 activities; there is no need to build up a hierarchy between forest management and other Article 3.4 activities.

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 approach (Reporting Method 1 of the IPCC GPG LULUCF) 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 Convention reporting. The spatial assessment units for the submission of the Kyoto Protocol and Convention report cover the entire territory of Latvia. 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 are presented in a single plot. In total 23583 sectors in 16383 sample plots were

[183] 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 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)."

used for calculations. Each sector in average represents 274 ha of the country area including internal wetlands. The standard error of mean of representation of the country area is 0.3 % (19.4 kilo ha). Summary of methodology of the national forest inventory is attached to annex. ARD activities are accounted as long as the forest definition is met (minimum assessment unit 0.1 ha). 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, it is kept. Note that only the first cycle of the NFI is complete therefore; both, methodologies and output data will be revised during the second cycle.

11.2.2 Methodology used to develop the land transition matrix

The land transition matrix is based on the results of land use changes to forest derived from the NFI of the period 2004-2008. Methodology for estimation of earlier land use changes, including deforestation activities is under development in the LSFRI Silava. The assessment methods at the NFI grid points are described above. Merging principles of the NFI land use categories into the LULUCF categories is shown in Table 11.2. Estimation of afforested and deforested area in 2009 is based of extrapolation of the NFI data and the research results[184]. After completion of the second round of the NFI in 2013 the land use change figures will be updated in the following years according to empiric data of land use changes.

Table 11.2 Land transition matrix – areas and changes in areas between the previous and the current inventory year (2011, kilo ha)

Kilo ha		Art. 3.3		Art. 3.4	Other	Total
		Aff. / Ref.	Deforestation	FM		
Art. 3.3	Aff. / Ref.	218.70			-	218.72
	Deforestation		36.38	-	-	36.38
Art. 3.4	FM		1.09	3 128.45	-	3 129.54
Other				NA	NA	3 071.59
Total		218.70	36.38	37.47	3 127.36	3 071.59

11.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

Latvia implements the Reporting Method 1 for lands subject to Article 3.3 and Article 3.4 activities. The area of Latvia is reported as a single region. The main data source for area estimates and tree biomass estimates was the National Forest Inventory (NFI) database (23583 sectors in 16383 sample plots were used for calculations). The sample design determines the theoretical location of sample plots and in the field sample plots were located by a GPS device and the actual location data were logged. LANDSAT images series from 1990, 1995 and 2000 were geographically referenced to fit to the actual location of sample plots before satellite image analysis. Since the geographical location of NFI sample plots were known, the results could be computed for geographically referenced areas. Geographical locations are identified by the coordinates of centres of the NFI sample plots.

Soil properties (carbon stock in litter and soil) in forest lands were determined in permanent 16 x 16 km grid of 95 sample plots (Figure 11.1). Results of comparison of carbon stock in

[184] Lazdiņš, "Harmonization of land use matrix in Latvia according to requirements of international greenhouse gas reporting system - extending outputs of National Forest inventory program."

soil at different depths including litter in mineral soils are shown in Figure 11.2. These results demonstrates, that mineral soils in forest lands are not source of emissions, but can be net sink. However, number of plots is insufficient to finalize conclusions about carbon stock change in forest lands.

