LATVIA'S
NATIONAL INVENTORY REPORT

Submission under UNFCCC and the Kyoto Protocol

Common Reporting Formats (CRF)
1990 – 2010

2012

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 1990-2010 including KP-LULUCF data tables. The CRF tables are compiled with the UNFCCC CRF Reporter software (version 3.5.2.).
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 31.12.2011 and transfers of the units during the year 2011.

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The Latvia's inventory report as well as the CRF tables can be downloaded from the 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 1990-2010.

The GHG inventory is prepared according to the UNFCCC reporting guidelines on annual inventories (UNFCCC 2006). For the preparation of the 2012 submission CRF Reporter v.3.5.2 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, and more detailed information is in the Standard Electronic Tables (SEF).

ES.2 SUMMARY OF NATIONAL EMISSION AND REMOVAL RELATED TRENDS

ES.2.1 GHG inventory

In 2010, Latvia's greenhouse gas emissions totalled 12077,03 Gg CO_2 eq. excluding LULUCF.

Latvia's total GHG emissions without LULUCF in 2010 showed a decrease of 54.5% comparing to the base year.

In 2010, Latvia's total GHG emissions including LULUCF demonstrated a decrease of 148.1% from 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, 1995- 2010), Gg CO_2 eq

GREENHOUSE GAS EMISSIONS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	CO2 equivalent (Gg)																					(%)
CO2 emissions including net CO2 from LULUCF	2 807.98	-405.68	-4 997.00	-6 853.51	-7 667.40	-8 141.90	-9 042.02	-6 972.70	-6 304.32	-6 368.27	-7 660.38	-7 572.56	-6 600.09	-7 879.41	-8 854.51	-9 797.67	-12 423.65	-13 464.68	-14 948.00	-13 396.77	-8 855.64	-415.37
CO2 emissions excluding net CO2 from LULUCF	19 057.77	17 479.52	14 002.07	11 736.26	10 229.12	9 037.15	9 127.80	8 600.64	8 217.57	7 634.19	7 068.51	7 436.27	7 415.44	7 612.16	7 775.47	7 778.56	8 254.89	8 621.92	8 181.45	7 388.93	8 480.21	-55.50
CH4 emissions including CH4 from LULUCF	3 713.14	3 615.46	3 074.21	2 282.57	2 077.01	2 064.97	2 013.14	1 987.57	1 909.78	1 798.13	1 815.95	1 878.93	1 881.68	1 802.86	1 817.59	1 853.43	1 756.90	1 798.53	1 818.78	1 811.60	1 776.09	-52.17
CH4 emissions excluding CH4 from LULUCF	3 693.77	3 592.97	3 036.31	2 257.16	2 047.78	2 028.78	1 976.72	1 941.19	1 858.22	1 740.07	1 757.10	1 846.03	1 841.71	1 765.14	1 783.41	1 818.59	1 718.64	1 767.19	1 790.60	1 777.27	1 735.66	-53.01
N2O emissions including N2O from LULUCF	4 023.01	3 760.73	2 968.36	2 173.08	1 930.41	1 755.64	1 698.12	1 703.37	1 646.19	1 561.97	1 586.39	1 691.91	1 661.73	1 738.22	1 715.61	1 781.89	1 785.27	1 835.63	1 819.89	1 844.64	1 892.28	-52.96
N2O emissions excluding N2O from LULUCF	3 803.98	3 541.55	2 745.53	1 953.70	1 710.90	1 535.39	1 519.66	1 524.11	1 466.50	1 381.28	1 405.75	1 517.90	1 486.30	1 563.46	1 541.56	1 608.09	1 609.58	1 662.23	1 646.96	1 682.02	1 743.73	-54.16
HFCs	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	0.64	0.87	2.09	3.07	3.52	5.48	8.19	10.92	17.53	21.30	34.17	73.02	115.63	95.33	100.16	105.17	100.00
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	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
SF6	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	3.38	4.41	5.37	7.53	7.12	8.60	10.08	13.53	12.25	100.00
Total (including LULUCF)	**10 544.13**	**6 970.51**	**1 045.57**	**-2 397.86**	**-3 659.98**	**-4 320.40**	**-5 329.60**	**-3 279.16**	**-2 744.57**	**-3 003.66**	**-4 251.29**	**-3 991.55**	**-3 042.38**	**-4 316.39**	**-5 294.63**	**-6 120.65**	**-8 801.33**	**-9 706.29**	**-11 203.92**	**-9 626.84**	**-5 069.84**	**-148.08**
Total (excluding LULUCF)	**26 555.52**	**24 614.03**	**19 783.90**	**15 947.12**	**13 987.80**	**12 602.21**	**12 625.35**	**12 068.54**	**11 546.08**	**10 760.04**	**10 238.12**	**10 810.36**	**10 757.74**	**10 962.71**	**11 127.11**	**11 246.94**	**11 663.25**	**12 175.57**	**11 724.42**	**10 961.90**	**12 077.03**	**-54.52**

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	Change from base to latest reported year
	CO2 equivalent (Gg)																					(%)
1. Energy	19 102.99	17 608.31	14 345.23	12 240.32	10 656.60	9 461.61	9 537.18	8 974.91	8 558.76	7 914.81	7 363.26	7 732.04	7 715.00	7 885.24	7 914.49	8 046.48	8 432.54	8 769.84	8 335.24	7 612.61	8 400.67	-56.02
2. Industrial Processes	598.87	536.07	256.64	83.67	146.72	160.21	176.30	183.28	185.07	223.00	179.75	207.90	224.76	249.09	393.05	291.98	358.43	421.08	394.21	365.30	638.76	6.66
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	36.72	29.67	36.23	36.10	55.96	64.72	43.97	27.06	41.95	-17.27
4. Agriculture	6 002.03	5 628.81	4 423.38	2 936.83	2 531.32	2 331.76	2 261.71	2 249.97	2 131.15	1 943.96	1 965.59	2 104.88	2 070.93	2 122.09	2 085.53	2 179.19	2 171.49	2 263.30	2 227.95	2 259.52	2 329.57	-61.19
5. Land Use, Land-Use Change and Forestry(5)	-16 011.39	-17 643.52	-18 738.33	-18 344.97	-17 647.78	-16 922.61	-17 954.95	-15 347.70	-14 290.65	-13 763.70	-14 489.41	-14 801.91	-13 800.13	-15 279.10	-16 421.75	-17 367.59	-20 464.58	-21 881.86	-22 928.34	-20 588.74	-17 146.87	7.09
6. Waste	800.92	794.36	714.45	644.95	612.64	607.14	606.50	615.90	627.21	633.23	684.70	714.66	710.33	676.62	697.82	693.20	644.83	656.64	723.05	697.40	666.09	-16.84
7. Other	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)(5)	**10 544.13**	**6 970.51**	**1 045.57**	**-2 397.86**	**-3 659.98**	**-4 320.40**	**-5 329.60**	**-3 279.16**	**-2 744.57**	**-3 003.66**	**-4 251.29**	**-3 991.55**	**-3 042.38**	**-4 316.39**	**-5 294.63**	**-6 120.65**	**-8 801.33**	**-9 706.29**	**-11 203.92**	**-9 626.84**	**-5 069.84**	**-148.08**

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.

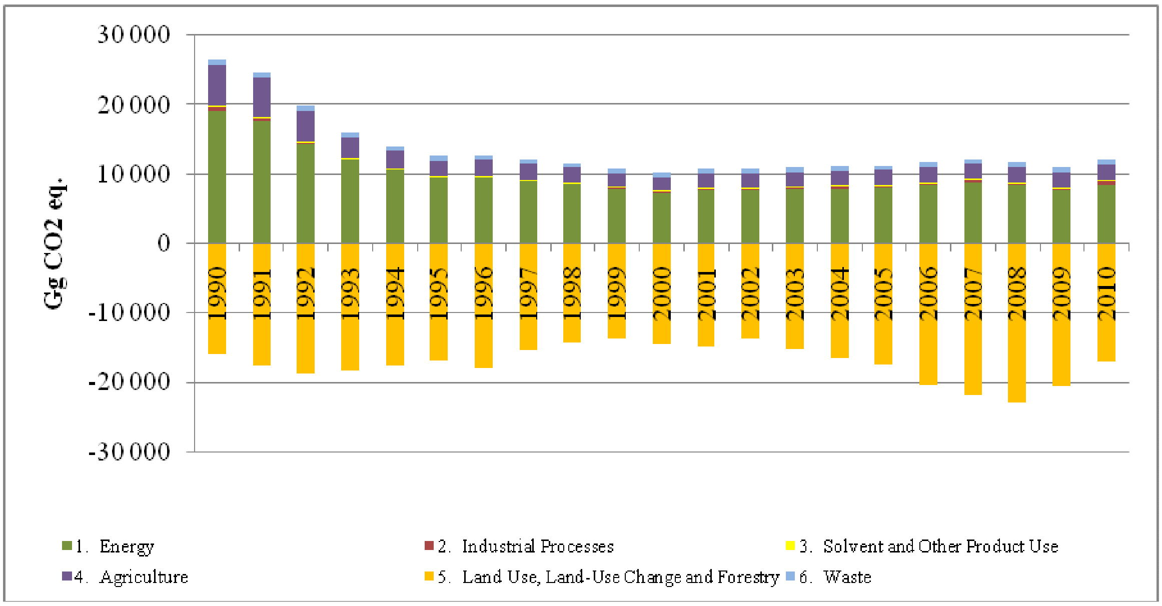


Figure ES.1. Latvian greenhouse gas emission trends by sector, Gg CO_2 eq.

The **Energy sector** is the most significant source of GHG emissions with 69.6% share of the total emissions in the 2010. GHG emissions increased 2009-2010 approximately by 10%. Energy-related emissions vary mainly according to the economic trend, the energy supply structure and climate conditions. Large part of energy sector emissions comes from transport sector.

Agriculture is the second most significant source of GHG emissions, with approximately 19.3 % of Latvia's total emissions. Emissions from agriculture include CH_4 and N_2O emissions. GHG emissions increased in 2010 by 3% compare with 2009. The annual emissions have reduced approximately by 61.2% since 1990 due to decreases in the number of livestock, nitrogen fertilisation and etc.

Emissions from the **Waste sector** consist of CH_4 and N_2O emissions and have been decreased since 1990. In 2010, emissions were approximately 16.8% lower than in 1990. In 2010, emissions from the Waste sector were 666.09 Gg CO_2 equivalents; it contributes about 6 % of total GHG emissions (excluding LULUCF).

The **Industrial Processes** category contributes approximately 5.3% 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. For 2010, despite to economical crisis in 2009, total emissions increased significantly (74.8%) due to overall increasing of activity for industrial production processes.

Solvent and Other Product Use made only about 0.3% 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 17.3% since 1990.

Land use, Land use change and forestry (LULUCF) is a net sink in Latvia. In 2010, CO_2 removals were -17146.87 Gg CO_2 eq compared to -16011.39 Gg CO_2 eq in the base year that is approximately 7.1 % 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(1)				Accounting Parameters	Accounting Quantity
	2008	2009	2010	Total		
A. Article 3.3 activities						
A.1. Afforestation and Reforestation						-1 453.10
A.1.1. Units of land not harvested since the beginning of the commitment period	-440.66	-506.22	-506.22	-1 453.10		-1 453.10
A.1.2. Units of land harvested since the beginning of the commitment period						NA,NO
Harvested lands	NA,NO	NA,NO	NA,NO	NA,NO		NA,NO
A.2. Deforestation	488,23	408,70	359,73	1 256,66		1 256,66
B. Article 3.4 activities						
B.1. Forest Management (if elected)	-23 598,81	-21 102,11	-17 309,08	-62 010,00		-6 233,33
3.3 offset						0.00
FM cap					6 233.33	-6 233.33
B.2. Cropland Management (if elected)	NA	NA	NA	NA	0.00	0.00
B.3. Grazing Land Management (if elected)	NA	NA	NA	NA	0.00	0.00
B.4. Revegetation (if elected)	NA	NA	NA	NA	0.00	0.00

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

	NO_x	CO	NMVOC	SO_2
1990	64,58	455,10	101,48	104,78
1991	59,10	399,73	75,62	85,88
1992	50,03	386,82	70,86	72,87
1993	45,09	384,95	70,98	67,40
1994	42,37	372,01	69,91	67,26
1995	39,13	347,36	67,23	49,09
1996	39,45	354,55	69,80	55,19
1997	38,67	325,74	66,57	42,90
1998	37,76	305,45	64,24	38,49
1999	36,19	290,83	63,83	30,29
2000	35,96	289,21	64,60	16,10
2001	39,04	298,27	68,79	12,52
2002	38,63	287,35	64,73	11,04
2003	38,95	288,21	64,55	8,82
2004	38,64	283,62	109,62	6,77
2005	37,12	282,38	73,28	6,60
2006	37,21	281,34	74,55	5,84
2007	38,16	265,59	83,18	5,66
2008	33,92	248,93	73,64	4,67
2009	31,73	267,56	60,53	4,08
2010	33,44	256,70	64,95	3,15

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 2 239 008 (2010) 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 20^{th} 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. 157 of Cabinet of Ministers (17.02.2009) determinates the institutions that are responsible for GHG inventory preparation. At the moment this act is under development as new determination of responsibilities of institutions is planned.

Ministry of Environmental Protection and Regional Development, Climate Policy and Technology Department coordinate policy related to climate change and renewable energy in Latvia, compile national inventory as well as 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 2010. 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, and more detailed information is in the Standard Electronic Tables (SEF).

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 (including compilation of the final NIR and CRF, approval of QA/QC plan and procedures);
- 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.

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.

For 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.

Before final GHG inventory are reported to European Commission and UNFCCC secretariat it is forwarded to the involved ministries for review and approving. Several meetings (related 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.

Inventory team was met many times during inventory preparation. Responsible institutions were invited to discuss and find solutions for problems identified by ERT.

The detailed responsibilities of the institutions involved in preparing activity data and calculating emissions are summarized in the Table 1.1.

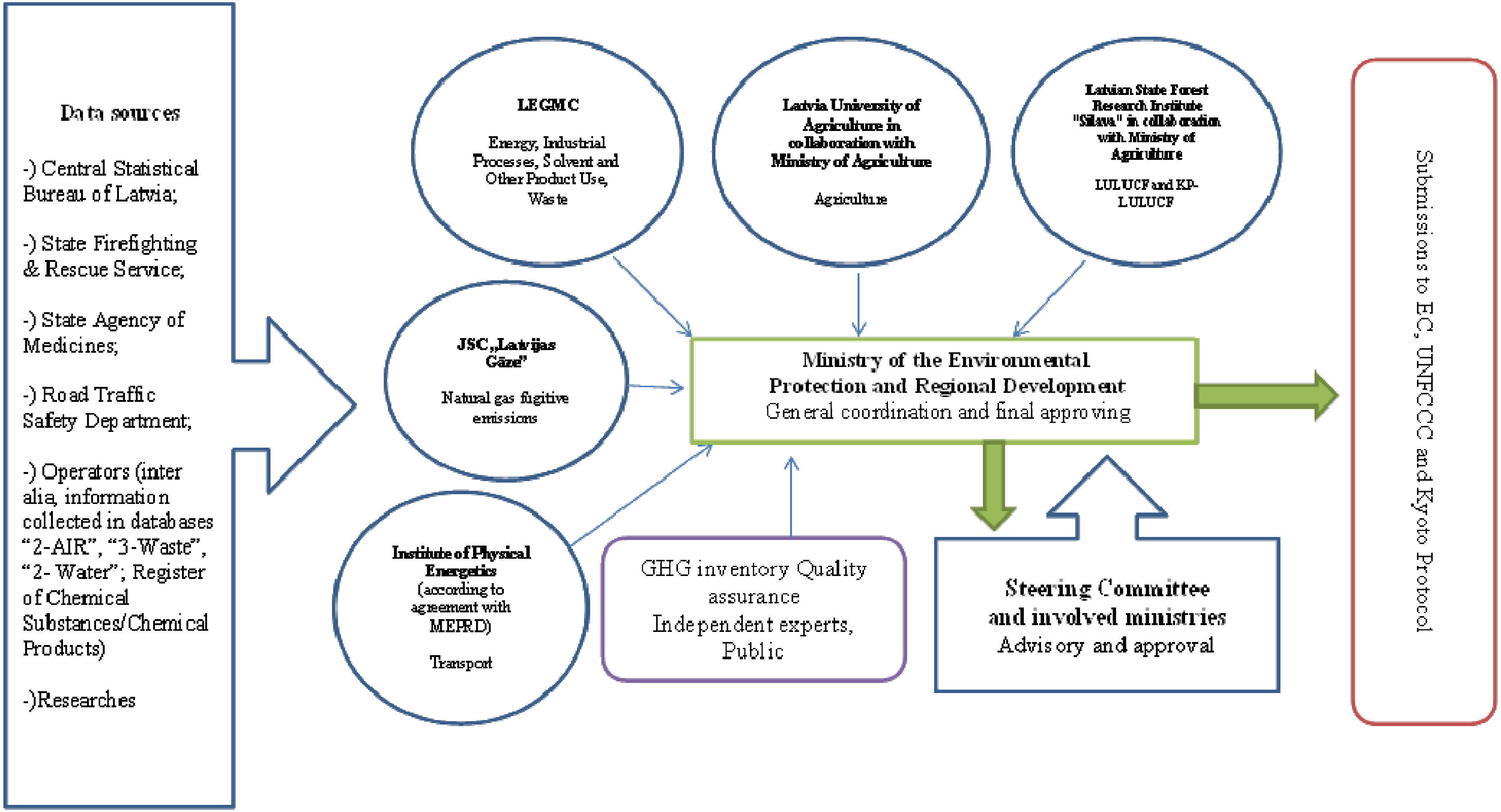


Figure 1.1 The structure of National Inventory System

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"
Table 5.(IV) CO_2 emissions from agricultural lime application	Activity data	CSB
	Calculations	Latvian State Forest Research Institute "Silava"

CRF sectors	Data	Responsible institutions
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 2012 submission contains estimates for the 1990-2010.

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	Latvia University of Agriculture send to MEPRD report about emissions from Agriculture, including information about used assumptions, activity data	till 1st December

Element	Activity	Responsible performers	Procedures	Due date
		with Ministry of Agriculture	which was received from CSB.	
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 updated CRF Reporter version 3.5.2 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 1990–2010.

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 1 method is used to identify key sources for time period 1990-2010. 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 2012, key categories for 2009 and 2010 (Table 1.4) were identified as described in the IPCC GPG 2000 using Tier 1 level and trend assessment taking into account qualitative criteria. Category uncertainty estimates developed under tier 1 uncertainty analysis are incorporated in Tier 1 approach for detemination of key sources.

Table 1.4 Key categories for 2010

IPCC GHG Source and Sink Categories	Direct	Key category	Criteria for identification
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	Yes	L,T, Q
1.A.3.b Road Transportation - Diesel Oil	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,T, 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
5.A.2 Unmanaged Waste Disposal Sites	CH_4	Yes	L,T, Q
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	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.2.f Other - Gaseous Fuels	CO_2	Yes	L,T, Q
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	Yes	L,T, Q
1.A.3.c Railways - Liquid Fuels	CO_2	Yes	L,T, Q
1.A.4.b Residential - Biomass	CH_4	Yes	L,T, Q
1.A.2.f Other - Solid Fuels	CO_2	Yes	L,T, Q
1.A.4.b Residential - Liquid Fuels	CO_2	Yes	L,T, Q
1.A.2.f Other - Liquid Fuels	CO_2	Yes	L,T, Q
4.B.Manure Management	N_2O	Yes	L,T, Q
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	Yes	L,T, Q
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	Yes	L,T, Q
1.A.4.b Residential - Solid Fuels	CO_2	Yes	L,T, Q
6.B.1 Industrial Waste Water	CH_4	Yes	L,T, Q
6.A.1 Managed Waste Disposal on Land	CH_4	Yes	L,T, Q
4.B Manure Management	CH_4	Yes	L,T, Q
2.F(a).1 Refrigeration and Air Conditioning Equipment	HFCs	Yes	L,T, Q
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	Yes	L,T, Q
1.B.2.b Natural Gas	CH_4	Yes	L,T, Q
4.D.2 Pasture, Range and Paddock Manure	N_2O	Yes	L,T, Q
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	Yes	L,T, Q
6.B.2 Domestic and Commercial Waste Water	CH_4	Yes	L,T, Q
1.A.3.b Road Transportation - LPG	CO_2	Yes	L,T, Q
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	Yes	L,T without LULUCF, Q
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	Yes	L,T without

			LULUCF, Q
6.B.2 Domestic and Commercial Waste Water	N_2O	Yes	L,T without LULUCF, Q
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	Yes	L,T without LULUCF, Q
5.A.1 Forest Land remaining Forest Land	CO_2	Yes	L, T, Q
5.A.2 Land converted to Forest Land	CO_2	Yes	L, T, Q
5.B.2 Land converted to Cropland	CO_2	Yes	L,T, Q
5.B.1 Cropland remaining Cropland	CO_2	Yes	L,T, Q
5.E.2 Land converted to Settlements	CO_2	Yes	L,T, Q
5.A.1 Forest Land remaining Forest Land	N_2O	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.

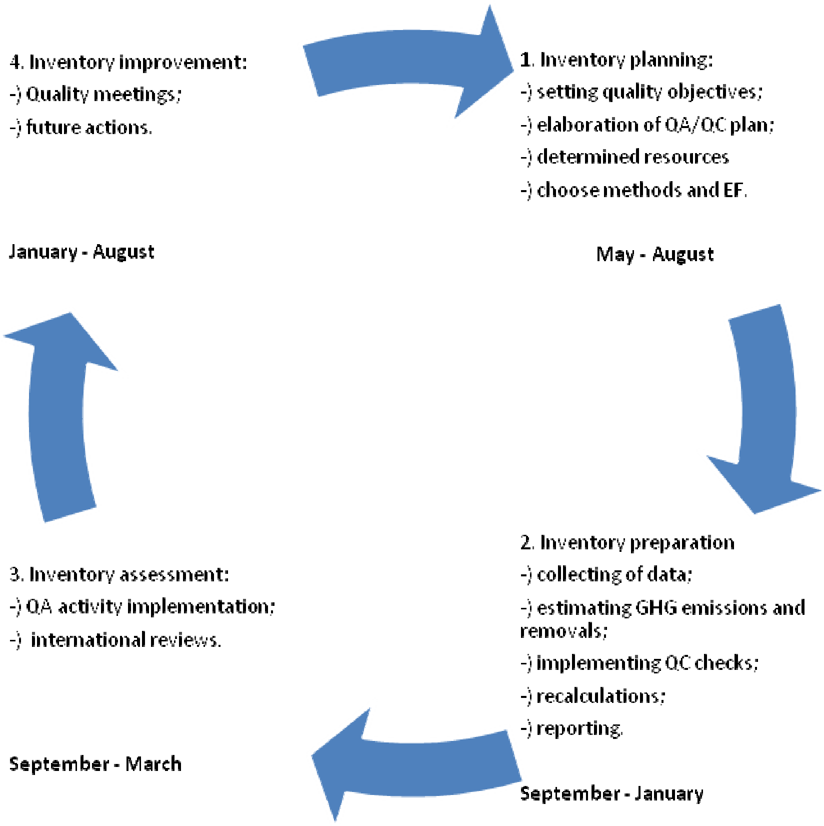
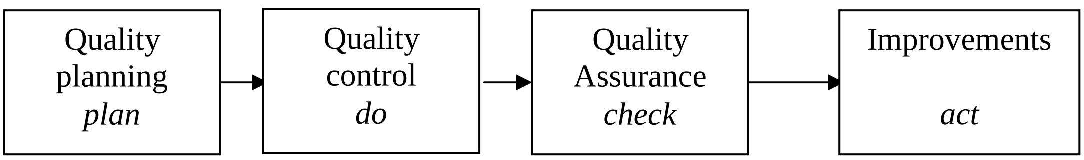


Figure 1.2 Inventory process

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 2012 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 2012, 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).

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.

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 2012:

-) 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. NIC prepared NIR according to UNFCCC reporting guidelines. Sectoral experts before sending NIR to NIC checked if all information is consistent with CRF. It is checked if recalculations and methodological changes are explained in NIR.

-) Expert in LEGMC prepared quality control procedures according to the IPCC GPG 2000 Tier 1 method for Industrial Processes. All findings were documented by using check-lists and introduced in GHG inventory. All corrections are archived.

-) 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.

-) For Agriculture sector quality control check was done by MEPRD, CSB and MoA. Findings were documented and introduced in the emission evaluation as well as in NIR. The general findings following:

- Wrong Fraction of Nitrogen in crop for buckwheat, mixed cereals and pulses for 1990 – 2009 were used.

-) For Transport sector 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.

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 complex projects have to be described in detail;
- All quality indicators have to be described;

[2] Central Statistical Bureau Quality Guidelines (http://www.csb.gov.lv/csp/content/?lng=en&cat=4164)

- 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.

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:

- Principles of revision policy of Macroeconomical statistics are available in the CSB website.
- Database of Macroeconomic statistics data revision analysis established.
- Common data revision policy is under development.

Detailed source specific QA/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.

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.

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

- Survey and calculations documentation system;
- Quality indicators documentation system;

- Thesaurus;
- 2 sub systems – internal & external.

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 on the hard disks of the individual expert's desktops.

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

All information (including corresponding letters) used for inventory compilation are collected on the special server and the backup of data are made periodically.

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 2012 has been done according to the Tier 2 method presented by the IPCC GPG 2000. The Tier 2 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.

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.

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).

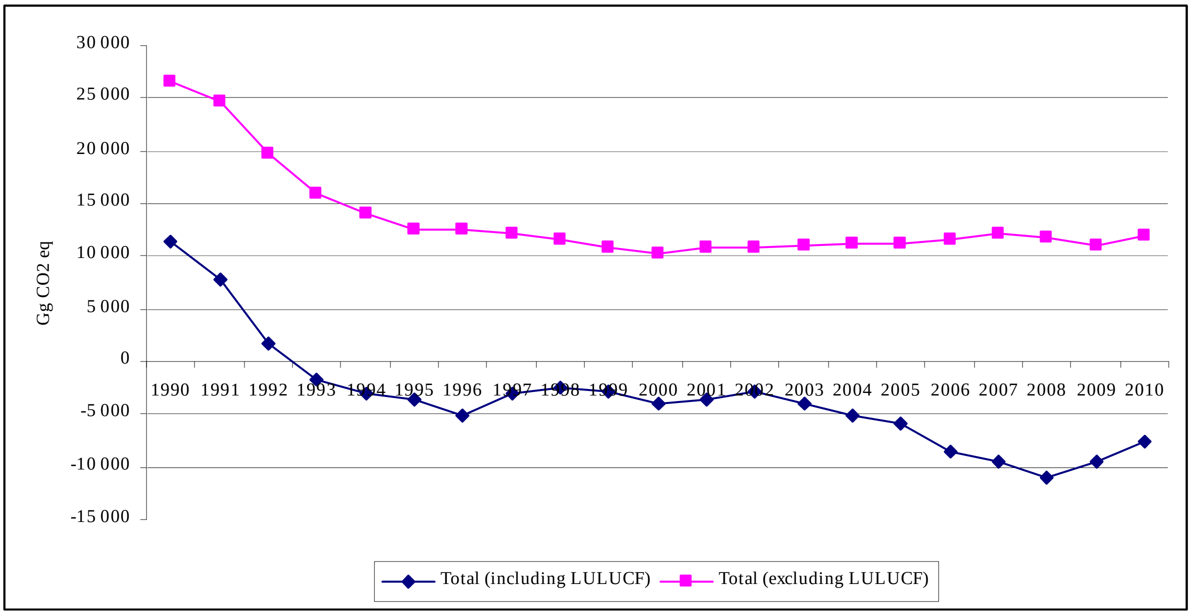


Figure 2.1 Latvia's aggregated greenhouse gas emissions in 1990-2010 (Gg CO_2 eq)

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 2010, CO_2 emissions contribute 70.3% of Latvia's total greenhouse gas emissions. In 2010, total CO_2 emissions had decreased by approximately 55.5% since 1990.