Figure 11.1 Permanent grid of the Level 1 forest monitoring plots

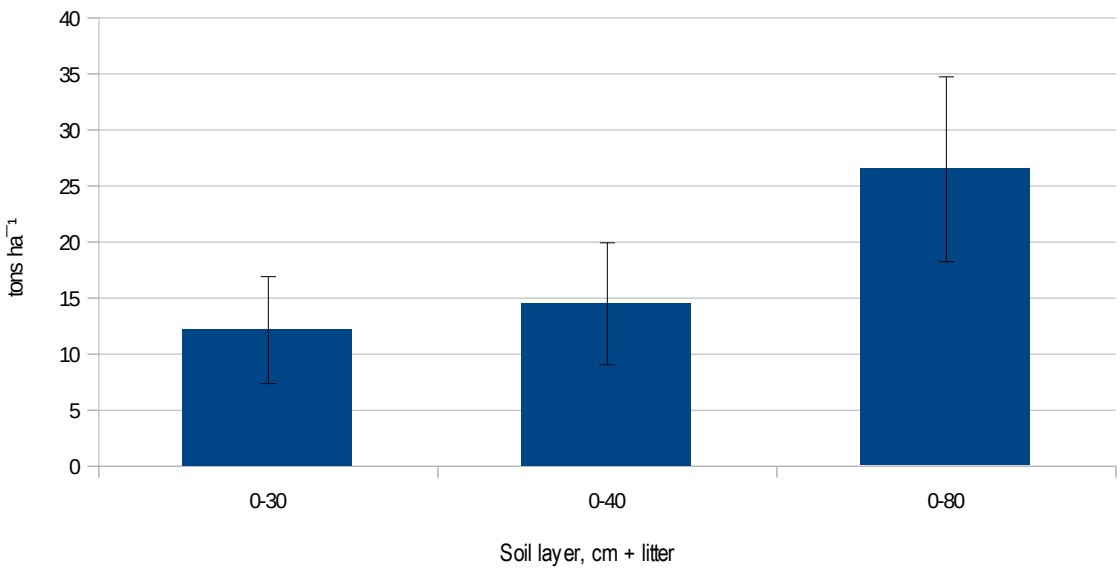

Figure 11.2 Carbon stock changes (between 2006 and 2012) in forest soils in Level I forest monitoring plots at different depths[185]

[185] Lazdiņš, A., Liepiņš, K., Lazdiņa, D., Jansons, Ā., Bārdule, A., 2012. Mežsaimniecisko darbību ietekmes uz siltumnīcefekta gāzu emisijām un CO_2 piesaisti novērtējums (pārskats par 2012. gada darba uzdevumu izpildi) (No. 5.5-5.1/001Y/110/08/8). LVMI Silava & Meža nozares kompetences centrs, Salaspils.

11.3 ACTIVITY-SPECIFIC INFORMATION

11.3.1 Methods for carbon stock change and GHG emission and removal estimates

11.3.1.1 Description of the methodologies and the underlying assumptions used

Methods for estimating carbon stock changes in forests (for Article 3.3 afforestation/reforestation and Article 3.4 forest management) are the same as those used for the UNFCCC greenhouse gas inventory (chapter 7.2.4. Methodological issues and 7.2.7. Category-specific recalculations). Estimations of carbon stock changes in living biomass on lands remaining forests is based on measurements of radial increment of growing trees and calculation of so called actual potential increment of timber volume therefore mortality is not considered in calculations of stock changes. Due to this reason stock changes in dead wood and litter also are not accounted to avoid overestimations of removals in these carbon pools. 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 (**Figure 11.3**). Average standard error of mean of the estimation at different ages is 35 %.