The most important source of CO_2 emissions (Gg) in 2010 was fossil fuel combustion – 93.5%, including Energy Industries – 28.4%; Manufacturing Industries and Construction – 13.3%; Transport – 40%, Other sectors (Agriculture, Forestry, etc.) – 18.3%.

Other anthropogenic emission sources of CO_2 are Industrial Processes – 6.1%, 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 2010, LULUCF in Latvia removed -19710.9 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 2010 contribute approximately 14.4% of total GHG emissions (excluding LULUCF). The methane emissions (Gg) decreased by 53% in 2010 since 1990.

Agricultural soils are the main source of N_2O emission in Latvia generating 89.5% of all N_2O emissions (Gg) in 2010. 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 2010, mainly due the decrease in the emissions from agriculture.

Emissions from HFCs and sulphur hexafluoride (SF_6) consumption are reported for the period 1995-2010. Total HFCs emissions (Gg CO_2 eq) increased in 2010 compared with 2009. SF_6 emissions from electrical equipment are reported and contribute 12.25 Gg CO_2 eq in 2010.

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.

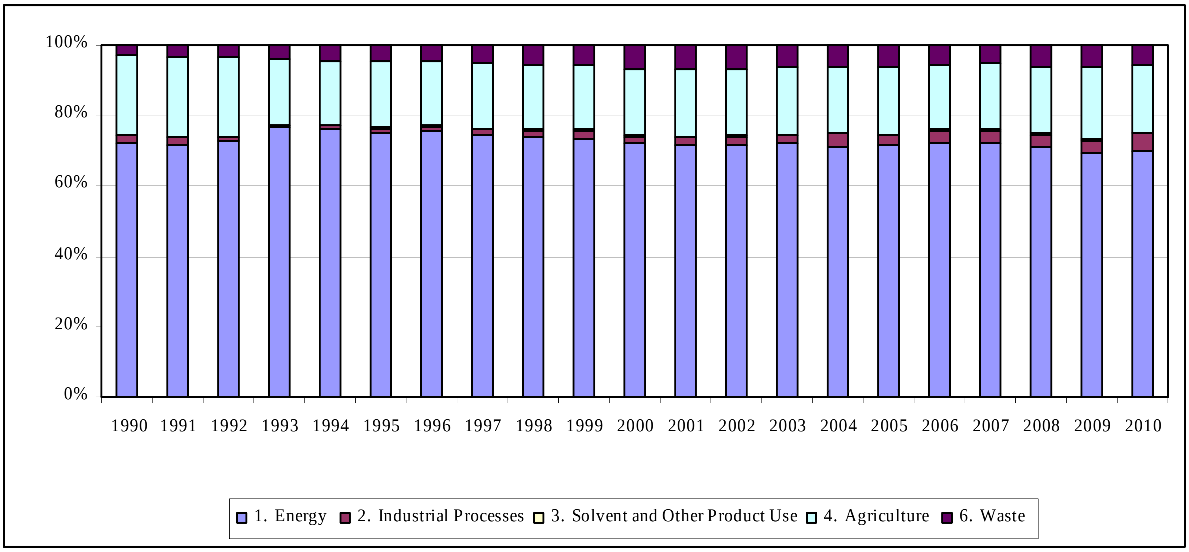


Figure 2.2 Latvia's greenhouse gas emissions by source 1990–2010 excluding LULUCF

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.

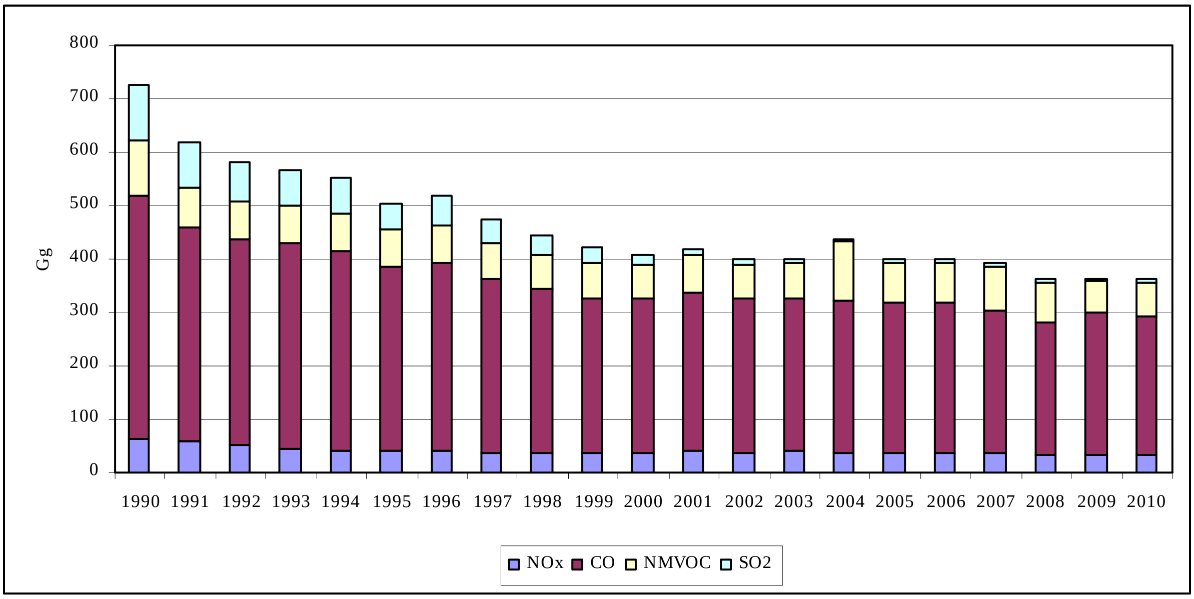


Figure 2.3 Total indirect greenhouse gas emissions trend 1990-2010 (Gg)

In 2010, the **sulphur dioxide emissions** were 3.15 Gg from which 95% originated in the Energy sector and 5% from Industrial Processes.

Nitrogen oxides were generated generally in the Energy sector 88.9% and 9.6% in the Industrial Processes. In 2010, the total emissions were 33.45 Gg. The Transport sector was responsible for 56% of the total emissions.

In 2010, **Carbon monoxide** emissions were 256.7 Gg, originated generally in the Energy sector (94%).

In 2010, total emissions of **non-methane volatile organic compounds** were 64.95 Gg from which Energy sector generated 55.8%, Solvent and Other Product Use approximately 20%, but Industrial Processes 24%.

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.

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, power plant (CHP) 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 35.6% in 2010, including heavy fuel – residual fuel oil and shale oil, with about 0.88% although the residual fuel oil consumption in 1990 was 20.75% from total fuel consumption in country. 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.

Table 3.1 Consumption of energy resources in Latvia (TJ)[3,4]

	1990	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Energy consumption – total	304109	173147	147390	172334	180438	184143	176540	165332	181501
Shale oil		79	2440	157	118	118	79	39	39
Liquefied petroleum gas	3689	1548	2140	2550	2687	2414	2186	2003	2103
Gasoline and aviation gasoline	26796	18128	14831	15126	16753	18299	16672	13941	12667
Jet kerosene	3067	1166	1123	2463	2852	3414	4105	4297	4926
Other kerosene	648	432	43						
Diesel oil (including gasoil)	43000	17166	20693	32887	36371	41343	39133	36500	38994
Residual fuel oil	63092	36134	9460	3167	2152	1624	1096	1421	1069
White spirits	84	84	126	126	126	84	84	42	40
Lubricants	1633	963	879	1088	1088	1088	1047	628	586
Bitumen	1633	712	2009	2512	3098	3349	3600	2218	1967
Paraffin waxes			126	335	251	251	209	293	461
Petroleum coke				429	627	132		165	627
Other liquids	2637	712	2553	209	1088	963	795	711	1005
Used oils	879			848	263	234	263	117	95
Coal	26098	7172	2761	3146	3409	4248	4248	3409	4378
Peat	3286	3838	2452	80	70	90	90	30	100
Peat briquettes	867	403	31			1	1	6	6
Coke	290	211	290	188	161	107	134	134	80
Oil shale	28								
Natural gas	99653	42279	45635	56852	58892	56922	55814	51381	61313
Wood and wood products:	27581	42102	39695	49396	49748	48706	46018	52591	51354
firewood				34351	34257	33808	32696	36354	33993
wood remains				8421	8102	7011	6129	7687	7829
wood chips				6134	6934	7361	6667	8112	8596
wood briquettes				221	221	238	238	204	374
wood pellets				270	234	288	288	234	562
Charcoal				60	30	45	60	60	60

[3] CSB. Annual Eurostat Energy Questionnaire, 2011

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

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Used tires				183	131	210	210	26	105
Municipal wastes								62	1076
Bioethanol					43		1	108	350
Biodiesel				107	60	73	82	73	808
Landfill gas				246	230	224	277	293	421
Sewage sludge gas				95	87	92	92	115	137
Straws					11	16	14	29	60

Total share of solid fuels in national market is quite low – approximately 2.51%. The solid fuel consumption in last years is stable still consumption had decreased by 85.1% since 1990. From 2009 to 2010 solid fuel consumption had increased by 28% that is explained with an increase of coal and peat consumption.

Natural gas consumption has a stable place in total fuel consumption when natural gas consumption is 32.49% in 1990 and 33.8% in 2010. Natural gas consumption decreased by 37.9% in 1990-2010. Still in last four years natural gas consumption had increasing tendency – from 2009 to 2010 even by 19%.

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 28.3% in 2010 by the side of 1990 when firewood consumption was only about 9.07% from total energy consumption.

In latest years liquid and gaseous biofuels are becoming more popular when in 2010 these biofuels consumption is 0.98% in comparison with 0.22% in 2007. In latest years also such biomass fuels as straws are used.

Hydroelectric power plants (HPP) and CHPs produce part of the electrical power, while part is imported (Table 3.2). 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 and heat production and consumption in Latvia (TJ)[5]

	Electricity								Heat				
	Production	Own use and losses	Import	Export	Final consumption				Production	Own use and losses	Final consumption		
					CRF 1.A.2.	CRF 1 A.3.	CRF 1.A.4.	TOTAL			CRF 1.A.2	CRF 1.A.4	TOTAL
1990	16 186	6 883	25 700	12 798	11 484	918	17 550	29 952	99 439	15 171	32 929	51 339	84 268
1991	11 790	6 682	15 217	7	10 807	785	17 255	28 847	96 120	16 096	33 394	46 630	80 024
1992	9 076	5 645	14 688	7	8 316	745	13 777	22 838	75 442	10 953	22 632	41 857	64 489
1993	10 350	6 102	9 619	612	5 440	688	10 904	17 032	54 846	9 954	7 154	37 738	44 892
1994	11 898	6 681	9 533	2 988	5 076	670	10 102	15 848	46 822	7 330	1 998	37 494	39 492
1995	10 573	6 372	9 529	1 408	5 130	677	10 267	16 074	46 112	8 215	1 969	35 928	37 897
1996	6 700	7 989	12 377	760	4 975	641	9 266	14 882	47 137	8 838	2 046	36 253	38 299
1997	10 634	7 694	6 566	4	5 519	634	8 935	15 088	45 721	8 317	1 976	35 428	37 404
1998	15 545	6 559	3 290	1 382	5 296	612	10 310	16 218	42 872	8 950	1 940	31 982	33 922
1999	9 932	5 774	9 349	2 311	5 130	554	10 375	16 059	36 191	8 115	1 162	26 914	28 076
2000	10 163	5 202	7 589	1 159	5 159	547	10 411	16 117	31 867	6 815	659	24 393	25 052
2001	10 210	5 688	8 424	1 645	5 562	623	10 314	16 499	33 937	7 038	641	26 258	26 899
2002	8 906	5 188	10 217	1 764	5 494	518	11 563	17 575	33 048	6 541	630	25 877	26 507
2003	8 330	5 065	9 616	137	5 778	490	12 456	18 724	33 516	6 409	626	26 481	27 107
2004	11 369	4 975	9 839	2 290	5 882	500	13 072	19 454	31 093	6 174	608	24 311	24 919
2005	12 139	4 767	10 278	2 545	6 120	533	13 972	20 625	31 144	5 886	684	24 574	25 258
2006	9 878	4 522	10 116	1 087	6 332	540	15 242	22 114	30 056	5 454	634	23 968	24 602
2007	10 030	4 194	17 870	7 070	6 538	504	16 740	23 782	28 685	4 911	554	23 220	23 774
2008	11 405	4 198	16 715	7 643	6 127	497	17 237	23 861	26 402	4 010	349	22 043	22 392
2009	12 625	4 032	15 333	9 378	5 421	436	16 114	21 971	26 308	4 063	298	21 947	22 245
2010	12 848	4 626	14 303	11 160	5 724	453	16 197	22 374	28 662	4 414	387	23 861	24 248

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

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 69.6 % share of the total emissions in the 2010.

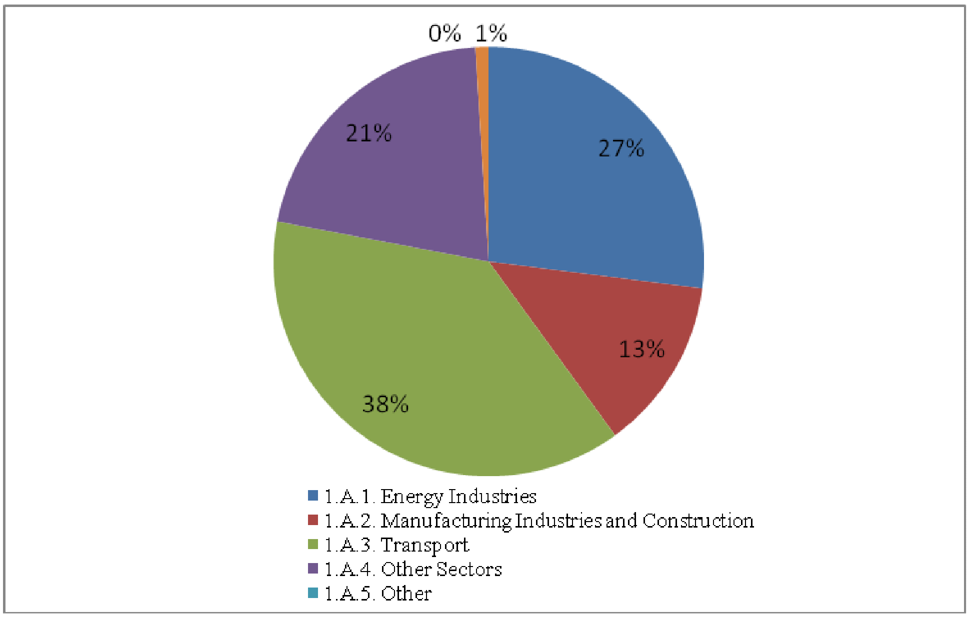


Figure 3.1 Emissions from the Energy sector in 2010

Biggest part of GHG emissions in Energy sector consists of Transport sector with 38% of total Energy sector's GHG emissions (Figure 3.1). Energy Industries and Other sectors make 2nd and 3rd place with 27% and 21% of total Energy sector's GHG emissions.

Table 3.3 GHG emissions from Energy sector in 1990–2010 (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, SF_6	CH_4
	Gg			Gg CO2 equivalent	Gg
1990	18408.26	12.52	0.51	18828.94	13.05
1991	16897.00	13.89	0.50	17344.34	12.57
1992	13701.25	12.61	0.45	14104.57	11.46
1993	11611.28	13.23	0.39	12010.16	10.96
1994	10041.92	13.08	0.37	10431.69	10.71
1995	8840.90	13.53	0.38	9242.58	10.43
1996	8914.15	13.90	0.39	9326.13	10.05
1997	8380.88	13.19	0.39	8777.93	9.38
1998	7996.34	12.31	0.37	8369.76	9.00
1999	7374.24	12.02	0.35	7734.61	8.58
2000	6852.76	11.34	0.34	7196.52	7.94
2001	7193.79	12.51	0.37	7570.34	7.70
2002	7173.97	12.22	0.37	7546.37	8.03
2003	7360.99	12.76	0.40	7753.34	6.28
2004	7378.68	13.11	0.42	7784.02	6.21
2005	7494.90	13.09	0.42	7900.65	6.94
2006	7931.02	12.75	0.41	8326.80	5.04
2007	8263.26	12.70	0.42	8661.40	5.16
2008	7852.57	11.74	0.40	8223.90	5.30
2009	7113.99	12.84	0.40	7507.28	5.02
2010	7921.30	12.16	0.40	8299.24	4.83

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 3.3).

GHG emissions from the Energy sector in the latest years were stable with a peak point in 2007 (since 2000) that is explained with sharp increase of national economy (Figure 3.2). GHG emissions in 2000-2007 have increased by 19.1% in the Energy sector. In the second half of 2008 recession in national economy already started caused by the crisis. That's why all GHG emissions decreased in 2007-2008 by 4.96% and by 8.67% in 2008-2009. In 2010, total GHG emissions again increased by 10.35% compared with 2009 as consumption of fuel increased too.

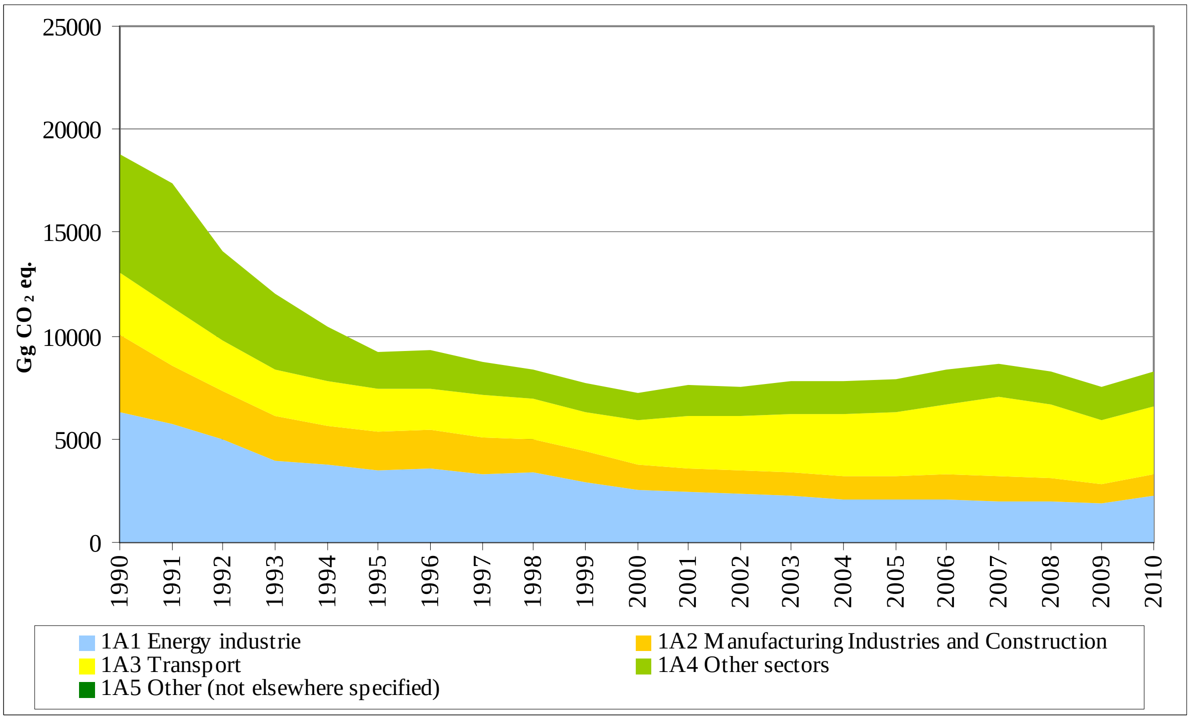


Figure 3.2 GHG emissions from Energy sector 1990–2010 (Gg CO_2 eq)

The sharp decrease in 2008-2009 is also explained with the crisis in national economy caused by global financial crisis. The winter in 2009 was quite warm with 0.7°C above normal therefore in 2009 GHG aggregated emissions in CRF 1.A.1 just a little less than in 2008 – 2.67%, but in 2010 in the all Energy sectors increase of emissions are observed.

The decrease of industrial production was influenced by economical situation when development of national economy was made of development of financial and real estate sectors but import dominated over export. Increase of cost and price as well as total inflation led to total decrease of industry. Therefore the GHG emissions from CRF 1.A.2 sector had decreased by 20.93% in 2008-2009, but for 2010 emissions increased by 20.62% as fuel consumption increased.

For Transport sector (1.A.3) emissions decreased from 2008 to 2009 by 12.3% 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 2.5% comparing to 2009.

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

In 2010, the largest part of indirect emissions contributes CO then NMVOC and NO_x emissions (Figure 3.3). Most CO and NMVOC emissions come from wood combustion in the Residential sector.

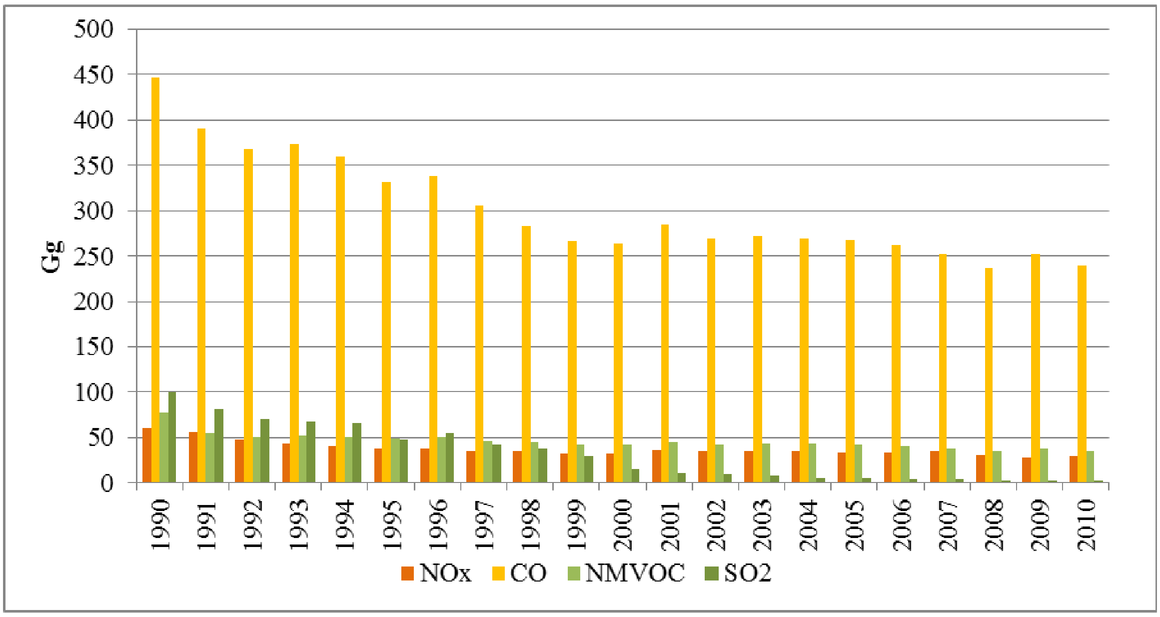


Figure 3.3 Total indirect GHG emissions from fuel combustion in 1990–2010 (Gg)

The biggest decrease is observed in SO_2 emissions where emissions decreased from 100.18 Gg in 1990 to 2.99 Gg emissions in 2010. 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.

Key categories

Key categories reported in the Table 3.4 are estimated without taking into account LULUCF sector by using Tier1 estimation level.

Table 3.4 Key categories in fuel combustion sector in 2010

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

IPCC GHG Source and Sink Categories (LULUCF not included)	Gas	
1.A.4.b Residential - Biomass	N_2O	T
1.A.4.b Residential - Gaseous Fuels	CO_2	L, T
1.A.4.b Residential - Liquid Fuels	CO_2	L
1.A.4.b Residential - Solid Fuels	CO_2	L, T
1.A.4.b Residential - Solid Fuels	CH_4	T
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	L, T
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	L
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	T
1.B.2.b Natural Gas	CH_4	L

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 3.5.

Table 3.5 Reported emissions from fuel combustion in Latvia in 2010

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	√	√	√	√	√	√	√
	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	√	√	√	√	√	√	√
	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								

Source	Fuel Type	Emissions						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	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	√	√	√	√	√	√	√
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

Source	Fuel Type	Emissions						
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
	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 7921.30 Gg (including Transport sector) in 2010 and accounted 93.5% of the total CO_2 emissions (Table 3.6).

CH_4 emissions from fuel combustion were 12.18 Gg (including Transport sector) in 2010 that makes 14.7% from total CH_4 emissions. The biggest part of CH_4 emissions contributes Other sectors – 11.35 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 0.40 Gg (including Transport sector) and accounted 7.1% of the total N_2O emissions in 2010.

Table 3.6 GHG emissions from fuel combustion in 1990–2010 (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	18828.94	6287.54	3755.98	2995.67	5789.75	NO	12.52	0.51
1991	17344.34	5765.89	2813.64	2807.94	5956.87	NO	13.89	0.50
1992	14104.57	4941.27	2376.82	2500.42	4286.05	NO	12.61	0.45
1993	12010.16	3986.81	2108.12	2291.16	3624.08	NO	13.23	0.39
1994	10431.69	3749.42	1909.86	2171.89	2600.51	NO	13.08	0.37
1995	9242.58	3434.02	1876.65	2070.17	1855.56	6.18	13.53	0.38
1996	9326.13	3567.00	1837.59	2036.06	1882.20	3.28	13.90	0.39
1997	8777.93	3324.49	1791.62	2029.19	1620.18	12.45	13.19	0.39
1998	8369.76	3368.71	1570.64	2002.35	1424.78	3.28	12.31	0.37
1999	7734.61	2940.21	1431.97	1952.25	1400.76	9.42	12.02	0.35
2000	7196.52	2489.94	1233.66	2165.31	1307.46	0.14	11.34	0.34
2001	7570.34	2432.64	1099.99	2560.24	1477.30	0.17	12.51	0.37
2002	7546.37	2328.13	1131.61	2640.83	1439.02	6.79	12.22	0.37
2003	7753.34	2260.27	1138.19	2790.04	1558.48	6.36	12.76	0.40
2004	7784.02	2070.04	1152.78	2930.70	1618.97	11.53	13.11	0.42
2005	7900.65	2058.68	1177.96	3055.92	1600.45	7.64	13.09	0.42
2006	8326.80	2085.41	1221.00	3360.24	1651.24	8.93	12.75	0.41
2007	8661.40	1955.82	1237.68	3800.02	1665.03	2.84	12.70	0.42
2008	8223.90	1928.29	1139.58	3588.82	1563.79	3.42	11.74	0.40
2009	7507.28	1876.84	901.04	3147.06	1580.05	2.29	12.84	0.40
2010	8299.24	2260.52	1086.92	3221.52	1729.06	1.22	12.16	0.40
Share of total 2010 GHG emissions	68.719%	18.717%	9.000%	26.675%	14.317%	0.010%	14.71%	7.03%

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 1990-2010 prepared for EUROSTAT[6] (Table 3.7).