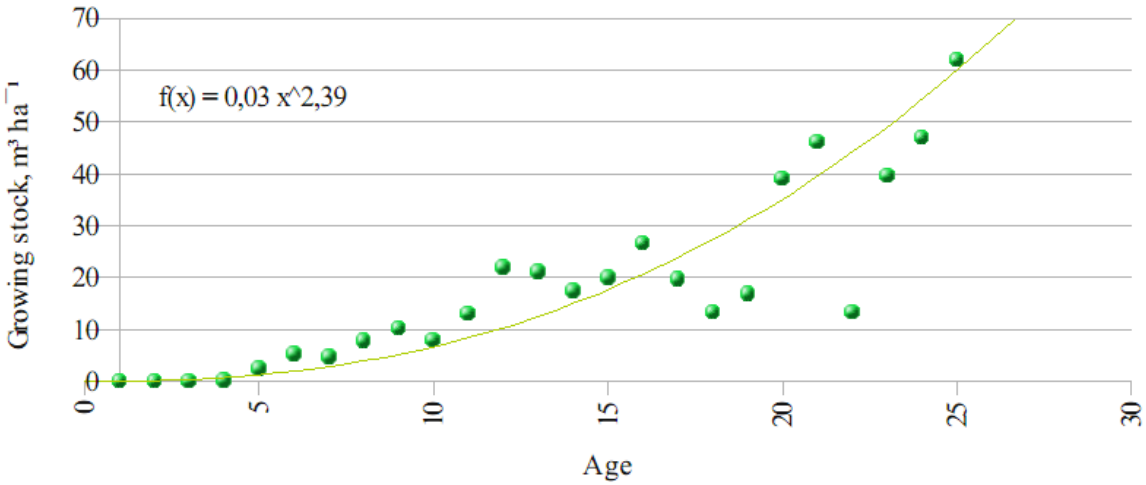

Figure 11.3 Average growing stock figures for afforested areas of different ages

Different approach was applied for the drain. The loss of tree biomass due to commercial harvesting was estimated according to the State Forest Service (summary of reports on harvesting permissions). 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 biomass from deforestation initially were reported under forest management as instant oxidation of all harvested biomass, because it is not possible to separate historical figures of harvesting associated with forest management and deforestation in national statistics. Expert judgement was applied to separate emissions from living biomass due to commercial harvesting with following deforestation. Average harvesting stock figures of felling types for 1995-2009 was used to extrapolate average harvesting stock per hectare for 1990-1994 (Figure 11.4). These figures were applied to deforested area to estimate losses in living biomass. Uncertainty level of the estimate according to the expert judgement is 90 %.

Methods described in chapter 7.2.4. Methodological issues were used to convert harvesting stock to CO_2. Extracted amount of CO_2 was excluded from KP 3.4 reporting.

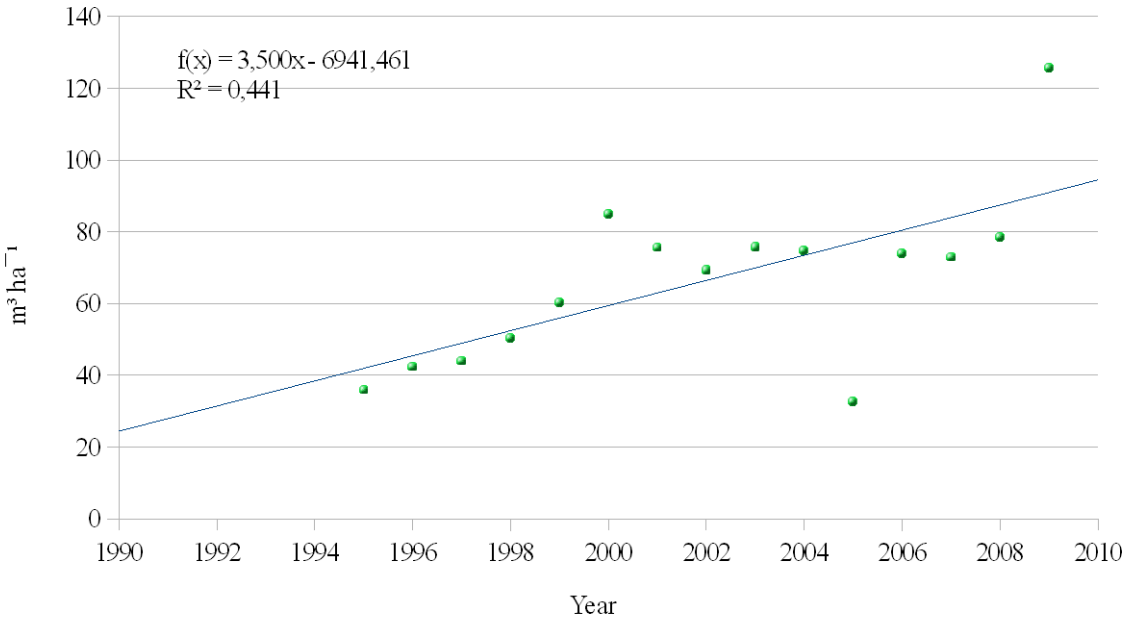

Figure 11.4 Historical figures of average harvesting stock

Carbon stock changes in dead wood, litter and mineral soils are reported under deforestation assuming that average carbon stock on forest lands in these pools instantly oxidise during conversion. Emissions from soil are calculated from 10 cm deep layer which corresponds to average conversion practice according to expert judgement. Average carbon stock in soil in 0-10 cm layer corresponds to – 337 tons of CO_2, in litter – to 78 tons of CO_2 and in dead wood – to 22 tons of CO_2. Removals in these pools due to afforestation and forest management are not accounted to avoid potential overestimations. Accounting of removals will be introduced as soon as the NFI will provide figures of natural mortality. Emissions from drained organic soils are accounted using the same methodology for afforested areas and historical forest lands assuming annual losses of soil carbon equal to about 2.49 tons of CO_2. Methodology is described in section 7.2.4 Methodological issues.

11.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

Methodology for estimation of removals of CO_2 in soil and litter carbon pools is under development and data about carbon stock changes in these carbon pools will be available for the reporting period 2008-2013. Carbon stock change in soil due to afforestation is not reported due to lack of reference figures for the grasslands' category. National figures about carbon stock in soil (weighted average of organic and mineral soils including litter 156 tons C ha^{-1}) available from the forest inventory are considerably higher than default values in TABLE 3.2.4[186] (71-115 tons C ha^{-1}). Therefore use of default reference levels for grasslands from TABLE 3.4.4[187] (the same values as for the forest lands) would lead to considerable overestimation of removals in soil due to afforestation. Similarly, changes in

[186] Default reference (under native vegetation) soil organic C stocks (SOCref) (tonnes C per ha for 0-30 cm depth).

[187] Default reference (under native vegetation) soil organic C stocks (SOCref) (tonnes C per ha for 0-30 cm depth).

dead wood stock identified in the NFI due to forest management and afforestation are not reported to avoid potential overestimations of removals in these pools. Therefore soil, litter and dead wood are considered as not a source, however methodology to estimate these carbon pools is under preparation.

Emissions from biomass burning are estimated according to methodology described in section 7.8 Biomass Burning (CRF 5 (V)).

11.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

Table 5(KP-I)A.1.3 Article 3.3 activities: Afforestation and Reforestation. Units of land otherwise subject to elected activities under Article 3.4. According to the fact that all forests in Latvia are managed, the whole area subject to afforestation/reforestation should be reported here since otherwise subject to forest management.

Table 5(KP-I)A.2.1 Article 3.3 activities: Deforestation. Units of land otherwise subject to elected activities under Article 3.4. Only forest management has been elected under Article 3.4. As Deforestation is a permanent loss of forest cover, any unit of land that has been deforested under Article 3.3 cannot also be subject to forest management under Article 3.4.

Table 5(KP-II)1. Direct N_2O emissions from N fertilization. No N fertilization is applied to forests in Latvia, so emissions are reported as not occurring.

Table 5(KP-II)2. N_2O emissions from drainage of soils. Reporting of these emissions is not mandatory; however estimates of emissions of N_2O are done using emission factors from TABLE 3a.2.1[188] of the IPCC GPG LULUCF 2003. Activity data utilized in calculations is area of drained organic and mineral soils. No new drainage systems is allowed to establish in forests therefore only emissions from existing drainage systems are accounted.

Table 5(KP-II)3. N_2O emissions from disturbance associated with land use conversion to cropland. N_2O emissions associated with conversion to croplands are reported using equations 3.3.13, 3.3.14 and 3.3.15 of the IPCC GPG LULUCF 2003. Carbon stock changes for calculation of the emission's factor taken from losses of carbon stock from the upper 10 cm of soil due to instant oxidation after conversion.

Table 5(KP-II)4. Carbon emissions from lime application. No lime is applied to forests in Latvia, so emissions are reported as not occurring. This is consistent with UNFCCC reporting, where all liming is assumed to occur in cropland remaining cropland.

11.3.1.4 Changes in data and methods since the previous submission (recalculations)

Two types of changes are included into this KP LULUCF reporting:

updates of values, like use of the same number of decimal signs in representation of land areas in different years;

correction of notation keys, setting of NE instead of NO in the land use categories, where absence of the emissions / removals are scientifically approved and where research work is initiated to obtain necessary values.