Difference between CO_2 emissions estimated with RA and SA for liquid fuels is quite high from 3.3% in 1995 to -19.88% in 2000. Difference for solid fuels is smaller than for liquid fuels still it varies from -1.10% in 2010 to 7.72% 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 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 2008-2010.

Table 3.7 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

[6] EUROSTAT Annual Questionnaire by CSB, 2011

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
SA	139.23	123.90	103.88	96.84	91.06	74.30	80.17	68.86	67.72	63.21	52.85
Diff.	0.97	-0.71	0.17	-0.38	2.16	3.58	-0.70	-2.25	-2.04	-12.85	-14.97
CO_2 emissions - Liquid fuels											
RA	10378.85	9064.89	7664.84	7105.21	6877.38	5674.72	5890.10	4955.33	4877.66	4075.56	3076.63
SA	10296.26	9152.19	7670.40	7150.49	6748.47	5493.37	5946.31	5082.69	4990.97	4637.05	3840.06
Diff.	0.80	-0.95	-0.07	-0.63	1.91	3.30	-0.95	-2.51	-2.27	-12.11	-19.88
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	2579.26	1863.57	2285.05	1967.26	2404.35	2357.10	2252.10	2490.76
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.	NO	NO	NO	NO	NO	NO	NO	NO	NO	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.	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00	0.00

Continuation of Table 3.7

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
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
SA	52.82	52.73	54.26	55.62	55.45	60.13	65.17	60.28	54.95	56.55
Diff.	-8.52	-15.06	-10.05	-7.74	-8.81	-9.55	-8.42	-7.20	-14.34	-13.30
CO_2 emissions - Liquid fuels										
RA	3501.71	3242.35	3550.43	3700.49	3605.29	3930.07	4304.63	4031.61	3400.11	3344.43
SA	3820.14	3811.78	3933.72	4035.89	4032.05	4342.90	4706.50	4354.99	3974.28	4100.18
Diff.	-8.34	-14.94	-9.74	-8.31	-10.58	-9.51	-8.54	-7.43	-14.45	-18.43
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
SA	5.17	4.18	3.48	2.84	3.41	3.64	4.45	4.41	3.57	4.51
Diff.	0.00	0.00	6.93	0.35	0.00	0.00	-0.02	1.48	-0.73	-1.01
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
SA	463.14	373.89	327.85	261.31	314.49	335.32	410.28	405.98	328.38	415.32
Diff.	0.10	0.07	7.72	0.47	0.07	0.07	0.05	1.67	-0.74	-1.10
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
SA	52.37	53.58	55.68	55.33	56.77	58.72	56.69	55.56	50.85	61.00
Diff.	1.72	1.05	1.31	0.96	0.28	0.44	0.58	0.60	1.26	0.50
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
SA	2890.22	2960.84	3075.34	3055.50	3133.83	3242.39	3129.81	3066.90	2807.00	3371.99

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Diff.	1.78	1.12	1.38	1.02	0.35	0.51	0.64	0.67	1.33	0.94
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
SA	0.25	0.33	0.29	0.31	0.18	0.13	0.21	0.37	0.08	0.94
Diff.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.53
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
SA	20.29	27.46	24.08	25.99	14.53	10.40	16.67	24.71	4.33	33.81
Diff.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	1.46

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.

CSB estimate total consumption data by taking into account production, import, export and international bunkering data. 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.

Statistical difference for liquid fuels occurs due to national circumstances. For liquid fuels especially diesel oil, gasoline and residual fuel oil there is a common situation with the so-called black market and illegal trade – that means that some amount of diesel oil is just bought in neighbourhood countries and then transferred (by illegal pipeline constructions, by tanks built-in in trucks) to Latvia by passing any custom and control institutions. There is a common situation that illegal port is made to oil transportation pipelines (these pipelines are used to transport oil products from neighbourhood countries to our harbours in transit). This illegal amount of diesel is sold to some other companies that report the amount as combusted amount. It means that company report the consumed amount of diesel oil but the company isn't responsible is or isn't this amount of diesel imported in legal way.

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.

For several fuels NCV changes one time 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 was 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 3.8).

Table 3.8 Carbon emission factors (t/TJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
gasoline	18.89318	18.89318	18.89318	18.89318	18.89318	18.89318	18.89318	18.89318	18.89318	18.89318	18.89318
diesel oil	20.40009	20.40009	20.40009	20.40009	20.40009	20.40009	20.40009	20.40009	20.40009	20.40009	20.40009
RFO	21.1133	21.1133	21.1133	21.1133	21.1133	21.1133	21.1133	21.1133	21.1133	21.1133	21.1133
LPG	17.1256	17.1256	17.1256	17.1256	17.1256	17.1256	17.1256	17.1256	17.1256	17.1256	17.1256
jet	19.71759	19.71759	19.71759	19.71759	19.71759	19.71759	19.71759	19.71759	19.71759	19.71759	19.71759

[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
kerosene											
other kerosene	19.71528	19.71528	19.71528	19.71528	19.71528	19.71528	19.71528	19.71528	19.71528	19.71528	19.71528
other oil	20.01194	20.633	20.633	20.633	20.01194	20.12154	20.01194	20.01194	20.01194	20.20355	20.65183
shale oil	NO	NO	NO	NO	NO	21.04701	NO	NO	NO	21.04701	21.04701
bitumen	22	22	22	22	22	22	22	22	22	22	22
lubricants	20.01194	20.01194	20.01194	20.01194	20.01194	20.01194	20.01194	20.01194	20.01194	20.01194	20.01194
petroleum coke	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
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	22
used oils	20.01297	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
white spirit	20	20	20	20	20	20	20	20	20	20	20
coal	23.65425	23.65425	23.65425	23.65425	23.65425	23.65425	23.65425	23.65425	23.65425	23.65425	23.65425
lignite	23.65425	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
coke	24.22071	24.22071	24.22071	24.22071	24.22071	24.22071	24.22071	24.22071	24.22071	24.22071	24.22071
peat briquettes	NO	26.4729	26.4729	26.4729	26.4729	NO	NO	NO	26.4729	26.4729	NO
peat	28.92537	28.92537	28.92537	28.92537	28.92537	28.92537	28.92537	28.92537	28.92537	28.92537	28.92537
natural gas	15.17313	15.17313	15.32126	15.32052	15.19028	15.16683	15.15835	15.14573	15.15061	15.1206	15.15705
solid biomass	30.01493	30.01493	30.01493	30.01493	30.01493	30.01493	30.01493	30.01493	30.01493	30.01493	30.01493
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	23.0303	23.0303
municipal wastes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Continuation of Table 3.8

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
gasoline	18.89318	18.89318	18.90607	18.90607	18.90607	18.90607	18.90607	18.90607	18.90607	18.90607
diesel oil	20.40009	20.40009	20.40009	20.40009	20.40009	20.40009	20.40009	20.40009	20.40009	20.40009
RFO	21.1133	21.1133	21.1133	21.1133	21.1133	21.1133	21.1133	21.1133	21.1133	21.1133
LPG	17.1256	17.1256	17.1256	17.1256	17.1256	17.1256	17.1256	17.1256	17.1256	17.1256
jet kerosene	19.71759	19.71759	19.71303	19.71303	19.71303	19.71303	19.71303	19.71303	19.71303	19.71303
other kerosene	19.71528	19.71528	19.71528	19.71072	19.71072	19.71072	19.71072	19.71072	NO	NO
other oil	20.43171	20.29951	21.88749	22.62709	26.22155	21.66951	21.65943	22.1029	22.1029	22.1029
shale oil	21.04701	21.04701	21.04701	21.04701	21.04701	21.04701	21.04701	21.04701	21.04701	21.04701
bitumen	22	22	22	22	22	22	22	22	22	22
lubricants	20.01194	20.01194	20.01194	20.01194	20.01194	20.01194	20.01194	20.01194	20.01194	20.01194
petroleum coke	NO	27.5	27.5	27.5	27.5	27.5	27.5	NO	27.5	27.5
gasoline type jet fuel	NO	NO	NO	NO	19.352	19.352	19.352	NO	NO	NO
paraffin waxes	22	22	22	22	22	22	22	22	22	22
used oils	20.01297	20.01297	20.01297	20.01297	20.01297	20.01297	20.01297	20.01297	20.01297	20.01297
white spirit	20	20	20	20	20	20	20	20	20	20
coal	23.65425	23.65425	25.67506	25.67506	25.67506	25.67506	25.67506	25.67506	25.67506	25.67506
lignite	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
coke	24.22071	23.84099	23.84099	23.84099	23.84099	23.84099	23.84099	23.84099	23.84099	23.84099
peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
peat	28.92537	28.92537	28.92537	28.92537	28.92537	28.92537	28.92537	28.92537	NO	NO
natural gas	15.13616	15.15486	15.14796	15.14597	15.13915	15.14376	15.14212	15.13966	15.14063	15.14063
solid biomass	30.01493	30.01493	30.01493	30.01536	30.01536	30.01536	30.01536	30.01536	30.01536	30.01536
biogas	NO	14.91945	14.92006	14.74978	14.77301	14.402	14.77301	14.62456	14.62456	14.62456

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
liquid biofuels	NO	NO	NO	NO	19.3	19.3	19.3	19.3	19.3	19.3
industrial wastes	23.0303	23.0303	23.0303	23.0303	21.65455	21.65455	21.65455	23.1979	23.1979	16.6249
municipal wastes	NO	NO	NO	NO	NO	NO	NO	12.05227	12.31401	8.893724

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.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level. There are three such issues:

- Other Oil – carbon EF in 2004 is 22.63 (t/TJ) but in 2005 – 26.22 (t/TJ) – 15.89% diff.;
- Other Oil – carbon EF in 2005 is 26.22 (t/TJ) but in 2006 – 21.67 (t/TJ) – 17.36% diff.;
- Municipal Wastes – carbon EF in 2008 is 23.25 (t/TJ) but in 2009 – 27.81 (t/TJ) – 19.59% diff

In 2005 if comparing with neighbourhood years structure of other liquid fuels changed therefore average NCV in 2005 was lower (more light liquid fuels were used). That's why estimated CO_2 EF and estimated carbon emission factor increased in 2005.

Municipal wastes structure also influenced carbon emission factor change in 2008-2010.

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.
- By performing the consistency check for the IEF estimated in CRF Reporter and additionally verifying all changes that are higher than 10%.

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 account that ports in Latvia are focused on transit cargotransport, activities have big fluctuations and it depends from economical activities in neighbour countries and international trading activities. While emissions from aviation are stable and in last five years there can see stable increase. Total GHG emissions of International Bunkering are shown in the Figure 3.4.

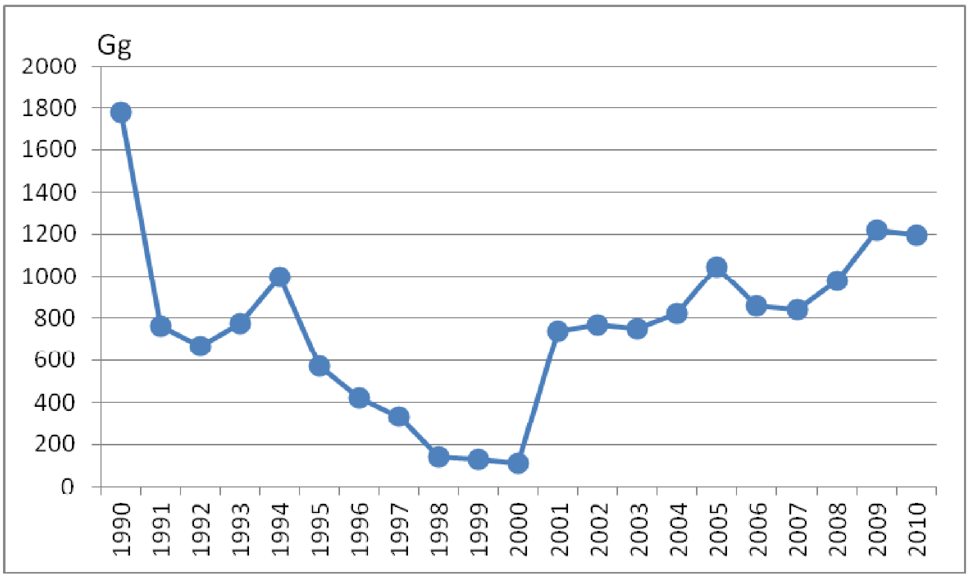


Figure 3.4 Emissions from International Bunkers (Gg CO_2 eq.)

Fuel consumption is obtained from CSB (Table 3.9).

Table 3.9 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

The emission factors are shown in Table 3.10

Table 3.10 Emission factors used in the calculation of emissions from International Bunkering

[8] CSB. Annual Eurostat Energy Questionnaire, 2009

	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

EMEP/CORINAIR 2009 Tier2 approach has been applied for emission calculation of jet kerosene in international aviation. Using Tier 2 approach, emissions for LTO (landing/take off) and cruise are calculated individually. Default EFs of LTO and cruise (jet kerosene) is used (EMEP/ CORINAIR 2009).

The SO_2 emissions factors are used consistent with sulphur content in diesel oil and RFO (see Table 3.11 and Table 3.12).

Table 3.11 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)
1990-1998	0.2	42.49	0.094
1999-2003	0.05	42.49	0.024
2004-2010	0.035	42.49	0.016

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

RFO	Fuel content	NCV	EF (Gg/PJ)
1990-1999	2.8	40.6	1.352
2000-2010	0.2	40.6	0.097

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 1990–2010.

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 3.13).

Table 3.13 Activity data for Feedstock's and non-energy use of fuels in 1990–2010 (TJ)

	Bitumen	Lubricants	Paraffin Wax	White Spirit
1990	1632.54	1632.54	NO	83.72
1991	544.18	1046.50	NO	83.72
1992	83.72	920.92	NO	83.72
1993	167.44	1088.36	NO	83.72
1994	544.18	1004.64	NO	83.72
1995	711.62	962.78	NO	83.72
1996	879.06	962.78	NO	83.72
1997	1632.54	879.06	NO	83.72
1998	2051.14	1004.64	NO	125.58
1999	2344.16	879.06	125.58	83.72
2000	2009.28	879.06	125.58	125.58
2001	1506.96	837.20	167.44	125.58
2002	2093.00	837.20	167.44	83.72
2003	2176.72	920.92	167.44	83.72
2004	2009.28	1004.64	251.16	125.58
2005	2511.60	1088.36	334.88	125.58
2006	3097.64	1088.36	251.16	125.58
2007	3348.80	1088.36	251.16	83.72
2008	3599.96	1046.50	209.30	83.72
2009	2218.58	627.90	293.02	41.86
2010	1967.42	586.04	460.46	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 2010 from total lubricants consumption are used as feedstocks and therefore 99.7% of carbon is reported as stored. Only 0.3% of total lubricant consumption is assumed as combusted and the emissions for the activity are included in Road Transport sector.

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

3.2.4 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.

3.2.5 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_x and SO_x 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.

3.2.6 Energy Industries (CRF 1.A.1)

3.2.6.1 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 3.14). There is no petroleum refining in Latvia.

Table 3.14 Emissions from 1.A.1 Energy industries in 1990–2010 (Gg)

	CO_2	CH_4	N_2O	GHGs (CO_2 eq)	NO_x	CO	NMVOC	SO_2
1990	6267.546	0.274	0.046	6287.544	13.972	5.505	0.495	37.213
1991	5747.495	0.259	0.042	5765.890	12.391	5.540	0.448	30.179
1992	4923.296	0.254	0.041	4941.268	10.671	5.711	0.437	27.534
1993	3969.771	0.237	0.039	3986.805	9.198	5.033	0.419	28.689
1994	3731.923	0.244	0.040	3749.425	9.184	4.457	0.436	32.468
1995	3417.928	0.233	0.036	3434.017	7.649	5.291	0.398	23.120
1996	3549.520	0.252	0.039	3567.001	8.494	4.778	0.429	28.837
1997	3305.679	0.286	0.041	3324.487	7.520	5.561	0.376	19.618
1998	3349.939	0.282	0.041	3368.708	8.037	4.618	0.337	20.444
1999	2924.935	0.229	0.034	2940.210	7.011	3.475	0.255	15.659
2000	2475.884	0.220	0.030	2489.944	5.227	4.439	0.231	7.157
2001	2419.396	0.210	0.028	2432.636	5.234	3.694	0.180	5.190
2002	2314.594	0.216	0.029	2328.127	5.147	3.521	0.169	4.876
2003	2245.970	0.230	0.031	2260.267	5.106	3.459	0.151	3.520
2004	2057.185	0.207	0.027	2070.036	4.792	2.780	0.115	2.121
2005	2047.518	0.181	0.024	2058.680	4.154	2.589	0.105	2.163
2006	2073.325	0.198	0.026	2085.410	3.837	2.776	0.103	1.222
2007	1943.805	0.195	0.026	1955.822	4.452	2.700	0.099	1.238
2008	1916.582	0.190	0.025	1928.287	3.372	2.670	0.094	0.741
2009	1865.046	0.190	0.025	1876.840	3.316	2.623	0.095	0.741
2010	2247.607	0.210	0.027	2260.518	3.126	3.016	0.107	0.775

Emissions from 1.A.1 sector are decreasing year by year until 2009 (Table 3.14), but in 2010 emissions increased. 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 decrease of GHG emissions in 2008-2009 is 2.67%, but increase in 2010 is by 20.44% comparing with 2009. Still CH_4 and N_2O emissions have increased in 2008-2010 by 0.32% and 10.4% 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. But still as solid and liquid biomass consumption has increased in the same time period and as total fuel consumption has decreased the GHGs emissions in final have decreased until 2009.

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.

The increase of CH_4 and N_2O emissions in 1995-1997 comparing neighbourhood years is explained with increase of wood consumption by 224.31% at the end of 90-ties emissions started to decrease till 2005. Emissions slightly increased in 2006 but then decreased again in 2007. Still as liquid fuels and solid fuels are combusted more in 2009 than in 2008 the CH_4 emissions have again increased, but N_2O emissions have decreased in 2010.

Also indirect GHG emissions from 1.A.1 Energy Industries were estimated (Table 3.14). SO_2 had biggest decrease by 97.9% in 1990–2010. 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. Other indirect GHG emissions in 2009–2010 decreased that is explained with the decrease of total fuel consumption combusted in stationary combustion installations. Still NMVOC and CO emissions have increased in 2010 due to increase of solid fuels consumption.

3.2.6.2 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 contents 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 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 2005-2010 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, research by 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 2012, 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 3.15).

Table 3.15 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 (2003-2010)	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 (2002-2010)	0.98	**86.97273** **85.60921**
Motor gasoline (for off-roads)	83.13	44 (1990-2002) 43.97	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 (1990-2003 43.21 (2004-2010)	0.99	**71.52524** **71.50869**
Shale oil	82.82	39.35	0.99	**76.34769**
Other kerosene	85.17	43.2 (1990-2002) 43.21 (2003-2010)	0.99	**71.51684** **71.50029**

[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

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
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 3.16). The fuel characteristics depend on structure of other liquid fuels. CSB reported average NCV from the information obtained from fuel consumers.

Table 3.16 Characteristics of other liquid fuels and estimated CO_2 emission factors

	1990	1991-1993	1994	1995	1996-1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Carbon content in working mass of fuel (C^d) %	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	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	41.00	41.267	38.273	37.022	31.947	38.658	38.676	37.9	39.447	39.447
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	0.99	0.99	0.99	0.99
EF with oxidation factor (EF CO_2) kg/GJ	72.593	74.846	72.593	72.991	72.593	73.288	74.914	74.116	73.636	79.397	82.079	95.118	78.606	78.569	80.178	77.03	77.03

<u>Natural gas</u>

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 1990-2010 was obtained from only natural gas supplier JSC "Latvijas Gāze" that collects / measures these data by themselves (Table 3.17).

Table 3.17 Characteristics of natural gas and estimated CO_2 emission factors

	Carbon content in working mass of fuel (C^d) %	NCV (Q_z^d) TJ/1000m3	Oxidation factor (p)	Natural gas density (ρ) t/1000m3	Emission factor with oxidation factor (EF CO_2) kg/GJ
1990	74.33	33.64	0.6867	0.995	55.3183
1991	74.33	33.64	0.6867	0.995	55.3183
1992	74.36	33.60	0.6923	0.995	55.8583
1993	74.15	33.71	0.6965	0.995	55.8556
1994	74.04	33.70	0.6914	0.995	55.3808
1995	74.26	33.73	0.6889	0.995	55.2953
1996	74.30	33.62	0.6859	0.995	55.2644
1997	74.39	33.62	0.6845	0.995	55.2184
1998	74.35	33.65	0.6857	0.995	55.2361
1999	74.31	33.62	0.6841	0.995	55.1268
2000	74.32	33.73	0.6879	0.995	55.2596
2001	74.36	33.78	0.6876	0.995	55.1835

[12] for wood – Q_z^d is TJ/1000m^3
[13] "Guidance manual for CO_2 emission estimations (Developed in accordance with UNFCCC and IPCC recommendations and physical characteristics of fuels used in Latvia)"

	Carbon content in working mass of fuel (C^d) %	NCV (Q_z^d) TJ/1000m3	Oxidation factor (p)	Natural gas density (ρ) t/1000m3	Emission factor with oxidation factor (EF CO_2) kg/GJ
2002	74.36	33.65	0.6858	0.995	55.2516
2003	74.38	33.64	0.6851	0.995	55.2265
2004	74.39	33.59	0.6839	0.995	55.2192
2005	74.40	33.59	0.6835	0.995	55.1944
2006	74.39	33.59	0.6838	0.995	55.2112
2007	74.38	33.54	0.6828	0.995	55.2052
2008	74.38	33.57	0.6833	0.995	55.1962
2009	74.37	33.70	0.686	0.995	55.1998
2010	74.42	33.65	0.686	0.995	55.2758

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.

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 3.18 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:

$$2\times\left(\frac{s}{100}\right)\times\frac{1}{Q}\times10^6\times\left(\frac{100-r}{100}\right)\times\left(\frac{100-n}{100}\right)$$

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 3.19). 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 3.19 below are used for emission estimation from off-roads.

Table 3.19 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 1990-2010 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 3.20 Fuel consumption in 1.A.1 Energy industries in 1990−2010 (PJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.1. Energy Industries											
Liquid Fuels	40.479	33.253	28.440	27.170	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	40.140	33.002	28.189	26.919	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	2.009	1.583	1.137	1.421	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
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											
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 3.20

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1.A.1. Energy Industries										
Liquid Fuels	5,277	5,076	3,606	3,144	2,395	1,512	1,389	0,905	1,214	0,932
Solid Fuels	1,645	1,290	0,873	0,280	0,244	0,135	0,371	0,466	0,482	0,430
Gaseous Fuels	33,579	32,544	34,078	32,415	33,355	35,235	32,668	32,698	31,303	38,662
Biomass	4,152	4,667	5,558	5,530	4,732	5,323	5,297	5,179	5,267	5,790
1.A.1.a. Public Electricity and Heat Production										
Liquid Fuels	5,108	4,864	3,437	2,932	2,183	1,300	1,219	0,692	1,044	0,719
Diesel oil	0,042	0,042	0,042	0,042	0,042	0,042	0,042	0,042	NO	NO
RFO	4,425	4,425	3,207	2,801	2,111	1,218	1,137	0,650	1,015	0,690
LPG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	0,167	0,042	0,029	0,088	0,029	NO	NO	NO	0,029	0,029
Shale oil	0,472	0,354	0,157	NO	NO	0,039	0,039	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
Coal	0,398	0,285	0,210	0,210	0,184	0,105	0,341	0,446	0,472	0,420
Peat briquettes	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
Natural gas	32,700	31,737	33,203	31,542	32,481	34,295	32,098	31,892	30,805	37,787
Biomass	3,670	4,185	4,700	4,672	4,250	4,841	4,754	4,636	4,510	5,287
Wood	3,617	4,097	4,644	4,570	4,132	4,741	4,675	4,556	4,390	5,084
Sludge Gas	0,053	0,088	0,056	0,102	0,118	0,100	0,079	0,080	0,120	0,119
Other Biogas	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,084
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

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Diesel oil	0,170	0,212	0,170	0,212	0,212	0,212	0,170	0,212	0,170	0,212
RFO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
LPG	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Shale oil	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
Coal	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
Natural gas	0,878	0,808	0,875	0,873	0,873	0,940	0,571	0,806	0,498	0,875
Wood	0,482	0,482	0,858	0,858	0,482	0,482	0,543	0,543	0,757	0,503

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

The biggest decrease in time period 1990–2010 for the two sub-sectors of 1A1 Energy industries sector was for liquid fuel consumption in 1A1a subsector – 98.21% (Table 3.20, 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 is increasing that is explained with increase of coal consumption in Energy industries – 300% in 2006-2010. The increase of solid fuel consumption was promoted by increase of oil price in world when coal combustion was cheaper than combustion of residual fuel oil and diesel oil.

Consumption of biomass fuel has increased by 1227.87% in 1990–2010. Solid biomass has lower cost and liquid and solid fuels were switched to biomass and natural gas.

Years 2006-2009 had quite high average temperature that's why fuel consumption for CHP 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. Fuel consumption decrease in 1A1 Energy industries sector is explained also with decrease of central heating supply consumers when they switched to individual heating supply

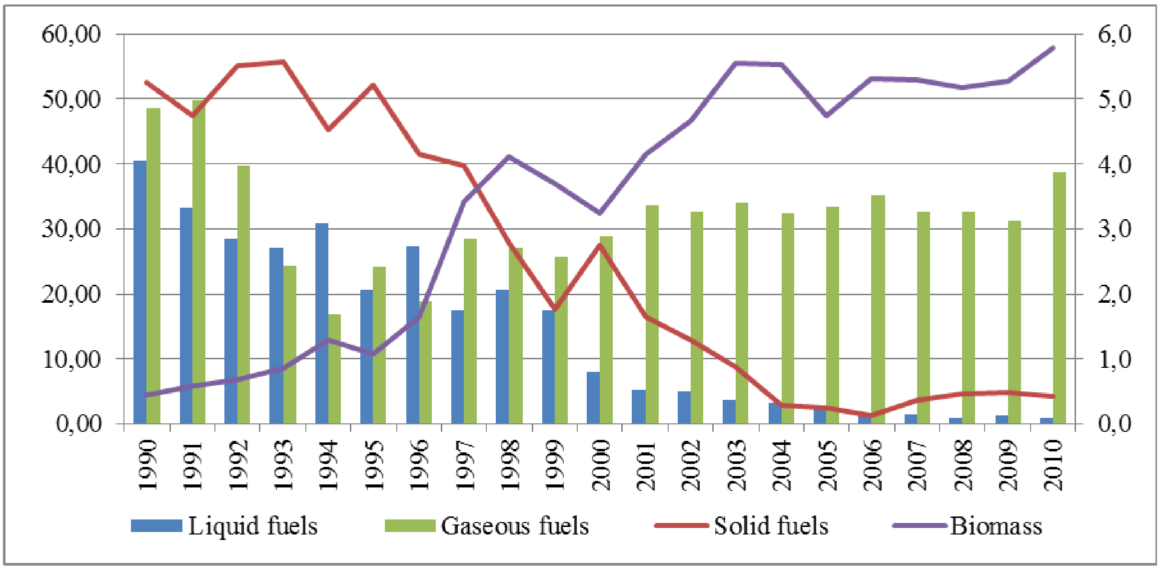


Figure 3.5 Fuel consumption in 1.A.1 Energy industries in 1990–2010 (PJ)

3.2.6.3 Uncertainties and time series consistency

Uncertainty in activity data of fuel combustion in 1.A.1 sector is ±2% in 2008. 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 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%.

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 30%.

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.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level. All issues given below in Table 3.21 were double-checked and large fluctuations were explained.

Table 3.21 IEF changes higher than 10% for 1.A.1 sector

Sectors	GHG	Unit	Year	First Year	Year	Second Year	Difference	Comment
1.A.1.a	Other Liquid Fuels/CO2	t/TJ	2004	82.07937892	2005	95.11825105	15.89%	In 2005 structure of other liquid fuels changed therefore average NCV in 2005 was lower (more light liquid fuels were used). That's why estimated CO_2 EF and estimated carbon emission factor increased in 2005.
1.A.1.a	Solid Fuels/CH4	kg/TJ	2008	2.251287996	2009	1.604655505	-28.72%	Large fluctuation of CH4 IEF is explained with changes of solid fuels structure. In 90ties significant amount of peat and peat briquettes were used in the sector (CH4 IEF for peat is 30 (kg/TJ) but for coal 1 (kg/TJ) and peat consumption dominated in the solid fuels consumption in the sector. Starting 2004 peat consumption is smaller than coal consumption and remains small when coal
1.A.1.a	Solid Fuels/CH4	kg/TJ	2007	2.614860372	2008	2.251287996	-13.90%	
1.A.1.a	Solid Fuels/CH4	kg/TJ	2006	5.663946231	2007	2.614860372	-53.83%	
1.A.1.a	Solid Fuels/CH4	kg/TJ	2004	7.475227727	2005	6.210512202	-16.92%	
1.A.1.a	Solid Fuels/CH4	kg/TJ	2003	22.95136789	2004	7.475227727	-67.43%	
1.A.1.a	Solid Fuels/CH4	kg/TJ	2000	25.41434665	2001	22.41833548	-11.79%	
1.A.1.a	Solid Fuels/CH4	kg/TJ	1999	22.41833548	2000	25.41434665	13.36%	
1.A.1.a	Solid Fuels/CH4	kg/TJ	1995	20.0999366	1996	23.17373559	15.29%	
1.A.1.a	Solid Fuels/CH4	kg/TJ	1993	16.55792129	1994	19.03406068	14.95%	
1.A.1.a	Solid Fuels/CH4	kg/TJ	1990	11.84805074	1991	15.36439774	29.68%	

Sectors	GHG	Unit	Year	First Year	Year	Second Year	Difference	Comment
								consumption increased three times in 2006-2007.
1.A.1.a	Solid Fuels/N2O	kg/TJ	2006	1.818146904	2007	1.544780585	-15.04%	Fluctuation of N_2O emissions is also explained with changes in solid fuels structure and mainly with changes in peat and peat briquettes consumption (N_2O IEF for peat is 4 (kg/TJ) but for coal 1.4 (kg/TJ) (see previous explanation).
1.A.1.a	Solid Fuels/N2O	kg/TJ	2003	3.368053673	2004	1.980537658	-41.20%	
1.A.1.a	Solid Fuels/N2O	kg/TJ	1990	2.37258386	1991	2.687842556	13.29%	

3.2.6.4 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.

3.2.6.4.1 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. 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. NO_x and SO_x emissions from national database "2-Air" are verified and approved by Regional Environmental Boards.

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.

3.2.6.4.2 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.

3.2.6.5 Source-specific recalculations

Activity data updates for 2000-2009 and corrections were done.

3.2.6.6 Source-specific planned improvements

The summarized necessary improvements are:

- Researches on use of the country specific emission factors for key category – CH_4 emissions from solid biomass combustion;
- 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.

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

3.2.7.1 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 1990–2010 (Gg)

	CO_2	CH_4	N_2O	GHGs (CO_2 eq)	NO_x	CO	NMVOC	SO_2
1990	3742.44	0.26	0.03	3755.98	5.16	28.00	1.46	23.26
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	2097.89	0.18	0.02	2108.12	3.12	11.37	0.83	14.38
1994	1899.68	0.17	0.02	1909.86	2.90	9.33	0.77	15.54
1995	1866.44	0.17	0.02	1876.65	2.85	6.71	0.66	14.92
1996	1826.92	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	1421.61	0.17	0.02	1431.97	2.38	7.59	0.71	8.83
2000	1224.75	0.16	0.02	1233.66	2.03	6.55	0.59	4.69
2001	1089.18	0.20	0.02	1099.99	2.02	8.32	0.73	2.39
2002	1121.43	0.19	0.02	1131.61	1.99	8.25	0.69	1.81
2003	1128.33	0.19	0.02	1138.19	1.96	7.35	0.64	1.39
2004	1140.18	0.23	0.02	1152.78	2.19	10.78	0.89	0.87
2005	1163.75	0.26	0.03	1177.96	2.37	12.72	1.07	1.11
2006	1204.86	0.29	0.03	1221.00	2.61	14.52	1.24	1.23
2007	1223.07	0.27	0.03	1237.68	2.51	13.38	1.13	1.25
2008	1124.20	0.28	0.03	1139.58	2.43	14.03	1.19	1.00
2009	881.77	0.33	0.04	901.04	2.52	16.71	1.49	0.65
2010	1063.25	0.40	0.05	1086.92	2.92	19.06	1.71	0.94

Emissions from 1.A.2 were increasing in 2001-2008; 2010 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 21.57%. 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 SOx increased in 2008-2010.

Also indirect GHG emissions from 1.A.2 sector were estimated (Table 3.22). In this sector SO_2 emissions decrease by 95.96% in 1990–2010. It is explained with fuel switching to natural gas and biomass from what 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.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:

$$Em = EF \times B_q$$

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 1999–2010 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	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Used tires	82.7556	82.7556	82.7556	82.7556	82.7556	82.7556	79.4	79.4	79.4	85.00	85.00	60.91

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 2008-2010 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		
Municipal wastes – Plant 1		82.81	-	-	-
Municipal wastes – Plant 2	85.19	120.95	82.69	117.6	155.97

SO_2 emissions factors

SO_x 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 1990-2010 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 1990–2010 (PJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.2 Manufacturing Industries and Construction											
Liquid Fuels	28.963	18.770	16.010	16.557	16.022	16.341	15.981	15.687	12.669	11.282	8.267
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										0.037	0.131
1.A.2.a. Iron and Steel											
Liquid Fuels	2.057	1.017	0.733	0.731	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
RFO	1.177	0.974	0.690	0.284	0.284	0.203	0.325	0.325	NO	NO	NO
Other liquid	0.837	NO	NO	0.447	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
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	0.000	0.000	0.000	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	4.694	5.429	5.205	5.239	4.133	2.971
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	4.060	4.791	4.222	4.385	3.492	1.746
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	0.039	NO	NO	NO	NO	0.630
Solid Fuels	1.069	0.598	0.655	0.593	0.581	0.309	0.309	0.267	0.184	0.239	0.140

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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	3.501	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 (please specify)											
Liquid Fuels	12.513	7.832	6.427	5.934	7.400	6.313	6.316	6.113	6.017	5.855	4.002
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	2.210	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	0.000	0.086	0.043	0.086	0.043	0.086			
Other liquid	0.126	NO	NO	NO	NO	0.042	NO	NO	NO	0.124	0.771
Shale oil	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.118	0.787
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
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
Wood	0.389	0.372	0.386	1.472	1.590	1.993	2.301	2.375	2.820	2.733	2.176
Other Fuels (please specify)	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
1.A.2 Manufacturing Industries and Construction										
Liquid Fuels	5.133	4.593	4.740	4.531	3.654	4.281	4.047	3.309	3.044	3.549
Solid Fuels	0.518	0.496	0.397	0.407	1.105	1.498	2.074	2.127	1.497	1.956
Gaseous Fuels	11.600	12.848	12.726	13.093	13.550	13.263	12.884	11.839	9.281	10.531
Biomass	3.856	3.393	3.309	4.706	5.535	6.429	5.388	5.797	8.641	9.810
Other Fuels	0.245	0.332	0.291	0.314	0.183	0.131	0.210	0.365	0.078	0.945
1.A.2.a. Iron and Steel										
Liquid Fuels	1.083	0.963	0.963	0.963	0.652	0.963	0.963	0.917	0.793	1.005
Diesel oil	NO	NO	NO	NO	0.042	NO	NO	NO	NO	NO
RFO	NO	NO	NO	NO	NO	NO	NO	0.122	0.081	NO
Other liquid	1.005	0.963	0.963	0.963	0.610	0.963	0.963	0.795	0.712	1.005
Shale oil	0.079	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
Coal	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.026
Coke	0.264	0.241	0.134	0.188	0.161	0.134	0.107	0.134	0.134	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.A.2.b. Non-Ferrous Metals										
Diesel oil	0.042	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
1.A.2.c. Chemicals										
Liquid Fuels	0.164	0.162	0.122	NO	NO	NO	NO	0.124	0.126	0.085
Diesel oil	NO	NO	NO	NO	NO	NO	NO	0.042	0.085	0.085
RFO	0.122	0.162	0.122	NO	NO	NO	NO	0.081	0.041	NA
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	0.042	NO	NO	NO	NO	NO	NO	NO	NO	NO
Coal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Natural gas	0.270	0.279	0.309	0.406	0.443	0.480	0.381	0.514	0.519	0.605
Biomass	0.046	0.029	0.019	0.047	0.029	0.059	0.073	0.188	0.130	0.188
Wood	0.046	0.029	0.019	0.047	0.029	0.056	0.072	0.187	0.127	0.187
Other Liquid Biofuels	NO	NO	NO	NO	NO	0.003	0.001	0.001	0.003	0.001
1.A.2.d. Pulp, Paper and Print										
RFO	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
Natural gas	0.135	0.134	0.168	0.168	0.202	0.235	0.201	0.201	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
1.A.2.e. Food Processing, Beverages and Tobacco										
Liquid Fuels	1.650	1.483	1.122	0.960	0.999	1.003	0.785	0.536	0.616	0.614
Diesel oil	0.467	0.340	0.340	0.340	0.297	0.255	0.212	0.212	0.212	0.170
RFO	0.974	0.893	0.609	0.406	0.406	0.447	0.325	0.122	0.244	0.284
LPG	0.046	0.046	0.046	0.046	0.046	0.091	0.091	0.046	0.091	0.091
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	0.084	0.126	0.088	0.130	0.171	0.171	0.117	0.117	0.029	0.029
Shale oil	0.079	0.079	0.039	0.039	0.079	0.039	0.039	0.039	0.039	0.039
Solid Fuels	0.140	0.141	0.158	0.105	0.132	0.105	0.079	0.079	0.052	0.055
Coal	0.114	0.114	0.131	0.105	0.105	0.079	0.079	0.079	0.052	0.052
Coke	0.026	0.027	0.027	NO	0.027	0.027	NO	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.003
Natural gas	2.781	2.989	2.765	3.242	3.154	3.254	2.688	2.373	1.935	1.918
Biomass	0.800	0.842	0.719	0.916	1.034	0.772	0.701	0.394	0.488	0.339
Wood	0.800	0.842	0.719	0.916	1.034	0.772	0.701	0.394	0.483	0.333
Other Liquid Biofuels	NO	NO	NO	NO	NO	NO	NO	NO	0.005	0.006
1.A.2.f. Other (please specify)										
Liquid Fuels	2.194	1.985	2.534	2.607	2.003	2.315	2.299	1.733	1.510	1.845
Gasoline	0.044	0.069	0.044	0.088	0.088	0.088	0.088	0.088	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
RFO	0.447	0.122	0.081	0.041	0.122	0.081	0.122	0.041	NO	0.041
LPG	NO	NO	NO	0.046	0.046	0.046	0.046	0.046	NO	NO
Jet fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	0.618	0.784	1.441	1.335	0.646	0.786	0.220	0.117	0.234	0.656
Shale oil	0.236	0.118	0.118	0.079	0.039	0.039	0.039	0.039	NO	NO
Solid Fuels	0.085	0.085	0.079	0.089	0.787	1.232	1.888	1.914	1.311	1.794
Coal	0.085	0.085	0.079	0.079	0.787	1.232	1.888	1.914	1.311	1.783
Coke	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.001
Peat	NO	NO	NO	0.010	NO	NO	NO	NO	NO	0.010
Natural gas	4.157	5.273	5.212	4.977	5.419	4.992	5.287	4.789	3.223	3.937
Wood	2.997	2.502	2.551	3.723	4.445	5.578	4.598	5.208	7.860	9.125
Other Fuels (please specify)	0.245	0.332	0.291	0.314	0.183	0.131	0.210	0.365	0.078	0.945
Industrial wastes (used tires)	0.245	0.332	0.291	0.314	0.183	0.131	0.210	0.210	0.021	0.107
Municipal wastes	NO	NO	NO	NO	NO	NO	NO	0.155	0.057	0.838

All fuel types with exception of biomass fuels have decreased in 1990-2010 when liquid fuels had the biggest decrease in time period – 87.75% (Table 3.26, Figure 3.6). It is explained with fuel switching processes when liquid fuels were switch 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.

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.

Although solid fuels consumption has increased in 1990-2010 by 22.37%. The increase of solid fuels – mainly coal consumption 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 393.05% increase. The increase of solid fuel consumption was promoted by increase of oil price in world when coal combustion was cheaper than combustion of residual fuel oil and diesel oil.

Consumption of biomass fuel has increased very significantly – by 1489.92% in 1990–2010. 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 switch to biomass and natural gas. Years 2006-2009 had quite high average temperature that's why fuel consumption for autoproducers 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.

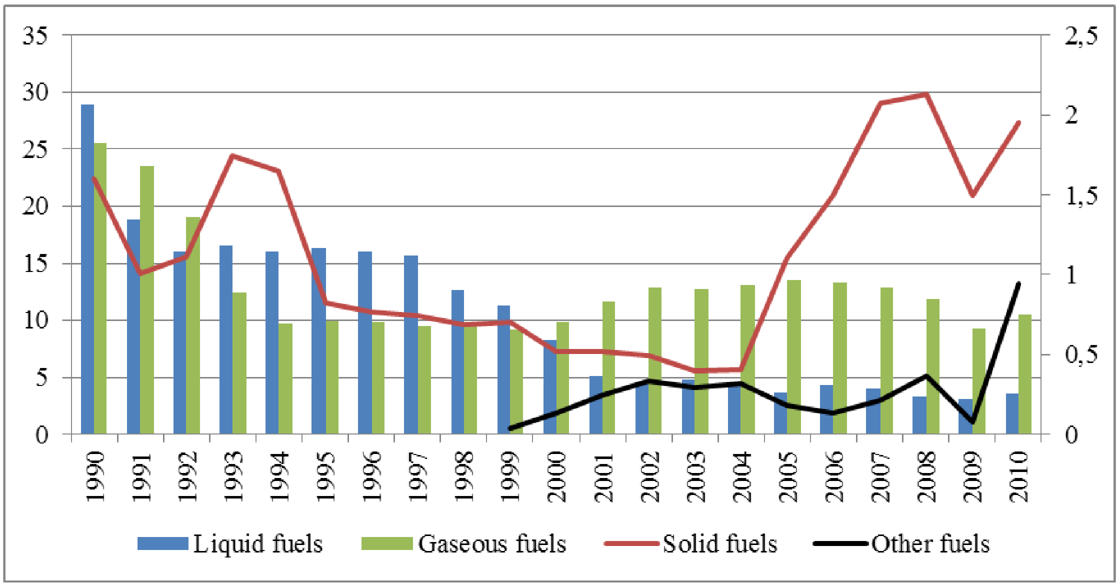


Figure 3.6 Fuel consumption in 1.A.2 Manufacturing industries and construction in 1990–2010 (PJ)

Consumption of used tires and municipal wastes in Mineral production reported as Other Fuels had increased in 1999-2010. The increase was influenced by sharp increase of cement production that was caused by increasing demand of construction materials and sharp development of construction sector.

3.2.7.3 Uncertainties and time series consistency

Uncertainty in activity data of fuel combustion in 1.A.2 sector is ±2% in 2010. 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.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level. All issues given below in Table 3.27 were double-checked and large fluctuations were explained.

Table 3.27 IEF changes higher than 10% for 1.A.2 sector

Sectors	GHG	Unit	Year	First Year	Year	Second Year	Difference	Comments
1.A.2.a	Liquid Fuels/CO2	t/TJ	2005	93.74	2006	78.61	-16.15%	In 2005 structure of other liquid fuels changed therefore average NCV in 2005 was lower (more light liquid fuels were used). That's why estimated CO_2 EF and estimated carbon emission factor increased in 2005.
1.A.2.a	Liquid Fuels/CO2	t/TJ	2004	82.08	2005	93.74	14.21%	
1.A.2.a	Other Liquid Fuels/CO2	t/TJ	2005	95.12	2006	78.61	-17.36%	
1.A.2.a	Other Liquid Fuels/CO2	t/TJ	2004	82.08	2005	95.12	15.89%	
1.A.2.e	Other Liquid Fuels/CO2	t/TJ	2005	95.12	2006	78.61	-17.36%	
1.A.2.e	Other Liquid Fuels/CO2	t/TJ	2004	82.08	2005	95.12	15.89%	
1.A.2.e	Solid Fuels/CH4	kg/TJ	1999	11.30	2000	10	-11.48%	Changes of CH_4 and N_2O emissions IEF are explained with appearance of peat briquettes consumption – peat briquettes are combusted in the sector only in 1994 and 1997-1999.
1.A.2.e	Solid Fuels/CH4	kg/TJ	1996	10	1997	11.16	11.58%	
1.A.2.e	Solid Fuels/N2O	kg/TJ	1999	1.57	2000	1.40	-10.74%	
1.A.2.e	Solid Fuels/N2O	kg/TJ	1996	1.40	1997	1.55	10.76%	
1.A.2.f	Solid Fuels/CH4	kg/TJ	2004	12.27	2005	10	-18.47%	Changes of all emissions IEF are explained with appearance of peat and peat briquettes consumption – peat is consumed in 1997-1998 and in 2004 but peat briquettes are combusted in the sector only in 1995-1996.
1.A.2.f	Solid Fuels/CH4	kg/TJ	2003	10	2004	12.27	22.66%	
1.A.2.f	Solid Fuels/CH4	kg/TJ	1994	10	1995	11.03	10.32%	
1.A.2.f	Solid Fuels/CH4	kg/TJ	1990	10	1991	11.46	14.55%	
1.A.2.f	Solid Fuels/N2O	kg/TJ	2004	1.69	2005	1.40	-17.38%	
1.A.2.f	Solid Fuels/N2O	kg/TJ	2003	1.40	2004	1.69	21.04%	
1.A.2.f	Solid Fuels/N2O	kg/TJ	1990	1.40	1991	1.59	13.51%	
1.A.2.f	Liquid Fuels/CH4	kg/TJ	2008	4.44	2009	3.40	-23.41%	CH_4 emissions from liquid fuels in this sector are influenced with the amount of gasoline consumption in off-roads as gasoline fuel only has different CH_4 EF comparing to other liquid fuels types. That's why part of gasoline fuel in total liquid fuel consumption influence average IEF of liquid fuels in the sector.
1.A.2.f	Liquid Fuels/CH4	kg/TJ	2007	3.84	2008	4.44	15.65%	
1.A.2.f	Liquid Fuels/CH4	kg/TJ	2004	3.62	2005	4.11	13.51%	
1.A.2.f	Liquid Fuels/CH4	kg/TJ	2003	2.83	2004	3.62	27.75%	
1.A.2.f	Liquid Fuels/CH4	kg/TJ	2002	3.67	2003	2.83	-22.78%	
1.A.2.f	Liquid Fuels/CH4	kg/TJ	2001	2.96	2002	3.67	23.82%	
1.A.2.f	Liquid Fuels/CH4	kg/TJ	2000	2.53	2001	2.96	17.20%	
1.A.2.f	Liquid Fuels/CH4	kg/TJ	1998	2.70	1999	2.36	-12.63%	
1.A.2.f	Liquid Fuels/CH4	kg/TJ	1996	3	1997	2.69	-10.39%	
1.A.2.f	Liquid Fuels/CH4	kg/TJ	1995	2.33	1996	3	28.64%	
1.A.2.f	Liquid Fuels/CH4	kg/TJ	1994	2.86	1995	2.33	-18.26%	
1.A.2.f	Liquid Fuels/CH4	kg/TJ	1993	3.78	1994	2.86	-24.43%	
1.A.2.f	Liquid Fuels/CH4	kg/TJ	1990	5.38	1991	3.35	-37.71%	

3.2.7.4 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.

3.2.7.4.1 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.

1. 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.

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.

3.2.7.4.2 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.

3.2.7.5 Source-specific recalculations

Some small activity data updates and corrections were done. As well as it was able to obtain more data for several sectors for historical years.

3.2.7.6 Source-specific planned improvements

The summarized necessary improvements are:

- Researches on use of the country specific emission factors for key category – CH_4 emissions from solid biomass combustion;
- 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 Transport (CRF 1.A.3)

3.2.8.1 Source category description

This section describes GHG emissions resulting from transport fuel combustion. In 2010, this source category was responsible for approximately 38.9% of GHG emissions from fuel combustion activities.

Total GHG emissions in the transport sector after the dramatic drop in years 2008 and 2009 has stabilised in year 2010 (see Figure 3.7). The main reason for the decreasing in the period 2008-2009 was the economic recession in Latvia, which affected the fuel consumption mainly in the road transport.

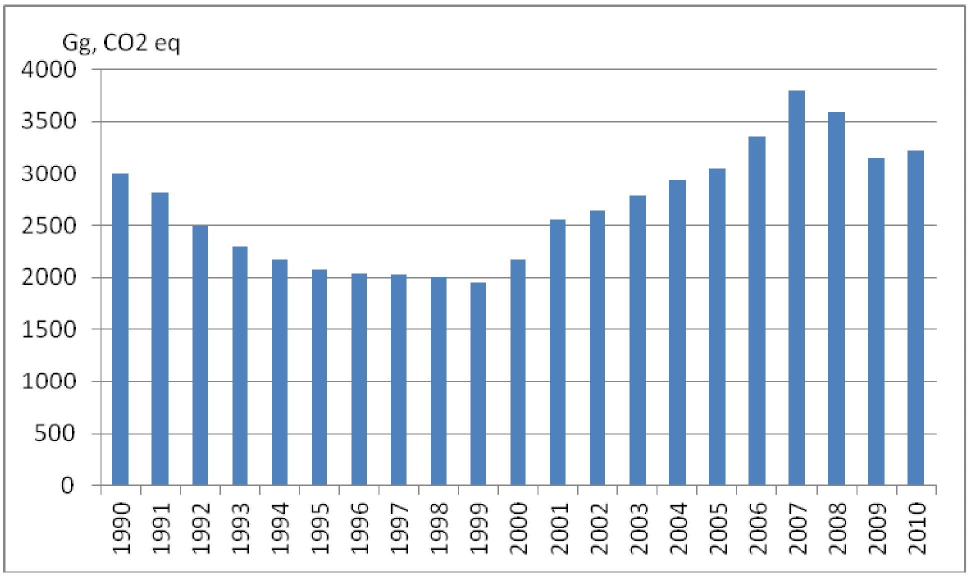


Figure 3.7 GHG emissions development in transport 1990 – 2010

The road transport constitutes a convincing majority of the total GHG emissions in the transport sector. In 2010, it gave 91.9 % of total emissions but the next largest emission source is a railroad - 7.31 % (see Figure 3.8).

CO_2 emissions constitute nearly 98.4 of the total GHG emissions in the transport sector and they are key sources in road transport and railway (Figure 3.9).