Changes made to the KP LULUCF reporting are relevant to those implemented under the Convention reporting. More detailed information is available in section 7.2.7. Category-specific recalculations.

11.3.1.5 Uncertainty estimates

Uncertainties are estimated on the base of the NFI data, the default values provided by the IPCC GPG LULUCF 2003 and expert judgement, where other data are not available. Uncertainty of soil carbon (CO_2) and nitrogen (N_2O) are estimated according to data obtained

[188] Default emission factors N_2O emissions from drainage of forest soils.

within the scope of the international forest soil monitoring project BioSoil and values provided in the IPCC GPG LULUCF 2003. Total level of uncertainty of emissions from soil is 90 %.

Uncertainty level of forest area is 0.3 %, uncertainty of afforested area is 1.7 %, uncertainty of annual increment of forest lands is 0.9 %, uncertainty of increment on afforested lands 16 %. Uncertainty of deforested area is 36 %. Uncertainty of area of drained organic soils in forest lands remaining forests is 0.8 %, uncertainty of area of drained organic soils in afforested lands 3.4 %. Uncertainties calculated as standard error of mean. A standard error of mean of harvesting stock according to forest regulations is 10 %. BEFs utilized in calculations according to expert judgement have total uncertainty level of about 30 %.

11.3.1.6 Information on other methodological issues

Latvia has decided to account for the emissions and removals under Article 3 paragraphs 3 and 4 in the end of the commitment period. Latvia is still developing methods for estimation of emissions and removals of greenhouse gases and their uncertainties. For that reason, the estimates presented in this submission for 2008-2009 might change for the final report of the commitment period.

The argument for applying NFI data is that it is the only continuous inventory and monitoring system in Latvia which covers all land uses and gives reliable estimates for land use and tree growth. It is also a system which can be used in combination with the Level I forest monitoring system to monitor carbon stock changes in soil, dead wood and litter.

11.3.1.7 The year of the onset of an activity, if after 2008

According to paragraph 18 of the annex to decision 16/CMP.1 accounting of anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from land use, land-use change and forestry activities under Article 3, paragraphs 3 and 4 begin with the onset of the activity or the beginning of the commitment period whichever comes later.

11.4 ARTICLE 3.3

Latvia reports all emissions by sources and removals in living biomass from AR activities in the table 5(KP-I)A.1.1 – Afforestation/Reforestation: units of land not harvested.

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:

-) planted or seeded grasslands;

-) abandoned grasslands which are naturally forested and converted to forest lands.

In Latvia all land use categories (cropland, grassland, forest) are to be considered managed; therefore any land use change occurs between managed 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 naturally afforested lands.

On the basis of the definitions provided in the Decision 19/CMP.136, natural afforestation and reforestation occurred on abandoned agricultural lands have to be included in the Article 3.3: a frequent forest management strategy, in Latvia, consists, in fact, in the

exploitation of natural re-growth caused, for instance, by the seed of adjacent trees. 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), therefore induced by man.

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 agriculture occurs to less extend and generally is associated with removal of woody vegetation from abandoned farmlands and it was more common in 90^{ths}.

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 changes and Land Use Changes.

Afforested areas fulfil the criteria for the forest definition of the Latvia's NFI which are:

minimum forest area 0.1 ha, ground coverage by woody species at least 20 % and minimum width of 20 m;

height of trees at the maturity age is higher than 5 m.

Deforested areas can be detected by two combined characteristics:

- the forest definition of Latvia's NFI has ceased to apply;
- there are significant visible changes in soil structure or ground vegetation which do not go 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).

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; therefore, the deforestation follows to temporary unstocking of forest lands which is accounted under forest management.

Deforestation and relevant land use changes (construction of forest roads) is regulated by national laws.

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

Restocking is assumed for forest areas that have lost forest cover through harvesting or forest disturbance, unless there is deforestation as described above. 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.

11.5 ARTICLE 3.4

Accounting of land use changes and GHG emissions is based on the National forest inventory, where each sample plot has remark on land use category in the convention and Kyoto protocol reporting. Respectively overlapping of accounting of emissions and removals

is not possible. The extrapolated values, like losses in living biomass due to deforestation are calculated by splitting of total harvesting stock into regenerative harvesting and deforestation on the base of average harvesting stock per hectare.