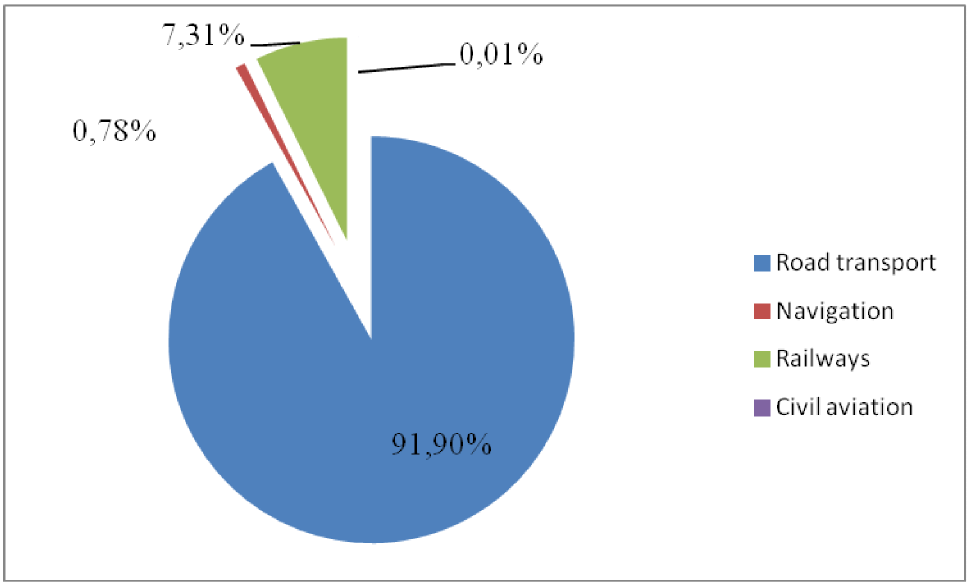


Figure 3.8 GHG emissions in transport by sub-sectors (year 2010)

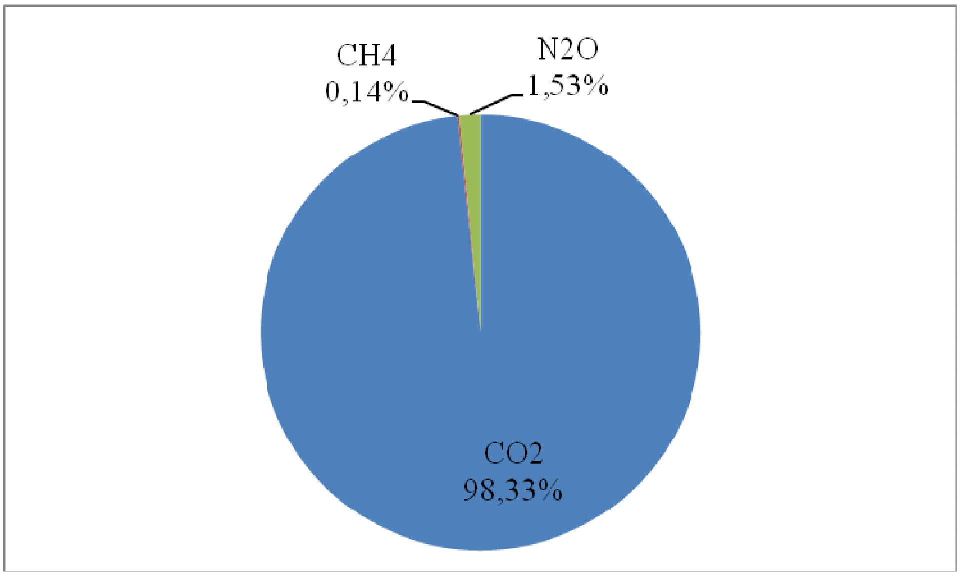


Figure 3.9 GHG emissions in transport sector by gases (year 2010)

Determinative of the CO_2 emission changes is the changes of the fuel consumption (Figure 3.10). In 2010, total fuel consumption in the transport sector, compared to 2009 level, has increased by 3.2 %. In different subsectors various changes have taken place in 2010. In civil aviation the fuel consumption has increased by 50%, whereas in the road transport it has increased by 2.7 %. In the railway the fuel consumption has decreased by 8.4 %, but in navigation it has increased by 80%. The road transport consumes 91.4 %, the railway – 8.1% and the civil aviation and navigation – the residues from the total fuel consumption in the transport sector.

Diesel oil is the major fuel type in the transport sector and it constitutes 67.85 %, and is followed by gasoline – 27.35 %, but LPG constitutes 2.2% and biomass 2.6% of the total fuel consumption in the transport sector. A share of biomass has increased from 0.5% in year 2009 up to 2.6% in year 2010. Biomass mainly is used in road transport but small portion is consumed in railway as well.

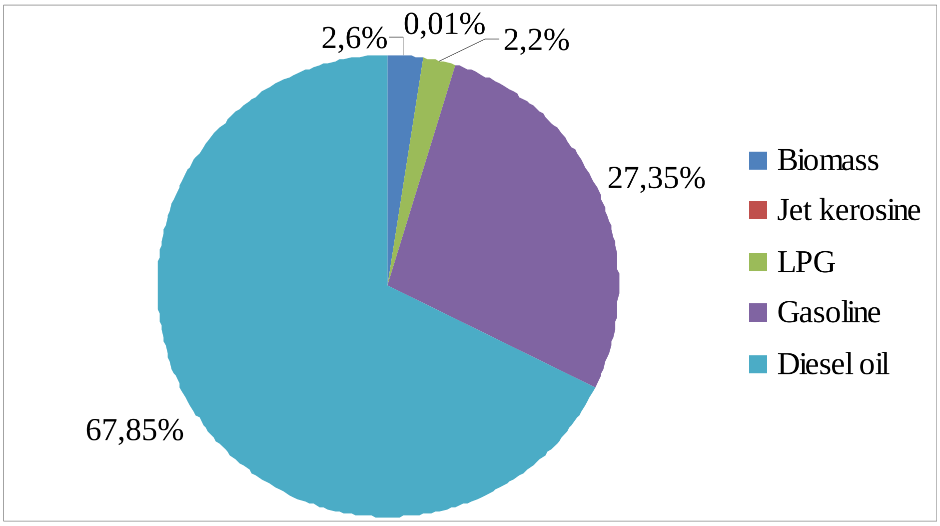


Figure 3.10 Fuel consumption in transport by fuel type (2010)

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

3.2.8.2.1 Source category description

In Latvia, civil aviation, excluding international flights, is really narrow. In 2010, the fuel consumption in civil aviation constituted 0.01 % of GHG emissions from the total GHG emissions in transport (Figure 3.11).

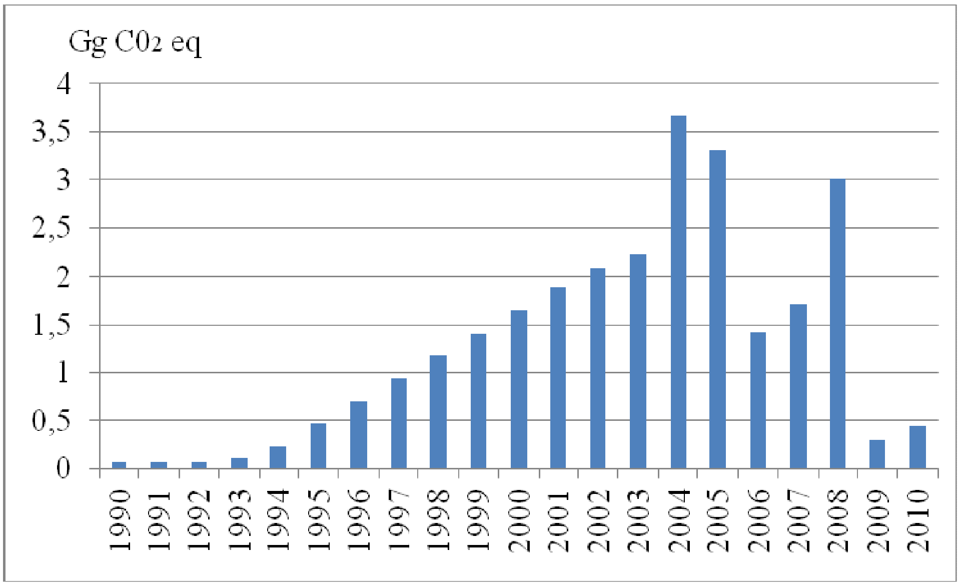


Figure 3.11 GHG emissions in civil aviation (Gg CO_2 eq)

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 you see, after the state owned (51% 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.

3.2.8.2.2 Methodological issues

Methods

The 2006 IPCC Guidelines Tier 2 and Tier 1 approaches have been applied. Tier 2 approaches have been applied for jet kerosene emission calculation for time period 2004-2010. Tier 1 approach has been applied for aviation gasoline emission calculation.

Using Tier 2 approach, emissions for LTO (landing/take off) and cruise are calculated individually. Prior to the emission calculation, representative aircraft type was chosen, for which the fuel consumption and emission data exist in the EMEP/CORINAIR databank.

Activity data

The data about fuel consumption in aviation is derived from the CSB. Starting from 2006 CSB has included in the survey parameter - used in domestic aviation. 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.

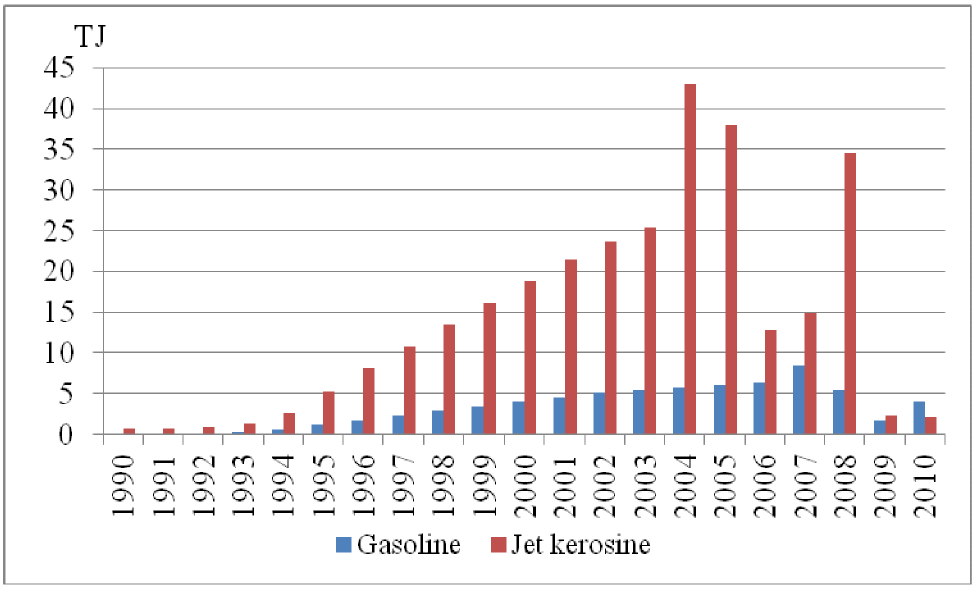


Figure 3.12 Fuel consumption in domestic civil aviation (TJ)

Table 3.28 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
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

	Jet kerosene (TJ)	Aviation gasoline (TJ)
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

Emission factors

Default EFs of LTO and cruise (jet kerosene) for civil aviation is used (EMEP/CORINAIR 2006).

Table 3.29 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

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

3.2.8.3.1 Source category description

The road transport constituted 91.9 % of GHG emissions in the transport sector in 2010. After the rapid growth in the period 2000 – 2007, emissions in 2009 have sharply decreased (Figure 3.13). 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% (2010) of the total freight in the country. It is in a place increasing of this share by approximately 8%, compare with year 2009. In the freight road transport the inland freight constitutes approximately 90% of gross – timber products, food products, household goods and building materials are dominant. Wherewith the domestic consumption reduction in 2009 defined the fuel consumption reduction for the freight transport and mainly fuel diesel by 11%. Fuel consumption in road transport has increased by 5.2% in year 2010 compare with 2009. In different fuels various changes have taken place in 2010 compare with 2009. Gasoline consumption has decreased by 10%, whereas diesel consumption has increased by 9 % and LPG consumption by 14%. The main feature is a sharp increasing of biomass consumption in year 2010, more than 6 times.

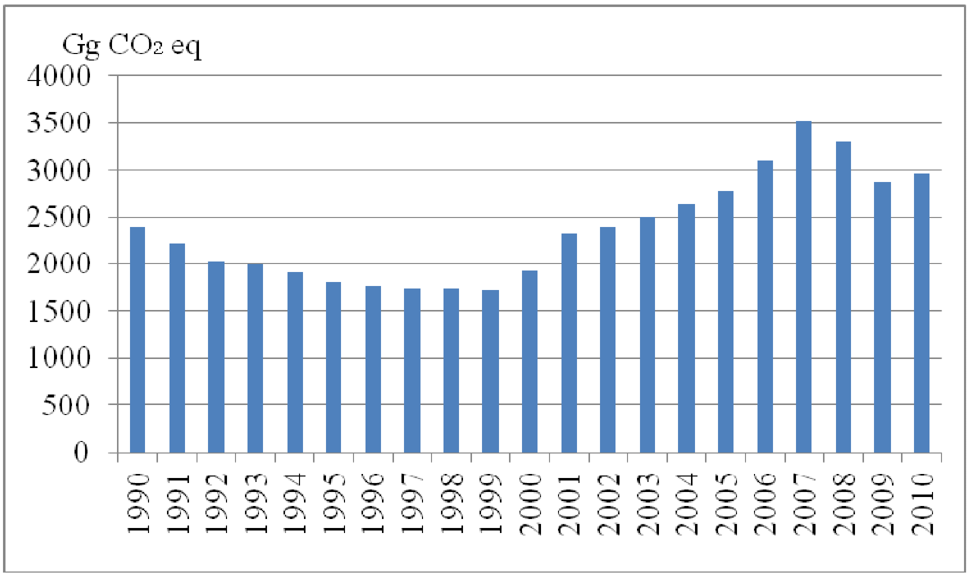


Figure 3.13 GHG emissions in road transport (Gg CO_2 eq)

In time period 1990 – 2010, essential changes have taken place in the structure of GHG emissions created by the road transport (see Table 3.30). In 2010, 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 3.30 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	892.53	690.62	20.67	159.28	28.77	1027.40
2010	810.90	724.35	18.17	195.52	27.62	1103.39
Trend 2009/1990 (%)	-26.82	1603.96	-88.50	260.77	-92.74	150.87

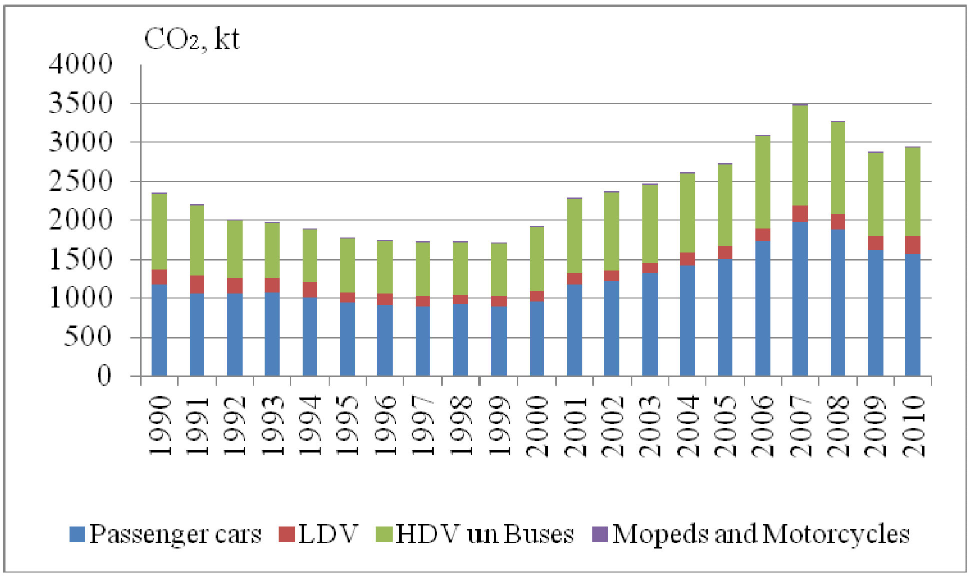


Figure 3.14 CO_2 emissions in road transport by vehicle types (Gg)

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 3.14, 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 53,7%, HDV41,2% and LDV 9,3% in year 2010.

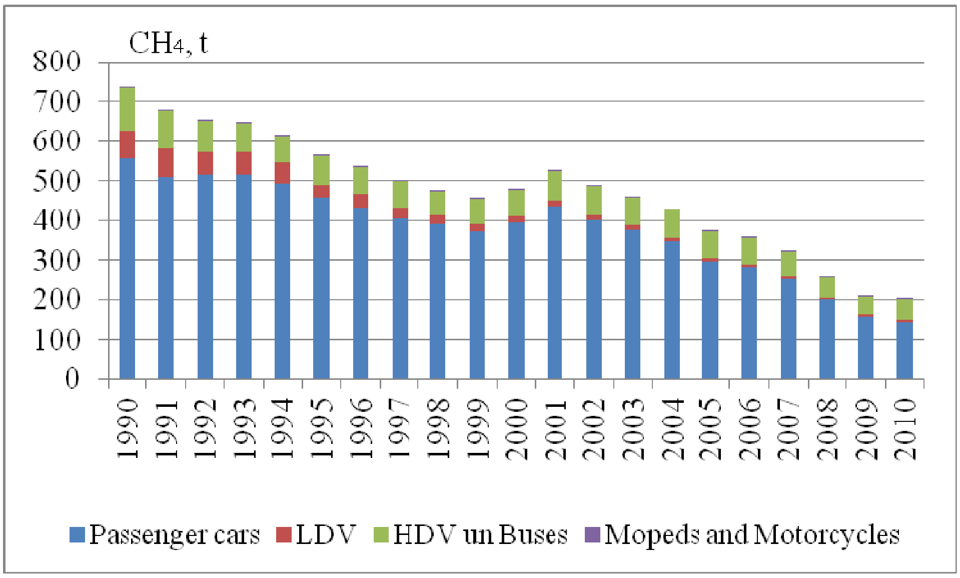


Figure 3.15 CH_4 emissions in road transport by vehicle types

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 2010 with decreasing of gasoline consumption by passenger cars.

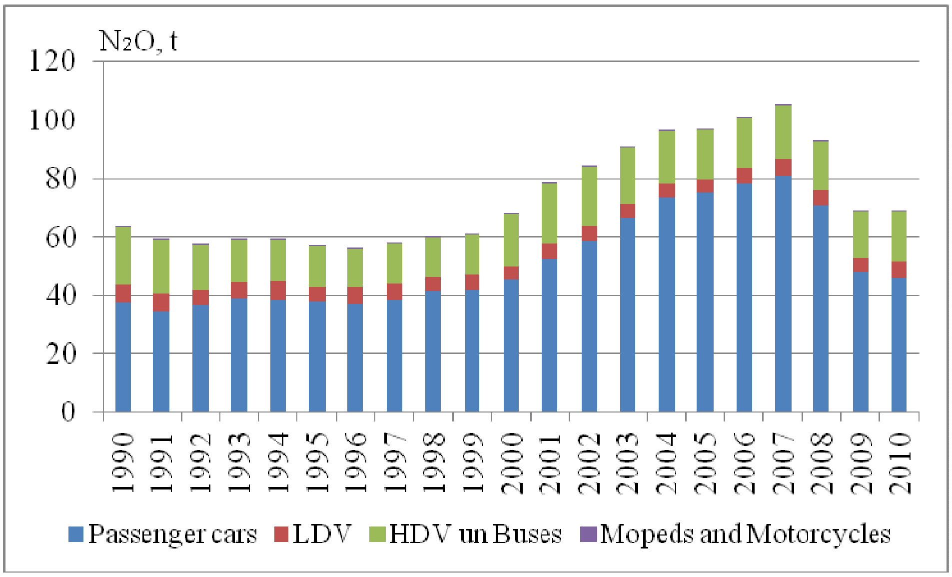


Figure 3.15 N_2O emissions in road transport by vehicle types

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:

- The main sources of N_2O emissions is passenger cars with gasoline engines;
- A sharp increase of a total number of passenger cars and vehicle km in the period 2000 – 2007 (see Figure 3.15) increasing N_2O emissions as well ;
- Substantial increase of a share of diesel cars in the period 2000 – 2010 (corresponding 12% and 33%) decreased N_2O emissions;
- A share of gasoline EURO 3 and EURO 4 passenger cars has increased from 15% to 48% corresponding in the years 2005 and 2010. It makes possitive impact to N_2O emissions because EF is approximately 2 times less compare with EURO 1 and EURO 2 cars;
- Implemented EF in the COPERT IV model for diesel cars, specially, in urban mode for EURO 3 and EURO 4 cars is higher compare to the EURO 1 and EURO 2 cars (corresponding 0.009 g/km and 0,002 g/km);
- A new more strong regulation concerning sulphur content into fuel (diesel and gasoline) came into force from year 2009. It makes a possitive impact to N_2O emissions as well.

3.2.8.3.2 Methodological issues

Methods

For road transport, the detailed methodology is used to make annual estimates of the Latvian emissions, as described in the EMEP/CORINAIR Emission Inventory Guidebook. 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 standards and emission degradation due to catalyst wear. Furthermore, the emission effects of cold-start and evaporation are simulated. Estimation of evaporative emissions of hydrocarbons and the inclusion of cold start emission effects are dealt with in the Latvian inventory by using LEGMC 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 (Table 3.31). Total mileage data for passenger cars, light duty trucks, heavy duty trucks and buses produced by the RTSD is used for the years 1996-2010.

Table 3.31 Activity data and sources used for emission calculation in road transport

Activity data	Source of activity data	Remarks
Fuel consumption	Calculated consumption by COPERT IV model	Calibrated with national statistics. Deviation less than 0,15%
Number of cars	Road Traffic Safety Directorate	For calculation it is used number of cars with permission to participate in traffic
Number of cars by fuel and vehicle type	Road Traffic Safety Directorate and expert calculation	Based on available data cars are grouped by fuel type, engine power, age and vehicle categories according to emission control system
Distance travelled by cars by fuel and vehicle type	Road Traffic Safety Directorate expert calculation	Based on an average data by cars classes it is modelled by fuel type, engine power, age and vehicle categories
Emission factors	National specific for CO_2 emissions, COPERT emission factors for CH_4 and N_20	CO_2 emission factors is based on carbon content in fuel

General information about activity data is presented in Figure 3.17 (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 actual fuel consumption. Using of actual fuel consumption instead of statistical data ensure that it is eliminated double counting for gasoline consumption in transport sector (statistical data of gasoline consumption includes fuel consumption for road transport and private boats in domestic navigation).

Table 3.32 Fuel consumption in road transport (TJ)

	Gasoline, TJ	Diesel oil TJ	LPG, TJ	Natural gas, TJ	Biomass, TJ
1990	24217	8326	592	339	
1991	22191	8116	501	195	
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	13585	25169	865	4	173
2010	12309	27451	989	-	1136

As seen in

Table **3.32** and Figure 3.16, the fuel consumption has essentially changed in the time period 1990 – 2010. 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 2010 by 24 % compare with year 2008. 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 2009 and 2010 by 11 % and 3 % corresponding compare with year 2008. It was in place substantial biomass consumption increasing in year 2009 and 2010 in road transport.

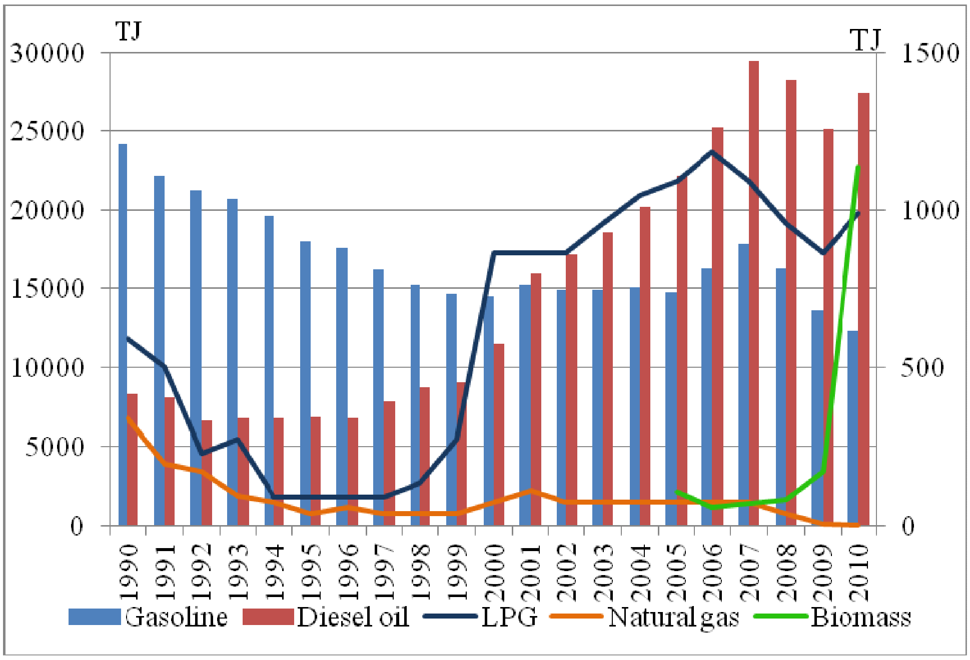


Figure 3.16 Development of Fuel consumption in road transport (TJ)
LPG, natural gas and biomass on right axes

The vehicle numbers per passenger cars sub-class and layers are shown in Figure 3.17.

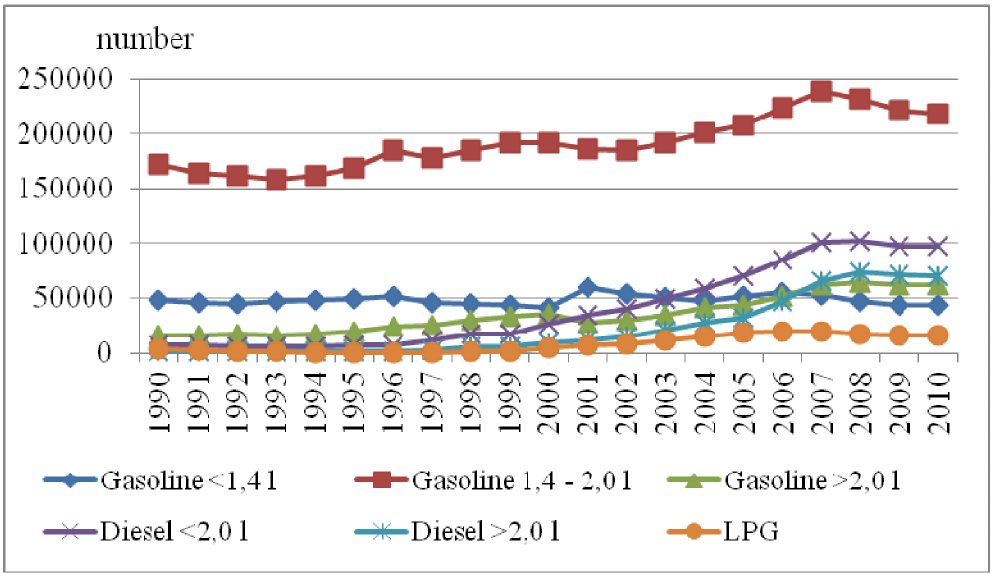


Figure 3.17 Distribution of passenger cars fleet by sub-classes

Analysing the development of the passenger car fleet in the time period 1990 – 2010, following features can be noted (Figure 3.18, Figure 3.19):

- 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;
- As of 2000, the number of cars with diesel engines, both, < 2.0l and > 2.0l, grow rapidly;
- As of 2002, in the car fleet with a gasoline engine, the number of EURO 1, EURO 2, EURO 3 and EURO 4 cars grow rapidly. In 2010 a share of EURO 3 and EURO 4 cars constitute 48,3%;
- As of 2003, in the car fleet with a diesel engine, the number of EURO 1, EURO 2, EURO 3 and EURO 4 cars grow rapidly. In 2010 a share of EURO 3 and EURO 4 cars constitute 45,3%.

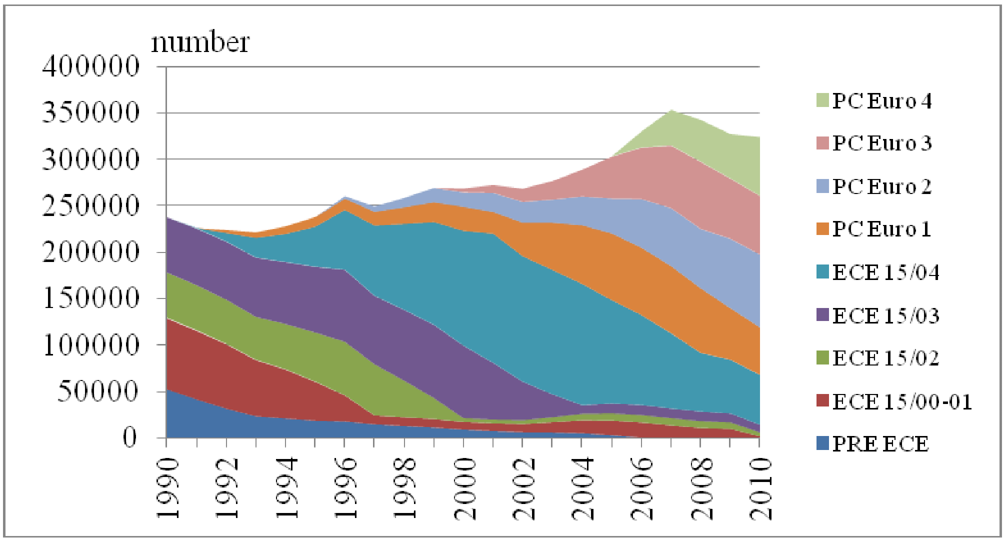


Figure 3.18 Distribution of gasoline passenger cars fleet by layers

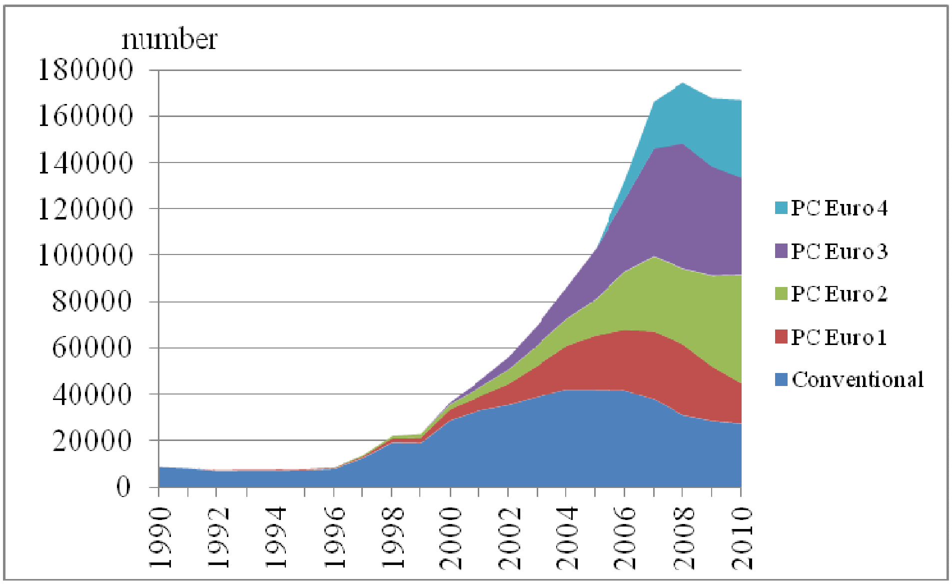


Figure 3.19 Distribution of diesel oil passenger cars fleet by layers

The vehicle numbers per LDV sub-class and layers are shown in Figure 3.20 and Figure 3.21.

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 2010 a share of diesel cars is 87.7%;
- As of 2002, the number of EURO 3 and EURO 4 cars rapidly increases. In 2010 a share of EURO 3 and EURO 4 cars constitute 48.5%;

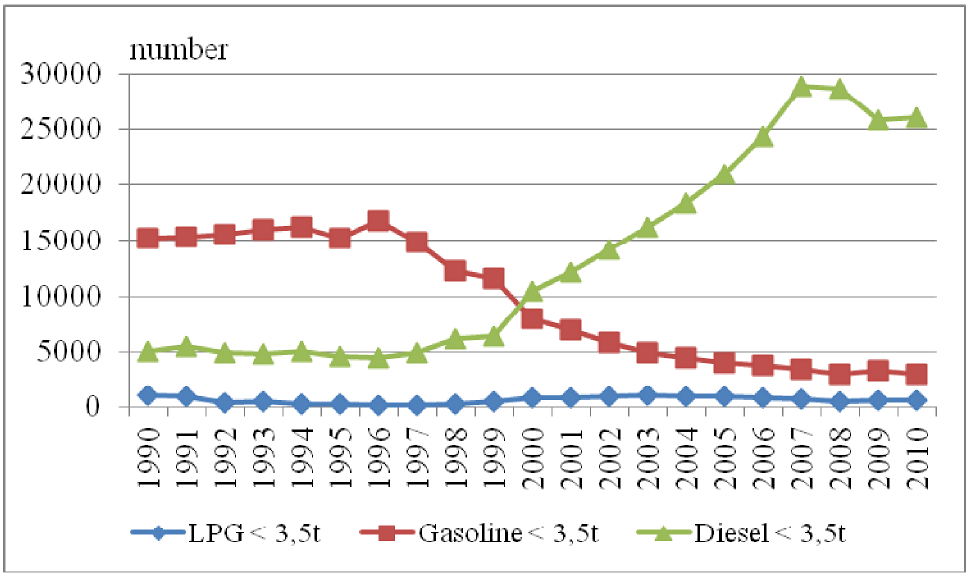


Figure 3.20 Distribution of light duty vehicles fleet by sub-classes

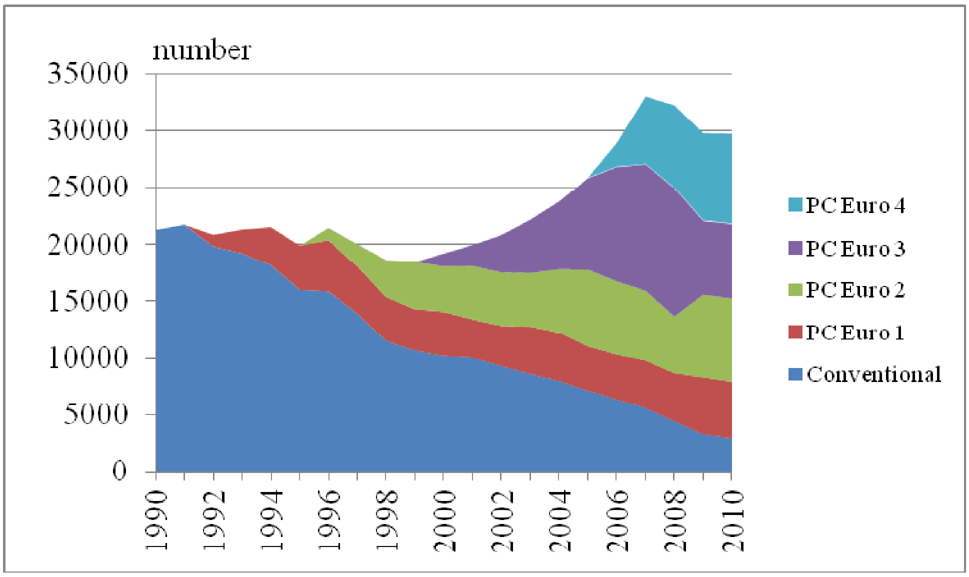


Figure 3.21 Distribution of light duty vehicles fleet by layers

The vehicle numbers per HDV sub-classes and layers are presented in Figure 3.22 and Figure 3.23.

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 8 % corresponding years 2000 and 2010;
- 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.

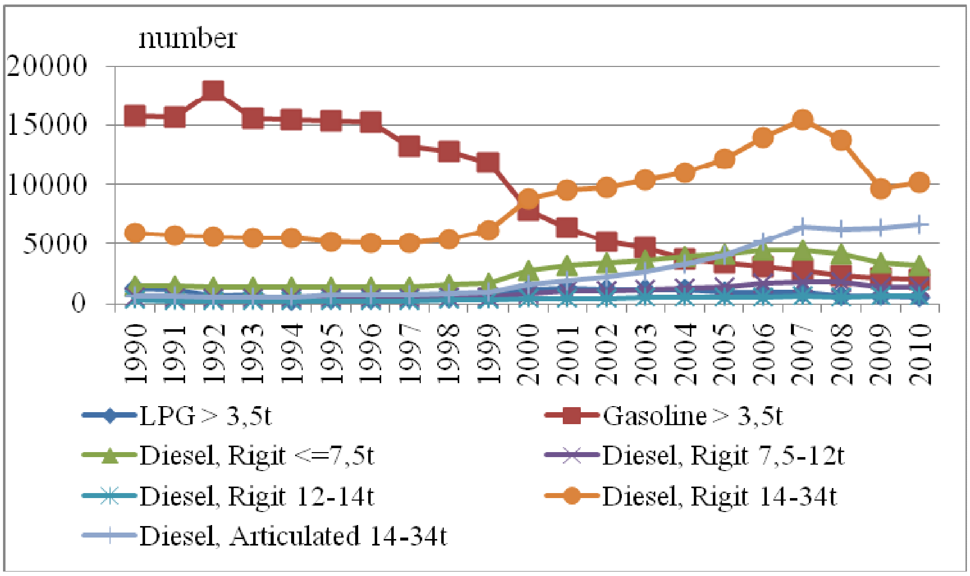


Figure 3.22 Distribution of heavy duty vehicles fleet by sub-classes

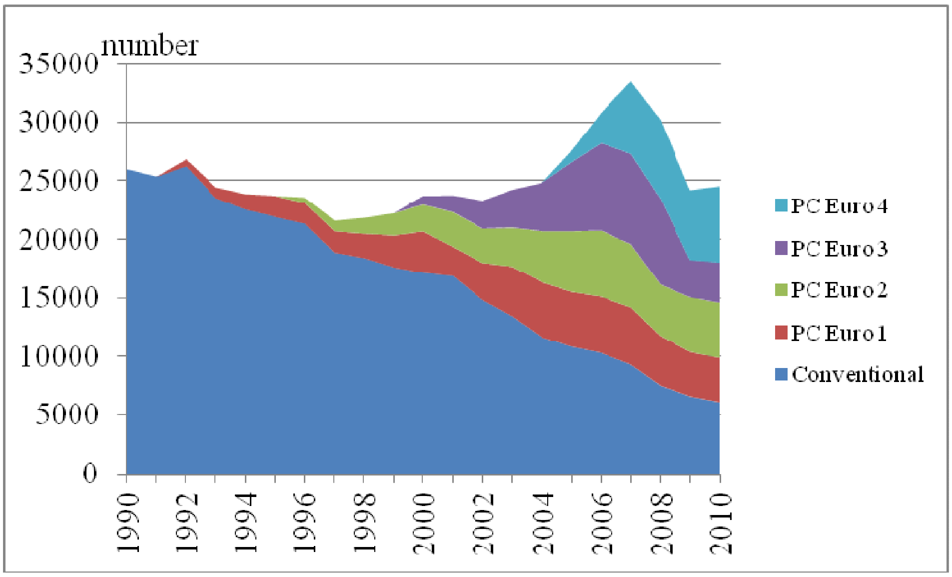


Figure 3.23 Distribution of heavy duty vehicles fleet by layers

Emission factors

CO_2 emissions in COPERT IV model were calculated, using country-specific CO_2 emission factor that is are calculated based on the information available on the C and H content in fuel. For gasoline the C content is 83.13%, it is calculated NCV for gasoline (43.96 MJ/kg) and estimated CO_2 emission factor in accordance Requirements from the IPCC Guidelines. Estimated Emission factor with oxidation factor is 68.6 kg CO_2 kg/GJ. Calculated and implemented CO_2 emission factor for diesel oil is 74 CO_2 kg/GJ.

N_2O un CH_4 emission factors comes from the COPERT IV model. They are specific for every vehicle classes, subclasses and layers (engine power, age and vehicle categories according to emission control system) and dependent from transport mode (urban, rural and highway).

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

3.2.8.4.1 Source category description

In 2010, the fuel consumption in railway constituted 7.31 % of GHG emissions from the total GHG emissions in transport. Freight transport has a dominant role in railway. The railway transport accomplishes approximately 51% (2010) 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. Railway transport includes railway transport operated by diesel locomotives.

Railway related fuel consumption is key sources for CO_2 emissions (Figure 3.24).

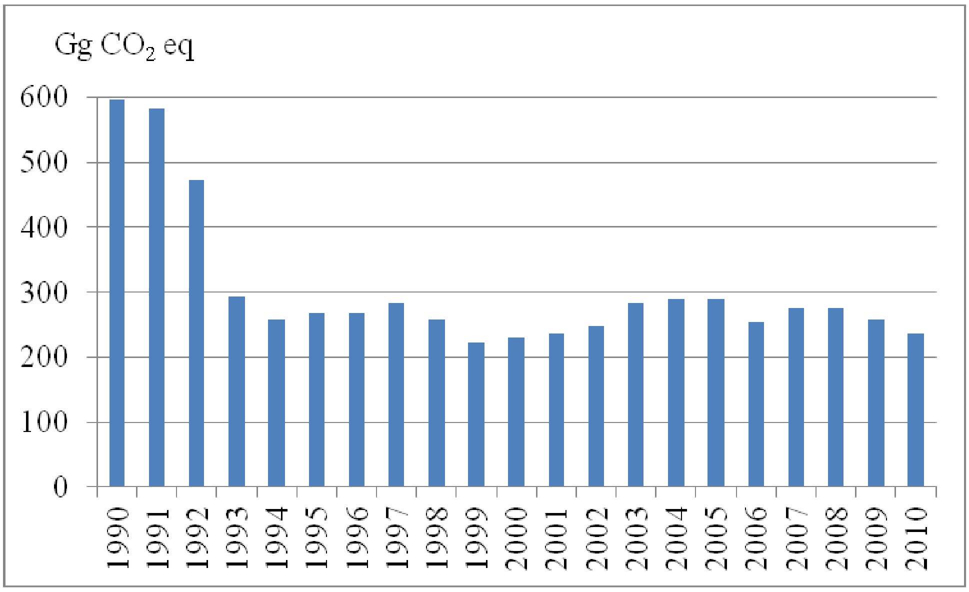


Figure 3.24 Development of GHG emissions in railway (Gg CO_2 eq)

3.2.8.4.2 Methodological issues

Methods

The 2000 IPCC Guidelines Tier 1 approach 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 3.25 and Table 3.33.

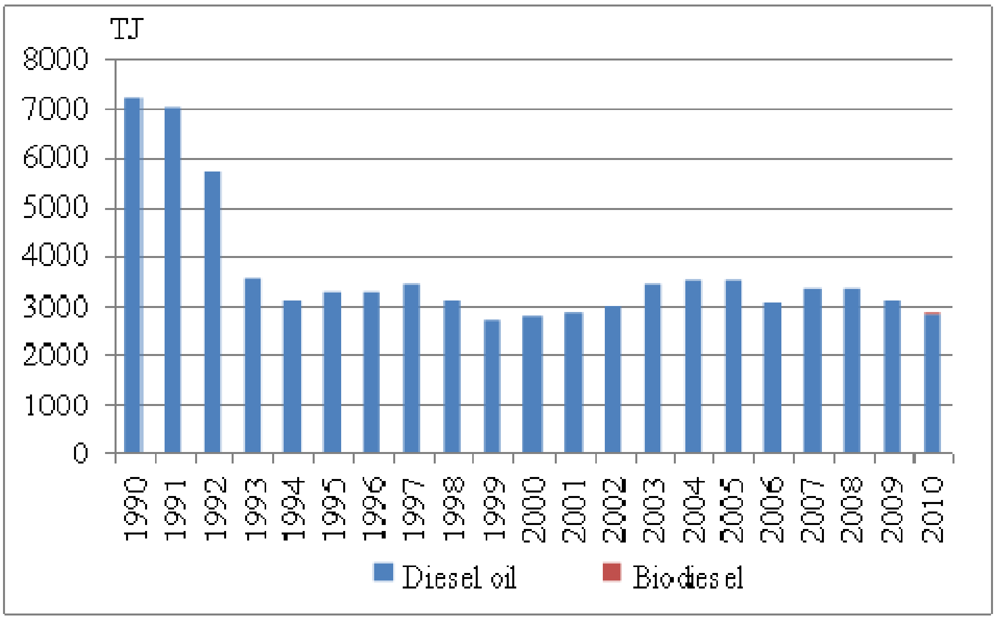


Figure 3.25 Development of fuel consumption in railway (TJ)

Table 3.33 Fuel consumption in railway (TJ)

	Diesel oil	Biodiesel
1990	7181	-
1991	7011	-
1992	5694	-
1993	3527	-
1994	3102	-

	Diesel oil	Biodiesel
1995	3229	-
1996	3229	-
1997	3399	-
1998	3102	-
1999	2677	-
2000	2762	-
2001	2847	-
2002	2974	-
2003	3399	-
2004	3484	-
2005	3484	-
2006	3059	-
2007	3314	-
2008	3314	-
2009	3102	-
2010	2804	35

Emission factors

Default EFs for railway is used (EMEP/Corinair 2009) (Table 3.34).

Table 3.34 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	0.0941

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

3.2.8.5.1 Source category description

In 2010, fuel consumption in navigation was responsible for 0.78 % of GHG emissions from total GHG emissions in transport.

Although Latvia has several ports, local navigation that could transport freight or passengers among local ports is not widely developed. Major activities in ports deal with international freight transport. Activities of domestic navigation comprise seasonal passenger transport by passenger vessels, freight transport among domestic ports and different miscellaneous vessels to ensure operation of ports. In 2010, the diesel oil consumption increased by 84%, compared to 2009 level, and thus also the GHG emissions (Figure 3.26). One of reasons for fuel consumption increasing was cold winter which request wide using of icebreakers for long period. In navigation, the emissions are calculated for diesel-fuelled water-borne vessels, miscellaneous vessels, towboats and barges and gasoline – fuelled private boats.

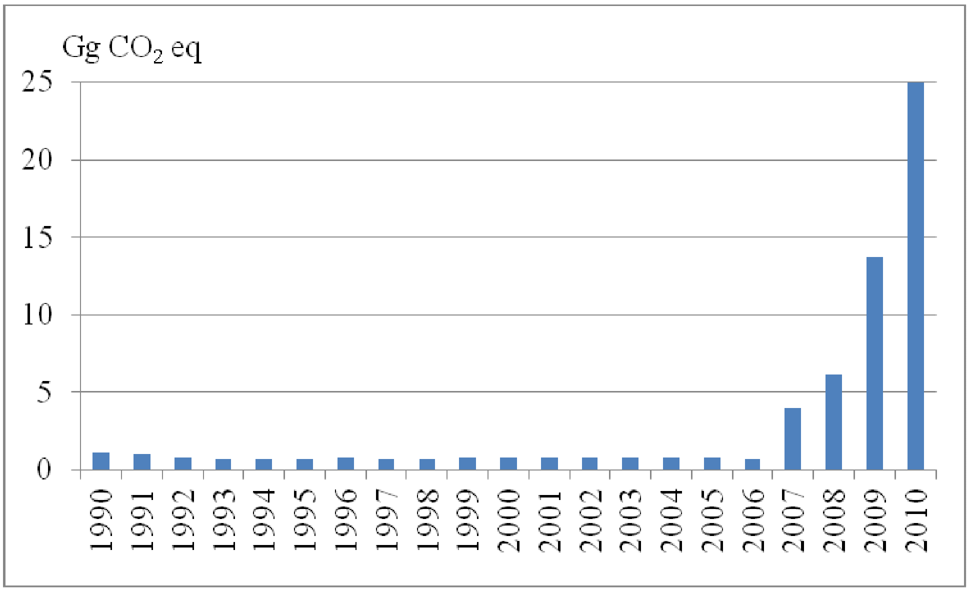


Figure 3.26 GHG emission development in navigation (Gg CO_2 eq)

3.2.8.5.2 Methodological issues

Methods

The 2006 IPCC Guidelines Tier 1 approach 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 from the study ("Evaluation of fuel consumption for domestic aviation and navigation", FEI, 2004). Development of fuel consumption in navigation is presented in Figure 3.27 and
Table **3.35**.

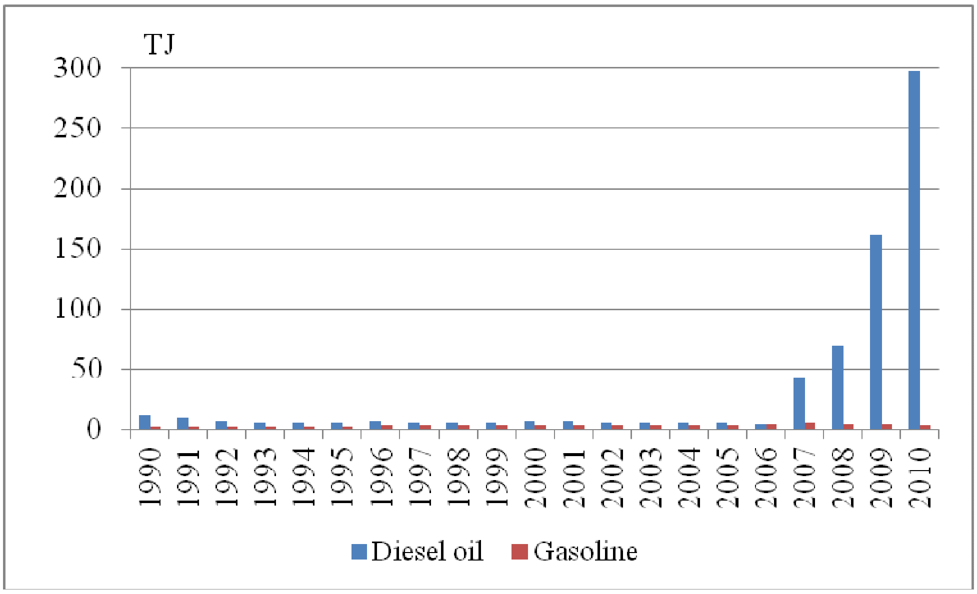


Figure 3.27 Development of gasoline and diesel oil fuel consumption in domestic navigation

Table 3.35 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	85	5
2009	170	4
2010	297	3

Emission factors

Default EFs for navigation is used (Revised 1996 IPCC Guidelines and EMEP/EEA 2009) (Table 3.36).

Table 3.36 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

3.2.8.6 Source - specific recalculations

The following recalculations and improvements of the emission inventories have been made in the transport sector since the emission reporting in 2009. (Table 3.37)

Table 3.37 Recalculations for Sub-category CRF 1.A.3 Transport

Sub-category	Recalculation	Improvements
Road transport (CRF A.3.b)	All emissions for year 2009 have been recalculated	Due to the correction of fuel consumption in road transport made by CSB, it is recalculated emissions of road transport for year 2009. Recalculation affected direct and non direct emissions
Navigation (CRF A.3.d)	All emissions for time period 1990 – 2009	Default EF from EMEP/EEA 2009 was implemented. Recalculation affected non direct emissions
Civil aviation (CRF A.3.a)	All emissions for time period 2005-2009	Taking into account comments and proposals from reviewers of the inventory 2009 default EF for jet Tier 2 approaches have been corrected and applied for jet kerosene emission calculation.

3.2.8.7 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 3.38).

Table 3.38 Planned improvements for Sub-category A.3. Transport

Sub-category	Planned improvements
Railway (CRF 1.A.3.C)	To make study for revising of activity data of railway and realize exercise for implementation of Tier 2 method in year 2012.

3.2.8.8 Uncertainties and time series consistency

Uncertainty in activity data of fuel consumption in transport is ±2% in 2010. 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 2 - 5%. CH_4 and N_2O emission factor used in estimation of emissions was taken from EMEP/EEA 2009 so uncertainty was assigned 50 %. Evaluated total uncertainty (activity data and emission factor) for CO_2 emissions in transport sector are from 2.83 % to 5.39 %. Evaluated total uncertainty for CH_4 and N_2O emission are from 50.04 % to 53.85 %.

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.

3.2.8.9 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.

3.2.8.9.1 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 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.
    - 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.

Each expert 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.

3.2.8.9.2 Additional QA/QC checks for Tier2 methodology

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

It is assessed that implemented default EF from COPERT IV model are applicable to national circumstances because model comprises all necessary technologies. Country specific EFs for CO_2 are calculated based on 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.

3.2.9 Other sources (CRF 1.A.4)

3.2.9.1 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 3.39 Emissions from 1.A.4 Other Sectors in 1990–2010 (Gg)

	CO_2	CH_4	N_2O	GHGs (CO_2 eq)	NO_x	CO	NMVOC	SO_2
1990	5503.71	11.20	0.16	5789.75	10.59	223.02	52.76	38.67
1991	5634.46	12.71	0.18	5956.87	10.75	199.13	31.78	36.08
1992	3992.90	11.50	0.17	4286.05	8.54	182.49	29.87	29.12
1993	3316.74	12.15	0.17	3624.08	7.70	191.50	31.55	23.36
1994	2298.12	12.04	0.16	2600.51	6.26	191.70	31.36	17.85
1995	1539.28	12.56	0.17	1855.56	5.67	189.78	32.07	9.47
1996	1556.67	12.92	0.18	1882.20	5.79	200.22	33.52	10.20
1997	1312.29	12.22	0.17	1620.18	5.30	188.87	31.71	7.59
1998	1137.95	11.36	0.16	1424.78	4.77	179.36	30.33	5.56
1999	1119.07	11.15	0.15	1400.76	4.74	174.66	29.39	4.07
2000	1043.00	10.47	0.14	1307.46	4.38	177.29	28.62	2.97
2001	1186.34	11.55	0.16	1477.30	4.80	192.49	30.63	3.39
2002	1153.95	11.31	0.15	1439.02	4.73	187.38	30.06	2.68
2003	1259.18	11.87	0.16	1558.48	4.99	197.38	32.15	2.10
2004	1309.88	12.22	0.17	1618.97	5.21	200.07	32.49	1.86
2005	1289.87	12.25	0.17	1600.45	5.15	208.10	32.89	1.73
2006	1350.50	11.89	0.16	1651.24	5.15	205.36	31.98	1.47
2007	1363.72	11.90	0.17	1665.03	5.22	202.76	31.40	1.19
2008	1284.88	10.99	0.15	1563.79	4.68	195.19	29.98	0.97
2009	1273.45	12.09	0.17	1580.05	4.94	213.93	33.22	0.81
2010	1441.48	11.34	0.16	1729.06	4.95	200.00	30.69	1.20

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 3.39). Increase of CO_2 emissions in 2000–2007 is explained with development of national economy and well-being of population. CO_2 emission is also affected by increase of individual heating supply consumers in 1.A.4.b Residential sector. Increase of gaseous fuels consumption, steady biomass fuel consumption and increase of peat consumption caused the decrease of CO_2 emissions and increase of CH_4 emissions. That's why methane emissions from 1.A.4 Other sectors had increased 8.25% in 2000–2010. Total GHG emissions from 1.A.4 Other Sectors increased in 2000 – 2010 by 32.25%. It can be explained with development of 1.A.4.a Commercial / Institutional sector. Decrease of central heating system role in residential households increase emissions from 1.A.4.b sector.