Taking into account the above information Latvia does not have emissions by sources and removals by sinks resulting from elected Article 3.4 activities that are accounted for under activities under Article 3.3.

11.5.1 Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

Forests in 1 January 1990 were under forest management, since Latvia considers all forest land managed, and, therefore, human-induced.

11.5.2 Information relating to Cropland Management, Grazing Land Management and Revegetation

Not applicable.

11.5.3 Information relating to Forest Management

According to the Forest law[189] forest management in Latvia is sustainable utilization and management of forests and forest resources so 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. Therefore all forest are considered as managed forests.

Area of managed forest lands is presented in Table 11.3.

Table 11.3 Area and growing stock of managed forests under Kyoto protocol reporting

Year	Total forest area, kilo ha	Drained organic soils, kilo. ha	Drained mineral soils, kilo. ha	Annual gross increment, kilo. m^3	Average gross increment, m^3 ha^{-1}
1990	3163.4	432.7	610.7	26651.2	8.4
1991	3160.9	432.4	610.2	26630.1	8.4
1992	3158.4	432.1	609.7	26609.1	8.4
1993	3155.9	431.7	609.2	26588.0	8.4
1994	3153.4	431.4	608.7	27756.3	8.8
1995	3150.9	431.0	608.2	27734.3	8.8
1996	3149.7	430.7	607.8	27723.2	8.8
1997	3148.4	430.5	607.5	27712.1	8.8
1998	3147.1	430.4	607.3	27700.9	8.8
1999	3145.9	430.2	607.0	28234.2	9.0
2000	3144.6	430.0	606.8	28222.9	9.0
2001	3143.0	429.8	606.5	28208.7	9.0
2002	3141.5	429.6	606.2	28194.6	9.0
2003	3139.9	429.4	605.9	28180.4	9.0
2004	3138.3	429.2	605.6	27577.5	8.8
2005	3136.7	429.0	605.3	27563.6	8.8
2006	3135.1	428.8	605.0	27549.8	8.8

[189] Latvijas Republikas Saeima, "Meža likums, 2000."

2007	3133.6	428.5	604.7	27535.9	8.8
2008	3132.0	428.3	604.4	27522.0	8.8
2009	3130.7	428.2	604.2	28352.8	9.1
2010	3129.5	428.0	603.9	28342.4	9.1
2011	3128.4	427.8	603.7	28332.5	9.1

Forest management activity is practised on the forest area as defined above. The area of forest and the area under forest management (forest land remaining forest) in the end of 1989 larger in compare to 2011 because of deforestation.

The Forest law lays down provisions on management and utilisation of forest. The purpose of the Act is to promote economically, ecologically and socially sustainable, management and utilisation of the forests in such a way that forests provide a sustainable satisfactory yield while biological diversity is being maintained.

11.6 OTHER INFORMATION

11.6.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

Key category analysis for KP-LULUCF was performed according to section 5.4 of the IPCC GPG LULUCF 2003. Only total CO_2 emissions and removals from forest management (Art. 3.4) has been assessed as key category, in accordance with the IPCC good practice guidance for LULUCF section 5.4.4. The value has been compared with Table 1.6 Key categories for the latest reported year (2010) based on level of emissions (including LULUCF).

Article 3.3 Afforestation and reforestation (CO_2): The associated UNFCCC subcategory CO_2 emissions and removals from land converting to forest land have been identified as key category. Total CO_2 emissions and removals from afforestation and reforestation (Art. 3.3) is larger than the smallest UNFCCC key category. Therefore AR is stated to be a key category. CO_2 emissions from deforestation also are a key category.

Article 3.3 Deforestation (CO_2): The associated UNFCCC subcategory CO_2 emissions from deforestation have been identified as key category. Total CO_2 emissions and removals from deforestation (Art. 3.3) is larger than the smallest UNFCCC key category. Therefore D is stated to be a key category.