Due to high costs of liquid fuels and increase of natural gas prices in Latvia CO_2 emissions have decreased by 0.89% in 2008-2009. Biomass has increased in 2008-2009 – by 10.53%. Natural gas has the second biggest decrease in 2008-2009 – by 6.59% mainly due to increasing costs of fuel influenced by increasing taxes in 2008-2009. Liquid fuels have decreased by 9.69% but solid fuels have the biggest decrease by 12.5% in 2008-2009. For 2010 emissions increased by 13.19% comparing with 2009 due to increase of all type of used fuels.

In 2009-2010 GHG emissions from 1.A.4 sector have increased by 9.43% as in other stationary fuel combustion sector due to increase of necessity for produced heat.

Also indirect GHG emissions from Other Sectors were estimated. SO_2 had biggest decrease by 96.89% in 1990–2010. It is explained with fuel switching to natural gas and biomass from what sulphur dioxide emissions aren't emitted.

3.2.9.2 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:

$$Em = EF \times B_q$$

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 2008-2010 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:

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

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 3.40).

Table 3.40 Characteristics of methane obtained from landfil gas and estimated CO_2 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 3.41). 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 3.41 below are used for emission estimation from off-roads.

Table 3.41 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
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

Emissions from 1.A.4 sector are calculated using fuel consumption data from the CSB prepared within Annual questionnaires for 1990-2010 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 3.42).

Data for 1.A.4.b sector is obtained by CSB with household surveys done once in 5 years and using extrapolation for the years in between.

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 3.42 Fuel consumption in 1.A.4 Other sectors in 1990–2010 (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	9.079	8.000	7.145	7.550	7.048
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	3.077	2.610	2.215	2.458	1.875
Gasoline	0.044	0.044	0.044	0.044	0.220	NO	0.085	0.087	0.041	0.086	0.086
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 liquid	0.251	NO	NO	NO	NO	NO	NO	NO	NO	0.041	0.081
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	3.099
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
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

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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
Wood	1.220	1.229	1.271	1.306	1.307	0.358	0.365	0.617	0.648	0.665	0.590

Continuation of Table 3.42

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1.A.4 Other Sectors										
Liquid Fuels	7.481	6.969	7.875	7.937	7.757	8.392	7.879	7.097	7.756	8.191
Solid Fuels	3.004	2.391	2.213	2.150	2.065	2.007	2.002	1.814	1.589	2.120
Gaseous Fuels	7.079	8.118	8.803	9.748	9.794	10.150	11.064	10.989	10.263	11.810
Biomass	36.562	36.295	38.321	39.574	39.522	38.380	38.399	35.487	39.230	36.448
1.A.4.a. Commercial/Institutional										
Liquid Fuels	2.046	1.869	2.196	2.167	1.810	2.225	1.892	1.579	1.564	1.493
Gasoline	0.075	0.046	0.039	0.041	0.042	0.038	0.043	0.039	0.044	0.044
Diesel oil	1.190	1.243	1.465	1.546	1.198	1.626	1.643	1.339	1.389	1.317
RFO	0.609	0.325	0.284	0.284	0.365	0.365	0.041	0.081	0.041	0.041
LPG	0.091	0.046	0.182	0.137	0.137	0.137	0.137	0.091	0.091	0.091
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	0.082	0.210	0.225	0.159	0.029	0.058	0.029	0.029	NO	NO
Shale oil	NO	NO	NO	NO	0.039	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
Coal	1.537	1.423	1.337	1.285	1.049	1.101	1.075	0.918	0.734	1.023
Peat briquettes	0.015	NO	NO	NO	NO	NO	0.001	0.001	0.006	0.002
Peat	NO	NO	0.010	NO	0.020	0.040	0.060	0.030	0.010	NO
Natural gas	3.359	4.117	4.286	4.768	4.753	5.010	5.704	5.701	5.428	5.618
Biomass	5.497	5.709	5.965	6.894	6.736	6.651	7.253	4.995	4.834	5.109
Wood	5.497	5.663	5.803	6.652	6.485	6.381	6.966	4.691	4.482	4.716
Landfil gas	NO	0.046	0.162	0.242	0.251	0.259	0.271	0.290	0.323	0.331
Straws	NO	NO	NO	NO	NO	0.011	0.016	0.014	0.029	0.058
Other Liquid Biofuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.004
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
Gasoline	0.132	0.132	0.132	0.132	0.220	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
RFO	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
Other kerosene	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
Coal	1.338	0.854	0.787	0.787	0.944	0.813	0.813	0.813	0.813	1.049
Peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.020
Natural gas	3.007	3.298	3.667	3.964	4.199	4.333	4.595	4.700	4.313	5.216
Wood (including charcoal)	30.519	30.078	31.850	32.073	32.234	31.195	30.433	30.168	33.667	30.742
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
Gasoline	0.011	0.017	0.044	0.044	0.044	0.044	0.044	NO	NO	NO
Diesel oil	3.739	3.399	3.994	4.079	4.164	4.461	4.504	4.079	4.122	4.461
RFO	0.244	0.244	0.244	0.203	0.162	0.041	NO	NO	NO	NO
LPG	NO	NO	NO	NO	NO	NO	NO	0.046	0.046	NO
Other kerosene	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Other liquid	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

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Coal	0.114	0.114	0.079	0.079	0.052	0.052	0.052	0.052	0.026	0.026
Peat briquettes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Peat	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	0.977
Wood	0.546	0.508	0.506	0.607	0.552	0.534	0.713	0.324	0.722	0.568

The biggest decrease in 1990-2010 was for solid fuel consumption – 90.99%, and liquid fuels consumption – 72.19% (Table 3.42). It is explained with fuel switching processes when solid and liquid fuels were switch to other more low-costs fuels. Also stronger legislation contributed fuel switching to the type of fuels with lower level of emissions.

Since 1992, biomass as fuel dominates in Other Sectors. Biggest part of solid biomass consumption goes to Residential sector where biomass is main fuel in small capacity burning installations. Consumption of biomass fuel has increased substantially by 53.63% in 1990–2010 in Residential sector.

Since 1997, gaseous fuel consumption is constantly increasing until 2007. These are types of fuels with lower cost 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 fluctuation of gaseous fuel are observed. The consumption of gaseous fuel increased by 15.07% in 2010 comparing to 2009.

3.2.9.3 Uncertainties and time series consistency

Uncertainty in activity data of fuel combustion in 1.A.4 sector is ±2% in 2010. 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 30%.

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.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level. All issues given below in Table 3.43 were double-checked and large fluctuations were explained.

Table 3.43 IEF changes higher than 10% for 1.A.4 sector

Sectors	GHG	Unit	Year	First Year	Year	Second Year	Difference	Comments
1.A.4.a	Liquid Fuels/CH4	kg/TJ	1995	10	1996	11.11	11.09%	Gasoline consumption fluctuations and the part of gasoline consumption in total amount of liquid fuels consumption. In 1995 no gasoline was used in off-roads. Only CH_4 EF of gasoline differs from other liquid fuels.
1.A.4.a	Liquid Fuels/CH4	kg/TJ	1994	11.50818	1995	10.00	-13.11%	
1.A.4.a	Liquid Fuels/CH4	kg/TJ	1993	10.15878	1994	11.51	13.28%	
1.A.4.a	Other Liquid Fuels/CO2	t/TJ	2005	95.11825	2006	78.61	-17.36%	In 2005 structure of other liquid fuels changed therefore average NCV in 2005 was lower (more light liquid fuels were used). That's why estimated CO_2 EF and estimated carbon emission factor increased in 2005.
1.A.4.a	Other Liquid Fuels/CO2	t/TJ	2004	82.07938	2005	95.12	15.89%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	2008	19.52047	2009	16.20	-16.99%	Changes of CH_4 IEF are explained with appearance and fluctuation of peat and peat briquettes consumption.
1.A.4.a	Solid Fuels/CH4	kg/TJ	2007	25.64436	2008	19.52	-23.88%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	2006	20.21341	2007	25.64	26.87%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	2005	15.45327	2006	20.21	30.80%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	2004	10	2005	15.45	54.53%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	2003	12.16326	2004	10.00	-17.79%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	2002	10	2003	12.16	21.63%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	2001	12.89378	2002	10.00	-22.44%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	2000	15.62821	2001	12.89	-17.50%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	1999	12.17576	2000	15.63	28.36%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	1998	18.28911	1999	12.18	-33.43%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	1997	26.35466	1998	18.29	-30.60%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	1996	30.57658	1997	26.35	-13.81%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	1995	20.79254	1996	30.58	47.06%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	1994	30.43331	1995	20.79	-31.68%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	1993	20.25809	1994	30.43	50.23%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	1992	25.64748	1993	20.26	-21.01%	
1.A.4.a	Solid Fuels/CH4	kg/TJ	1991	22.56967	1992	25.65	13.64%	
1.A.4.b	Liquid Fuels/CH4	kg/TJ	2005	25.3361	2006	27.90	10.14%	CH_4 and N_2Oemissions from liquid fuels in this sector is influenced with the amount of gasoline consumption in off-roads as gasoline fuel only has different CH_4 EF comparing to other liquid fuels types. That's why part of gasoline fuel in total liquid fuel consumption influence average IEF of liquid fuels in the sector.
1.A.4.b	Liquid Fuels/CH4	kg/TJ	2004	20.05258	2005	25.34	26.35%	
1.A.4.b	Liquid Fuels/CH4	kg/TJ	1999	10	2000	20.06	100.59%	
1.A.4.b	Liquid Fuels/N2O	kg/TJ	1999	0.6	2000	0.73	21.34%	
1.A.4.c	Liquid Fuels/CH4	kg/TJ	1990	22.03688	1991	10.91	-50.51%	
1.A.4.c	Liquid Fuels/N2O	kg/TJ	1990	0.840738	1991	0.62	-26.48%	
1.A.4.b	Solid Fuels/N2O	kg/TJ	1998	1.911361	1999	1.58	-17.29%	Changes of N_2O IEF are explained with appearance and fluctuation of peat and peat briquettes consumption.
1.A.4.b	Solid Fuels/N2O	kg/TJ	1997	1.647448	1998	1.91	16.02%	
1.A.4.b	Solid Fuels/N2O	kg/TJ	1994	1.482201	1995	1.72	15.81%	
1.A.4.c	Solid Fuels/N2O	kg/TJ	1997	1.587574	1998	1.40	-11.82%	
1.A.4.c	Solid Fuels/N2O	kg/TJ	1993	1.751479	1994	1.57	-10.39%	
1.A.4.c	Solid Fuels/N2O	kg/TJ	1992	1.540887	1993	1.75	13.67%	

3.2.9.4 *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.

3.2.9.4.1 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.

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.

3.2.9.4.2 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.

3.2.9.5 Source-specific recalculations

Some small activity data updates and corrections were done.

3.2.9.6 Source-specific planned improvements

The summarized necessary improvements are:

- Researches on use of the country specific emission factors for key category – CH_4 emissions from solid biomass combustion;
- 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;

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

3.2.10.1 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 3.44).

Table 3.44 Emissions from 1.A.5 Other sources in 1995–2010 (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

	CO_2	CH_4	N_2O	GHGs (CO_2 eq)	NO_x	CO	NMVOC	SO_2
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	2.2710	0.0001	0.0000	2.2863	0.0300	0.0352	0.0022	0.0007
2010	1.2046	0.0000	0.0000	1.2153	0.0051	0.0017	0.0009	0.0004

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.

3.2.10.2 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:

$$Em = EF \times B_q$$

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 3.45). 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 3.45 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 1990-2010 sent to EUROSTAT. The data collection system for 1.A.2 sector is the same as for 1.A.1 sector (Table 3.46).

Table 3.46 Fuel consumption in 1.A.5 Other sources in 1995−2010 (TJ)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1.A.5.b Other mobile sources																
Liquid fuels	**86.4**	**45.926**	**174.163**	**45.926**	**131.755**	**1.935**	**2.374**	**93.066**	**86.533**	**157.009**	**103.821**	**122.051**	**39.244**	**47.015**	**31.465**	**17**
aviation gasoline		2.726	1.363	2.726	2.155	1.935	2.374		4.837	2.858	2.374	5.716	0.967	5.408	1.143	NO
diesel oil								74.570	64.542	110.941	77.119	73.125	14.277	20.650	13.427	NO
jet fuel	86.4	43.200	172.800	43.2	129.6			17.496	17.154	43.210	24.327	43.210	24	20.957	16.895	17

3.2.10.3 Uncertainties and time series consistency

Uncertainty in activity data of fuel combustion in sectors CRF 1.A.5.b is ±2% in 2010 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. That's why activity data for the sector is assumed as quite high – 50%.

Emission factors used in estimation of emissions 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.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level. All issues given below in Table 3.47 were double-checked and large fluctuations were explained.

Table 3.47 IEF changes higher than 10% for 1.A.5.b sector

Sectors	GHG	Unit	Year	First Year	Year	Second Year	Difference	Comments
1.A.5.b	Liquid Fuels/CH4	kg/TJ	2007	1.599	2008	2.476	54.87%	All changes of IEFs are explained with structure of liquid fuels and part of total liquid fuels amount that particular fuel
1.A.5.b	Liquid Fuels/CH4	kg/TJ	2006	3.196	2007	1.599	-49.97%	
1.A.5.b	Liquid Fuels/CH4	kg/TJ	2005	3.843	2006	3.196	-16.83%	
1.A.5.b	Liquid Fuels/CH4	kg/TJ	2001	0.5	2002	4.085	716.97%	
1.A.5.b	Liquid Fuels/N2O	kg/TJ	2007	1.658	2008	1.385	-16.46%	
1.A.5.b	Liquid Fuels/N2O	kg/TJ	2006	1.161	2007	1.658	42.79%	
1.A.5.b	Liquid Fuels/N2O	kg/TJ	2005	0.960	2006	1.161	20.95%	
1.A.5.b	Liquid Fuels/N2O	kg/TJ	2001	2.0	2002	0.885	-55.76%	

3.2.10.4 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.

3.2.10.4.1 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.

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.

3.2.10.4.2 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.

3.2.10.5 Source-specific recalculations

There are no recalculations were done.

3.2.10.6 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 3.48 Reported emissions from fuel combustion in Latvia in 2010

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

Source	Emissions						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
1.B.2 Oil and Natural Gas							
1.B.a Oil	NO	NO	NO	NO	NO	√	NO
1.B.2.b Natural Gas	NO	√	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 3.49) 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 3.49 Fugitive NMVOC emissions from oil products 1990–2010 (Gg)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
2.979	2.533	2.411	2.342	2.239	2.019	1.994	1.833	1.715	1.656	1.324	1.387	1.351	1.324	1.407	0.861	0.642	0.629	0.499	0.643	0.738

For 2002–2010 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.

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 2002–2010 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 3.50).

Table 3.50 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 3.51) Activity data for 2002–2010 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 3.51 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 2002-2010 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 2002-2010 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.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level. There are no such issues.

3.3.1.4 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.

There are several steps for activity data used in emission estimation in 1990-2001 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.

NMVOC emissions reported for 2002-2010 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

It would be possible to estimate fugitive emissions from crude oil transportation via pipelines that occurred in the beginning of 90ties if activity data would be possible to obtain. For now only light liquid fuels are transported via pipelines as it was reported from pipelines infrastructure company.

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 3.52 Fugitive CH_4 emissions from natural gas 1990-2010 (Gg)

	CH_4	**NO_x**	**CO**
1990	13.05	NO	NO
1991	12.57	NO	NO
1992	11.46	NO	NO
1993	10.96	NO	NO
1994	10.71	NO	NO
1995	10.43	NO	NO
1996	10.05	NO	NO
1997	9.38	NO	NO
1998	9.0	NO	NO
1999	8.581	NO	NO
2000	7.94	NO	NO
2001	7.7	0.0000013	0.0000046
2002	8.03	0.0000013	0.0000046
2003	6.281	NO	NO
2004	6.213	0.0000013	0.0000046
2005	6.944	NO	NO
2006	5.035	NO	NO
2007	5.164	NO	NO
2008	5.302	NO	NO
2009	5.016	NO	NO
2010	4.83	NO	NO

Fugitive CH_4 emissions were decreasing in 1990–2001, only started from 2002 it fluctuates and continues to decrease (Table 3.52). 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. CH_4 emission increase in 2005 is explained with transmission pipeline accident in Valmieras district in April 2005 when significant amount of natural gas leaked. CH_4 emissions have decreased by 3.7% in 2010 comparing with 2009.

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 1990–2010. 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.

End user internal gas provision systems

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

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

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.

3.3.2.3 Uncertainties and time series consistency

Uncertainty of methane emission from natural gas consumption is assigned as quite low – 5%, as emissions were measured and estimated by only enterprise operated with natural gas in Latvia – "Latvijas Gāze" by methodology developed for enterprise. So activity data and emission factor is very precise.

Time series of the CH_4 emission is consistent and complete because the same methodology, emission factors and data sources are used 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.

Time series consistency was checked by verifying IEF changes and attention was paid to changes that increased 10% level. There are no such issues.

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.

"Latvijas Gāze" reports same emissions for national database "2-AIR" where reported emissions are verified and approved by the particular Regional Environment Board as the emissions are linked to natural taxes that company has to pay.

3.3.2.5 Source-specific recalculations

No recalculations have been done for the specific sector.

3.3.2.6 Source-specific planned improvements

According to Expert Review Team recommendation it is necessary to translate CH_4 estimation methodology and include it in the annexes of the NIR but due to lack of finances it will be done for the further inventories.

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 2010

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	√												

Source	Emissions												
	CO_2	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
4. Soda Ash Production and Use	NO												
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 5.28% of the total anthropogenic GHG emissions in Latvia in 2010. The most important emission source of the Industrial Processes in 2010 is CO_2 emissions from Mineral products and CO_2 emissions from Metal production.

Table 4.2 Greenhouse gas emission trend in 1990–2010 (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	598.871	585.985	12.829	0.0027	IE,NA,NE,NO	NE,NO	NE,NO	NA,NE,NO	NE,NO
1991	536.067	527.316	8.712	0.0018	IE,NA,NE,NO	NE,NO	NE,NO	NA,NE,NO	NE,NO
1992	256.644	250.884	5.734	0.0012	IE,NA,NE,NO	NE,NO	NE,NO	NA,NE,NO	NE,NO
1993	83.670	76.632	7.007	0.0015	IE,NA,NE,NO	NE,NO	NE,NO	NA,NE,NO	NE,NO
1994	146.724	140.137	6.552	0.0016	IE,NA,NE,NO	NE,NO	NE,NO	NA,NE,NO	NE,NO
1995	160.215	154.856	4.433	0.0013	0.643	0.473	NE,NO	0.0105	0.0265
1996	176.309	171.629	3.485	0.0014	0.873	0.498	NE,NO	0.0120	0.0280
1997	183.279	172.640	7.997	0.0023	2.086	0.558	NE,NO	0.0217	0.0372
1998	185.075	172.739	8.502	0.0023	3.074	0.948	NE,NO	0.0296	0.0456
1999	223.003	210.741	7.711	0.0024	3.523	1.287	NE,NO	0.0408	0.0568
2000	179.754	164.521	8.426	0.0025	5.479	2.320	NE,NO	0.0533	0.0693
2001	207.895	189.633	8.042	0.0025	8.191	32.199	NE,NO	0.0827	0.0987
2002	224.755	202.801	7.602	0.0025	10.917	32.770	NE,NO	0.1415	0.1575
2003	249.089	214.923	12.164	0.0027	17.531	65.510	NE,NO	0.1846	0.2006
2004	393.050	353.402	12.916	0.0027	21.304	125.300	125.300	0.2246	0.2406
2005	291.981	237.868	12.358	0.0027	34.167	132.945	132.945	0.3150	0.3310
2006	358.432	265.507	12.573	0.0027	73.020	161.714	161.714	0.2980	0.3177
2007	421.079	281.685	14.573	0.0027	115.631	131.955	131.955	0.3596	0.3791
2008	394.208	280.014	8.732	0.0026	95.330	194.094	194.094	0.4216	0.4435
2009	365.300	242.005	9.561	0.0022	100.159	199.867	199.867	0.5660	0.5899
2010	638.755	509.993	11.28	0.0027	105.174	321.454	321.454	0.5127	0.5347

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 55.85% in 2000-2008. It is explained with sharp development of Latvian industry when construction activities increased and industrial production of building materials also increased.

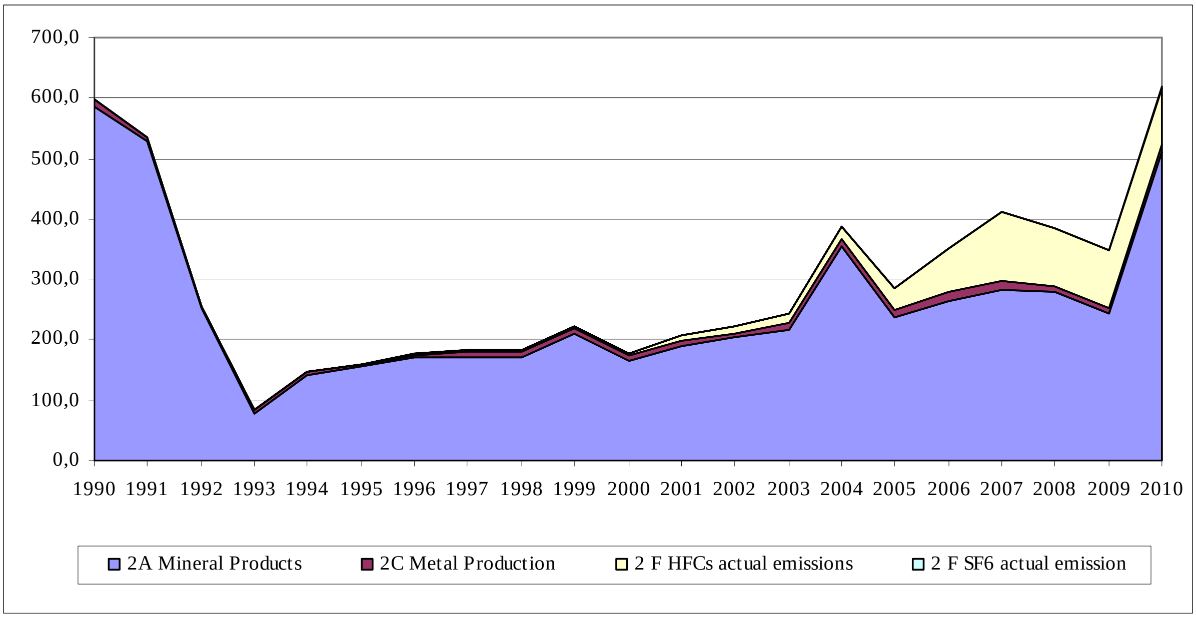


Figure 4.1 GHG emissions from Industrial Processes in 1990–2010 (Gg CO_2 eq.)

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 2010 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 1.388%. CO_2 emissions from 2.A.3 Limestone and Dolomite Use are key source according to Trend assessment with 0.167%.

HFCs emissions from consumption of f-gases are a key source category in 2010 according to Level and Trend assessments – 0.309% and 0.730% respectively (Table 4.3).

Table 4.3 Key categories of Industrial Processes sector in 2010 (%)

IPCC GHG Source and Sink Categories (LUCF not included)	Gas	% Level Assessment	% Contribution to trend
2.A.1 Cement Production	CO2	1.388%	0.486%
2.A.3 Limestone and Dolomite Use	CO2	0.065%	0.315%
2.A.6 Road Paving with Asphalt	CO2	0.132%	0.217%
2.F(a).1 Refrigeration and Air Conditioning Equipment	HFCs	0.309%	0.730%

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 1990–2010 (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	40.9999	4.7719	0.4829	0.0010	14.0098	0.0705
Share of total 2010 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.

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).

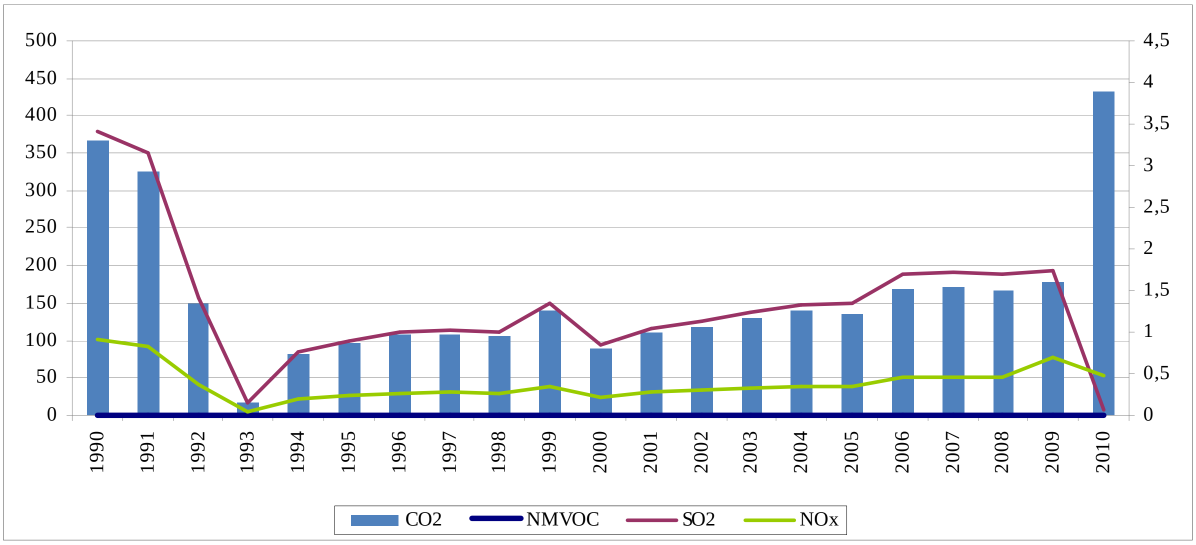


Figure 4.2 Emissions from Cement production in 1990–2010 (Gg)[14]

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.

[14] SOx, NOx and NMVOC emissions on secondary axis

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]

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

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 1990–2010 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 used limestone (%) and average CO_2 emission factor in 1990–2010 (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

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 answer from plant that average CaO content of years where data is available could be used was received.

For Submission 2012 the CaO content data for 2010 was requested to cement production plant. CO_2 emission factor for 2010 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 2012 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 weighed 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 2.5 times more clinker in 2010 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.

Table 4.7 CKD correction factor in 1990–2010

	Produced clinker	Produced cement kiln dust	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

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 CO_2 emissions from cement production. CKD ratio was changed to 8% that is maximum permissible good practice guidance limit of CKD (6%–8%) although official statistical data resulted in different CKD ratio.

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

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

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.

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.

Plant specific CO_2 emission factors and Tier2 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 necessary to implement Tier 2 QA/QC procedures for the sector as it's a key source category. It is important to revise CO_2 emission estimations using Tier2 level of QA/QC for the sector as plant specific parameters and values are used in emission estimation and these parameters need to be double-checked as some of them are doubtful.

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 2005–2010 (Gg)

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

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.

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 2005–2010 (Gg)

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

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.