Article 3.4 Forest management (CO_2): The associated UNFCCC subcategory Forest land remaining Forest land is a key category in level and in trend assessment (Tier 1). The contribution of forest management is also greater than other UNFCCC key categories.

11.7 INFORMATION RELATING TO ARTICLE 6

Latvia has issued 47 declarations of approval for participation of Latvian enterprises in JI projects hosted by other Kioto protocol Annex B countries.

Latvia is hosting one JI - The Liepaja Regional Solid Waste Management Project which was approved in 2012. The Liepaja Regional Solid Waste Management Project introduces a state-of-the-art waste management system to the Liepaja Waste Management Region including remediation of the existing landfill sites and the operation of energy cells for methane capture and utilization. There are two basic sources of GHG emission reductions from the project, methane and carbon dioxide:

1. Methane Capture and Combustion or Flare (Direct Effects): The captured methane at the Grobina and Skede Sites from the sanitary landfill gas collection system is destroyed by either

combustion or flaring, thereby reducing GHGs that would otherwise be emitted into the atmosphere.

2. Electric Generation Displacement (Direct Effects): Carbon dioxide emissions also are reduced by the project through the displacement of grid-based electricity by the landfill methane-based electricity produced at Grobina and Skede.

CHAPTER 12: INFORMATION ON ACCOUNTING OF KYOTO UNITS

12.1 BACKGROUND INFORMATION

The standard electronic format tables are included in the submission for the fourth time (see "SEF_LV_2013_2_14-26-6 11-4-2013.xls" 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 31.12.2012 as well as information on transfers of the units in 2012 to and from other Parties of the Kyoto Protocol.

12.2 SUMMARY OF INFORMATION REPORTED IN THE SEF TABLES

At the beginning of the 2012 there were 74 671 083 AAUs in the Latvia's national holding account and 2 756 343 EUAs converted from AAUs in the entity holding accounts. In addition, 7761 CERs were held in entity holding accounts. At the beginning of 2012 7 651 222 EUAs and 794 451 CERs and 27 222 ERUs were stored in Retirement account.

At the end of 2012 85 886 119 AAUs were left in National holding account, 264 246 CERs and 42 907 ERUs were held in the entity holding accounts.

2 847 924 EUAs_AAUs, 21791 ERUs and 53740 CERs were surrendered by Latvia's operators and retired to Latvia's national retirement account during compliance period at the beginning of 2012 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 96 385 265 Kyoto protocol units were stored in the ETR accounts at the end of 2012.

Latvia's assigned amount is 119 182 130 tonnes CO_2 eq

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 2012 in Latvia's ETR.

No transactions in Latvia's ETR were cancelled and only 2 was terminated, but with the response code that don't corresponded to the response codes of discrepant transactions.

The discrepant transactions are not listed in the table R2 and would technically not need to be reported.

12.3.2 List of CDM notifications

CDM notifications – reversal of storage notifications, non-certification notifications were received in the reporting period 2012.

The report "R3: List of CDM notifications" is reported empty.

12.3.3 List of non-replacements

No non-replacement occurred during reporting period 2012.

It was considered not to report "R4: List of non-replacements" report as the non-replacement list is empty.

12.3.4 List of invalid units

There weren't any invalid units in Latvia's ETR in the reporting period from 1st January 2013 to 31st December 2012.

The report "R5: List of invalid units" is reported empty.

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 2012.

As cancelled and terminated transactions in 2012 were not considered discrepant according to DES no specific actions to correct any problems were necessary

12.4 PUBLICLY ACCESSIBLE INFORMATION

The information required to be publicly accessible by the decisions 13/CMP/1 is available in the user interface of the Latvia's ETR – https://ets-registry.webgate.ec.europa.eu/euregistry/LV/index.xhtml as well as in the webpage http://ec.europa.eu/environment/ets/account.do?languageCode=lv.

12.5 CALCULATION OF THE COMMITMENT PERIOD RESERVE (CPR)

Latvia's commitment period reserve for Latvia is estimated as 100 % the most recent inventory multiplied with 5 years:

$$CPR = 5 * 11\,494{,}1850897317\ CO_2\ eq. = 57470{,}9254486585\ Gg\ CO_2\ eq.$$
$$or\ \ 57470925\ tonnes\ CO_2\ eq.$$

Latvia's assigned amount is 119 182 130 tonnes of CO_2 eq. and the commitment period reserve calculated as 90% of the assigned amount amounts to 107263917 tonnes of CO_2 eq.

The figure of commitment period reserve as 100 % of the most recent inventory is smaller as commitment period reserve based on assigned amount.

12.6 KP-LULUCF ACCOUNTING

Latvia has chosen accounting of all KP-LULUCF activities at the end of commitment period. No information on the accounting of the KP-LULUCF is therefore included in the SEF tables. Latvia's cap value is 6233.33 Gg CO_2 equivalents for the whole commitment period.

CHAPTER 13: INFORMATION ON CHANGES IN NATIONAL SYSTEM

In 2013, Steering committee of GHG inventory preparation was established for advisory purposes (Ordinance Nr.94, 28.02.2013.).

CHAPTER 14: INFORMATION ON CHANGES IN NATIONAL REGISTRY

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of EU has undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

(1) Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;

(2) Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;

(3) Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;

(4) Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;

(5) The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;

(6) The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;

(7) All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:

    (a) With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);

(b) The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;

(c) With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;

(d) The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;

(e) In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

The following changes to the national registry of Latvia have therefore occurred in 2012, as a consequence of the transition to the CSEUR platform.

Table 14.1 Functions of the national registry and its conformity with DES

15/CMP.1 annex II.E paragraph 32.(a)	Registry Administrators	1) Aiva Puļķe Secondary Latvian Emission Trading Registry administrator Latvian Environment, Geology and Meteorology Centre Address: Maskavas street 165, Riga, LV-1019 Tel.: +371 67032015 e-mail: Aiva.Pulke@lvgmc.lv 2) Jeļena Lazdāne Secondary Latvian Emission Trading Registry administrator Latvian Environment, Geology and Meteorology Centre Address: Maskavas street 165, Riga, LV-1019 Tel.: +371 67032015 e-mail: Jelena.Lazdane@lvgmc.lv 3) EU-ETS Registry Service Desk Tel.:+3210487534 e-mail: ETS-ServiceDesk@iriscorporate.com
15/CMP.1 annex II.E paragraph 32.(b)	Change regarding cooperation arrangement	The EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went to production on 20 June 2012. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. This description includes: • **Readiness questionnaire**

		• **Application logging** • **Change management procedure** • **Disaster recovery** • **Manual Intervention** • **Operational Plan** • **Roles and responsibilities** • **Security Plan** • **Time Validation Plan** • **Version change Management** The documents above are provided as an appendix to this document. A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as 2nd level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk with regards notably to connectivity or reconciliation issues.
15/CMP.1 annex II.E paragraph 32.(c)	Change to database structure or the capacity of national registry	In 2012, the EU registry has undergone a major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU registries (CSEUR). The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and lead to **successful certification on 1 June2012.**
15/CMP.1 annex II.E paragraph 32.(d)	Change regarding conformance to technical standards	The overall change to a Consolidated System of EU Registries triggered changes the registry software and required new conformance testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and lead to successful certification on 1 June 2012,
15/CMP.1 annex II.E paragraph 32.(e)	Change to discrepancies procedures	The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated **manual intervention** document and **the operational plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(f)	Change regarding security	The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated **security plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(g)	Change to list of publicly available information	http://ec.europa.eu/environment/ets/welcome.do?languageCode=lv

15/CMP.1 annex II.E paragraph 32.(h)	Change of Internet address	The new internet address of the Latvia registry is: https://ets-registry.webgate.ec.europa.eu/euregistry/LV/index.xhtml
15/CMP.1 annex II.E paragraph 32.(i)	Change regarding data integrity measures	The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated **disaster recovery plan.** The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(j)	Change regarding test results	On 2 October 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into Production. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted.
The previous Annual Review recommendations		There are no recommendations concerning the reporting of the changes in national registry.

CHAPTER 15: INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

No changes from the previous year in the information provided under article 3, paragraph 14.

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