4.2.3.2 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.

4.2.3.3 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 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.

[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)

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.

4.2.3.4 Source-specific recalculations

No recalculation has been done for the sector.

4.2.3.5 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 believable 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.

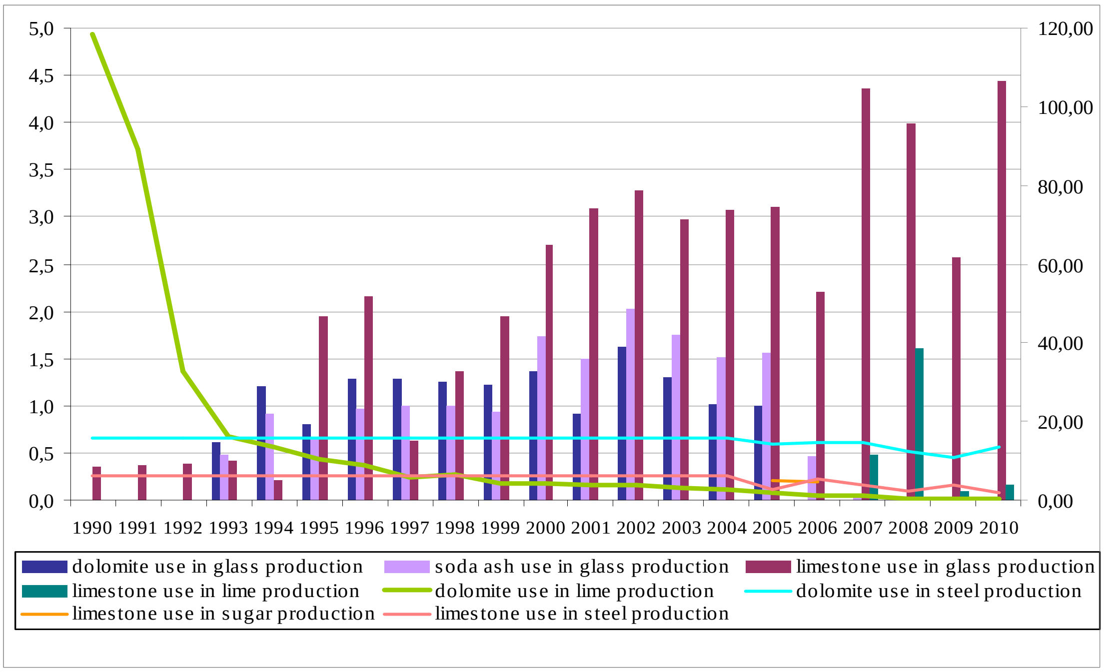


Figure 4.3 CO_2 emission from limestone, dolomite and soda ash use in 1990–2010 (Gg)[22]

The sharp decrease of limestone use in glass production plant in 1997 and accordingly the CO_2 emissions is explained with changed 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.

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

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

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

	1990–2010
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:

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

$0.3095_{\text{t CO2}}$ 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 $_{\text{dolomite use in lime production}}$ = $309.51_{\text{kg CO2}} \times 94.76\%$ = 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.

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**

	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)**
2007	53.096		9.899	30.405	9.017	3.776	1.078		**0.090**
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		

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.

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

It is necessary to perform Tier2 QA/QC procedure for the sector as third part revision of the used activity data and used emission estimation methodology is needed. The verification of the sector is planned to do for next submissions.

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.

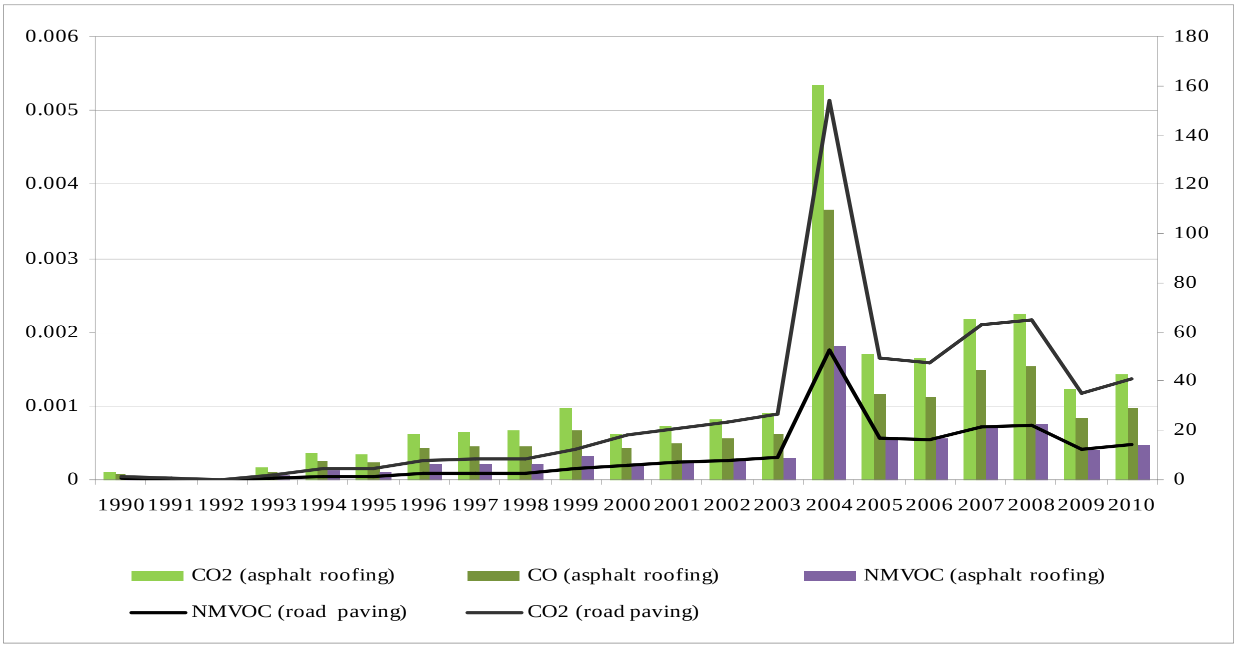


Figure 4.4 Emissions from asphalt roofing and road paving in 1990–2010 (Gg)[23]

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 (Figure 4.4).

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

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 2012 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)
[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)

Table 4.12 Emission factors for asphalt roofing and road paving in 1990–2010

	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 2012 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

[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)
2006	1116.6968	90%	10%	1005.0271	111.6697
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	971.3158	90%	10%	874.1842	97.1316

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 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.

4.2.5.5 Source-specific recalculations

No recalculation has been done for the sector.

4.2.5.6 Source-specific planned improvements

It is necessary to implement technology specific emission factors. It is possible to use Tier2 emission factors from EMEP/EEA 2009 still the activity data division according to technology is needed.

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.

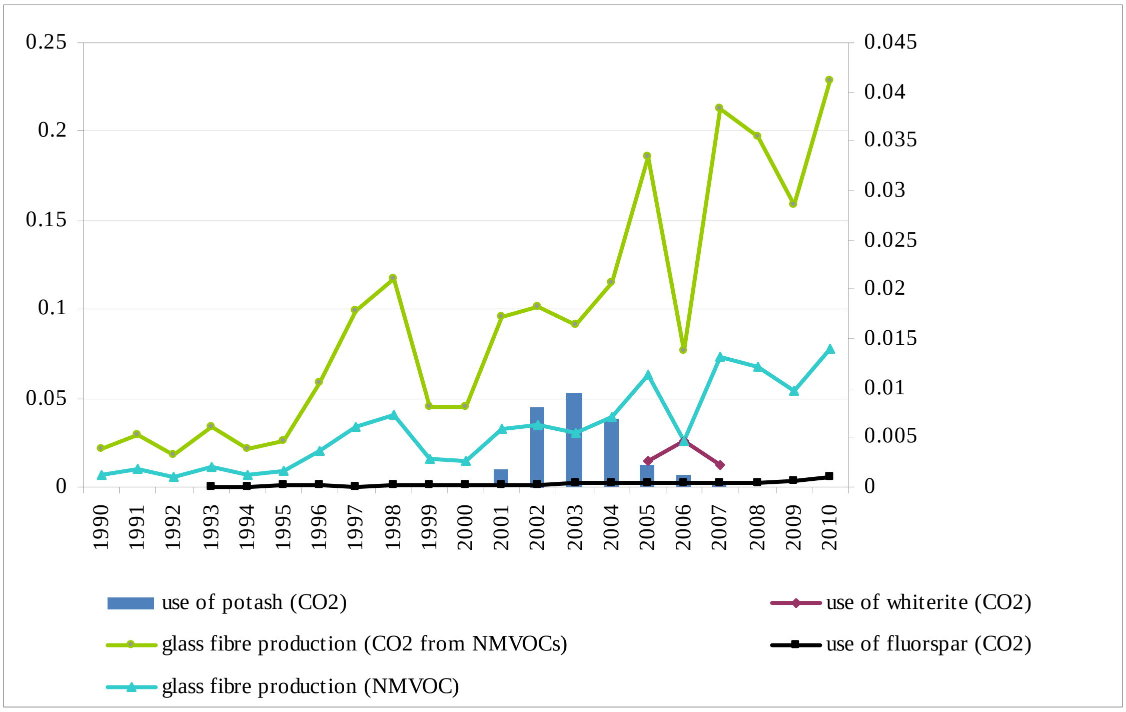


Figure 4.5 Emissions from raw materials use in glass production 1990-2010 (Gg)[29]

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).

[29] Emissions from use of potash on primary axis

NMVOC emissions for time period 1997-2010 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 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 1990–2010 (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**

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 1997-2010 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 2012 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. CO2 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 – 2010
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).

[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

Table 4.16 Activity data for raw materials use in glass production 1990-2010 (Gg)

	Use of potash	Use of fluorspar	Use of barium carbonate	Use of butylacetate
1990				0.0013
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		

In 2008-2010 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.

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.

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.

CO_2 emission estimation for 1990-1992

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. To make emission estimation more or less consistent CO_2 emission for year 2008 was recalculated.

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:

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

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

[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 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%.

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

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 (%)

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

EF_{MgCO3} – $MgCO_3$ emission factor (Gg/Gg)

Emission factors

Default CO_2 emission factors from the MRG for the $CaCO_3$ and $MgCO_3$ are used. CO_2 emission factor for $CaCO_3$ is 0.44 tCO_2/t $CaCO_3$ and CO_2 emission factor for $MgCO_3$ is 0.522 tCO_2/t $MgCO_3$.

Activity data

The content of $CaCO_3$ and $MgCO_3$ are determined in plant laboratories or stated in mineral deposits passport.

Activity data carbonate is $CaCO_3$, $MgCO_3$ or other alkali earth or alkali carbonates amount that is used during the reporting period input (clay). Carbonate mass is estimated using clay consumption amount and results of clay content measurement with maximal allowable process uncertainty of ± 2.5%. (Table 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.

Still for UNFCCC reporting the methodology change to lower tier is not acceptable so year 2008-2009 emissions were recalculated.

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.

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

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

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

where:
CO_2 – total CO_2 emissions from bricks production (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 (%)

[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)

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:
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 2005-2010 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
use of clay (Gg)	29.891	22.316	23.854	77.687	19.814	32.513
$MgCO_3$ content (%)	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%
$MgCO_3$ amount (Gg)	3.213	2.399	2.564	8.351	2.130	3.495
$CaCO_3$ amount (Gg)	3.823	2.854	3.051	9.936	2.534	4.158
$MgCO_3$ CO2 EF (tCO2/t oxide)	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
CO_2 emissions (Gg)	**3.359**	**2.508**	**2.681**	**8.73**	**2.23**	**3.65**
Average CO_2 EF (tCO_2/t oxides)	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 4^{th} 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 4^{th} 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 4^{th} 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 4^{th} 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 4^{th} 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

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

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

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.

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

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 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.

$$\boxed{CO_2 = \sum\left(\left(AD_{raw} \times AD_{CaO,MgO}/100\right) \times EF \times CF\right)}$$

where:
CO_2 – total CO_2 emissions from bricks production (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:

$$\boxed{CO_2 = \sum\left(\left(AD_{raw} \times AD_{additive}/100\right) \times 1.785 \times EF \times CF\right)}$$

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:

$$\boxed{AD_{raw} = \sum\left(AD_{bulk} \times M_{av} - M_{bulk} \times moisture/100\right)}$$

[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)

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 (%)

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 CO2 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	0.785	0.785	0.785	0.785	0.785	0.785	0.785	0.785	0,785	0,785	0,785	0,785

	2008				2009				2010			
oxide)												
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 (Gg)	**1.594**				**0.647**				**0.660**			

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.

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.

Plant specific CO_2 emission factors and Tier2 CO_2 emission estimation methodology

Tier2 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 1995-2010 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 4.25 CO_2 emissions from tile production in 1995-2010 (Gg)

	use of clay in tile production
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

Emissions are decreasing since 2003 with some fluctuation due to decrease of activity of tiles production plant. (Table 4.25) 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%.

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 4.26)

[43] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:229:0001:0085:LV:PDF, page 80

Table 4.26 Activity data for tile production in 1995-2010 (Gg)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
use of clay in tiles production	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

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.

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.

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 4.27 Emissions from 2.C Metal Production in 1990–2010 (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
Share of total 2010 emissions[53]	**0.09%**	**0.00%**	**0.023%**	**0.000%**	**0.002%**	**0.001%**

Biggest decrease occurred in time period 1990–1992 due to changes in Latvia's national economy (Table 4.27). Decrease of CO_2 emissions in 1990–1996 also occurred due to decrease of used crude iron in open-hear furnaces 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.

4.4.2 Methodological issues

Differs in CRF Reporter and in NIR.

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.

CO_2 emission estimations from crude steel production

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:

$$Emissions_{crude\ steel} = (\text{Mass of Carbon in the Crude Iron used for Crude Steel Production} - \text{Mass of Carbon in the Crude Steel}) \times 44/12 + \text{Emission factor}_{EAF} \times \text{Mass of Steel Produced in EAF}$$

According to information reported by steel producer:

- Average carbon content of crude iron using in steel production is 3 – 4% in 1990-2006, 4% for 2007, 2009, 2010, and 3% for 2008;
- Average carbon content of produced steel is 0.1 – 0.4% for 1990-2006, 0.3% for 2007-2008 and 0.2% for 2009, 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

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

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 4.28 below.

Table 4.28 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

	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
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

CH_4 and indirect GHG emission estimations from crude steel production

Methods

The CH_4, NMVOC, CO, NO_x and SO_2 emissions from iron and steel production are calculated at the LEGMC based on activity data from the CSB and steel production plant according to EMEP/CORNAIR methodology and emission factors.

Emission factors

Emission factors of methane and indirect GHG emissions are taken from EMEP/EEA 2009 (Table 4.29).

Table 4.29 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. Therefore CH_4 IEF

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.

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.

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 using Tier2 level of QA/QC for the sector as plant specific parameters and values are used in emission estimation and these parameters need to be double-checked as some of them are doubtful.

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.

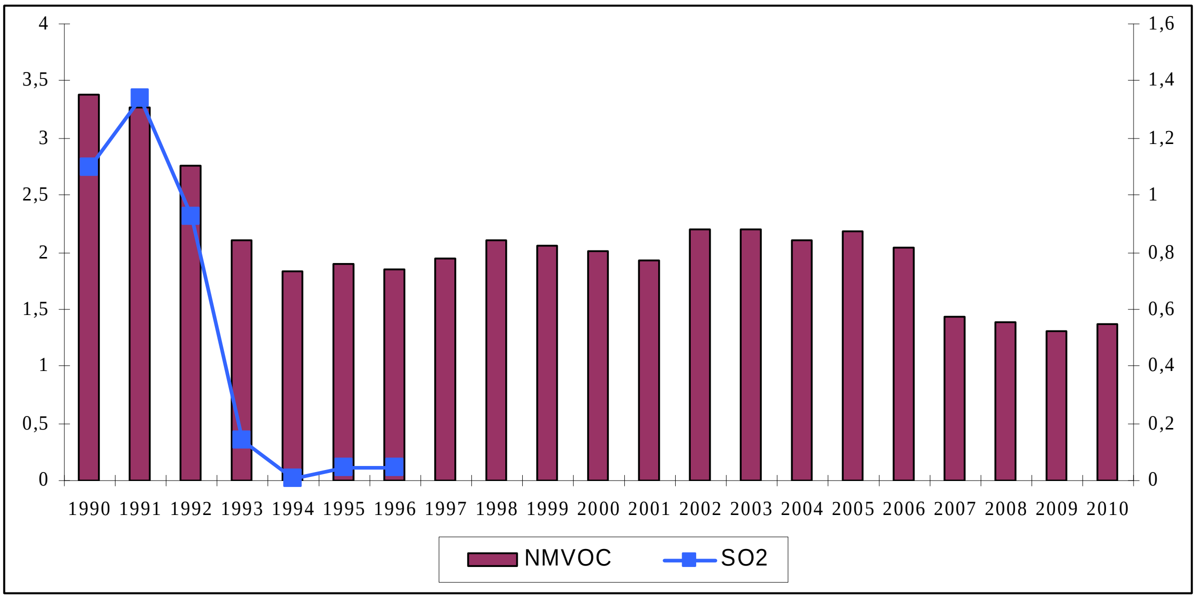


Figure 4.6 Total emissions from 2.D Other Production in 1990–2010 (Gg) [45]

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.

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 4.30) 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

[45] SO_2 emissions on secondary axis

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 4.30 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 4.31). LEGMC has signed an agreement with CSB to get data of total production of products from sectors where data are confidential.

Still for the 2007-2010 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 4.31 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
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	242.2	NO	37.48	89.9	405.8

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.

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.

4.5.5 Source-specific recalculations

No recalculations were done in the sector since last submission.

4.5.6 Source-specific improvement

For next inventory it is planned to make a research of the pulp and paper sector as there are two producers that are reporting activity data with PRODCOM code 17.11.14.00.00 – manufacture of pulp. Still it is not known is the pulp is produced in country or all raw materials are imported and then only mixed together.

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

[46] Project report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003", Riga 2004

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 105.17 (CO_2 eq. Gg) in 2010 (Table 4.32, Figure 4.7).

Table 4.32 Total emissions of HFCs in 1990–2010 (Gg CO2 eq)

sectors / years	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	**0.6430**	0.2791	0.0817	-	0.1755	0.0219	-	-	-	0.3640
1996	**0.8725**	0.4873	0.1132	-	0.0421	0.3319	-	-	-	0.3852
1997	**2.0860**	1.6794	0.1291	-	0.0878	1.4625	-	-	-	0.4066
1998	**3.0742**	2.4617	0.1451	0.0218	0.3159	1.9789	-	-	0.1560	0.4564
1999	**3.5230**	2.6813	0.1773	0.0523	0.1639	2.2878	-	-	0.6331	0.2086
2000	**5.4794**	3.6478	0.2096	0.0743	0.0354	3.3286	-	-	1.1240	0.7076
2001	**8.1905**	5.2025	0.2458	0.1718	0.0741	4.7108	-	0.0353	1.5751	1.3776
2002	**10.9175**	7.2413	0.2981	0.2456	0.0858	6.6118	-	0.0353	1.8483	1.7926
2003	**17.5309**	10.2603	0.3781	0.3329	0.2709	9.2785	3.2712	0.0882	1.7533	2.1578
2004	**21.3044**	15.1736	0.4683	0.8356	0.0949	13.7748	1.3537	0.1786	1.7357	2.8628
2005	**34.1669**	23.1556	0.5612	0.6314	0.1812	21.7818	5.6846	0.1150	1.9378	3.2739
2006	**73.0201**	42.7809	0.6658	7.9590	0.1299	34.0261	24.2162	0.1790	2.1704	3.6736
2007	**115.6309**	66.5944	0.7545	15.5038	NO	50.3360	41.8769	0.0402	2.5155	4.6038
2008	**95.3298**	85.6057	0.8363	23.3725	NO	61.3969	1.6516	0.0402	2.7253	5.3069
2009	**100.1594**	92.5969	0.8871	25.8968	NO	65.8130	0.0092	0.0402	2.5634	4.9496
2010	**105.1738**	96.1327	0.9430	25.0409	NO	70.1488	0.8505	0.0402	2.4708	5.6796

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.

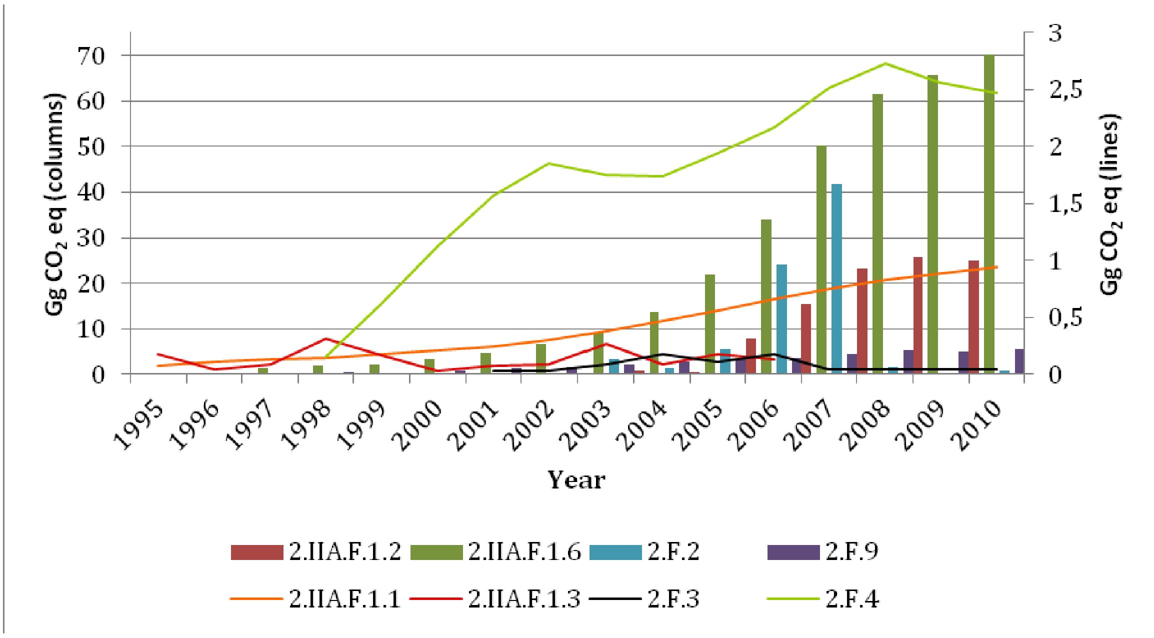


Figure 4.7 HFCs emissions from 2.F Consumption of Halocarbons and SF6 sector in 1990–2010 (Gg CO2 eq)[47]

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 (41.88). After that emissions have decreased very sharply (0.85 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.

4.6.2 Methodological issues

The calculation of actual emissions is done in accordance with IPCC methodology.

Data used in estimations of actual f-gases emissions and estimated emissions are reported in Annex III Relevant background information – Industrial Processes Sector.

4.6.2.1 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 2002-2010 data were taken from CSB database[51];

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[47] sectors 2.IIA.F.1.1, 2.IIA.F.1.3, 2.F.3 and 2.F.4 on the secondary axis

[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

3. percentage amount of households using refrigerators and freezers – for 1996, 2001, 2006 and 2010 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%.

4.6.2.1.1 HFC-134a from charging of domestic refrigerators and freezers

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:

$$HFC_{charged,t} = R \times n/f$$

where:
$HFC_{charged}$ – amount of HFC-134a charged in year t (tonnes);
R – amount of refrigerators and freezers charged with HFC-134a (units);
n – average equipment lifetime (years);
f – amount of HFC-134a charged once in lifetime of equipment

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 2001-2010 lifetime factor used in emission estimation is assumed as 10 years. So for years 2001-2010 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 (%)

[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
[53] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) Industrial Processes, p.2.56

4.6.2.1.2 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 (%)

4.6.2.1.3 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 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

[54] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) Industrial Processes, p.2.55
[55] http://www.likumi.lv/doc.php?id=96434&from=off

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 2005-2010.

4.6.2.2 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 2012 for year 2010. 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 2006-2010 data were obtained from reporting within previously mentioned new regulation act.

IPCC 1996 was used to estimate emissions from commercial freezing equipment.

4.6.2.2.1 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 2006-2010 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 (%)

4.6.2.2.2 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 2006-2010 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:

[56] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) Industrial Processes, p.2.53
[57] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) Industrial Processes, p.2.56

$E_{operation}$ – 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 (%)

4.6.2.2.3 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 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 2005-2010.

4.6.2.3 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.

[58] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) Industrial Processes, p.2.56

4.6.2.3.1 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 2007-2010 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:

$$E_{charged} = HFC_{charged} \times k$$

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 (%)

4.6.2.3.2 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"

4.6.2.3.3 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 2005-2010.

4.6.2.4 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.

4.6.2.4.1 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 (%)

4.6.2.4.2 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 70% in year 2010. The same percentage increase has to be applied for trucks when percentage of trucks equipped with MACs increase from 50% in 2000 to 75% in 2010.

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:

$$E_{operation} = E_{stocks} \times x$$

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 (%)

4.6.2.4.3 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-

[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
[61] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3) Industrial Processes, p.2.57

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 (%)

4.6.2.5 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:

$$HFC_{potential} = \sum HFC_{produced} + \sum HFC_{imported} - \sum HFC_{exported}$$

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)

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)

[62] http://www.ttc.lv/export/sites/default/docs/LRTA/Likumi/Chemical_Substances_and_Chemical_Products_Law.doc

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)

4.6.2.6 Foam Blowing (CRF 2.F.2)

Although the activity of building sector in last years radically increased emissions are 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.

4.6.2.6.1 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.

4.6.2.6.2 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)

4.6.2.7 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.

4.6.2.7.1 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

[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)

installed already filled with f-gases and there weren't any necessity to recharge them. Therefore only emissions from stocks were calculated.

4.6.2.7.2 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 (%)

4.6.2.7.3 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 (%)

4.6.2.7.4 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).

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 (%)

4.6.2.8 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

[65] http://www.ipcc-nggip.iges.or.jp/public/gp/english/3_Industry.pdf, p.3.117

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 (%)

4.6.2.8.1 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)

[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

4.6.2.9 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.

4.6.2.9.1 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 (%).

4.6.2.9.2 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 (%)

4.6.2.9.3 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 2003-2010 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.

4.6.2.9.4 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)

[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

$HFC_{containers}$ – amount of SF_6 held in containers (t)
x – losses from containers during operation period (%)

4.6.2.10 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]

4.6.2.10.1 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 (%)

4.6.2.10.2 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)

[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

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 (%)

4.6.2.10.3 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 (%)

4.6.2.10.4 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.

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.

4.6.5 Source-specific recalculations

In the sector 2.IIA.F.1.1 – Domestic Refrigeration new statistical data "percentage amount of households using refrigerators and freezers" was available for year 2010, therefore previous year data (2007-2009) was changed. The assumption, that percentage amount of households using refrigerators starting the year 2007 will increase by 0.3% was incorrect, and changed to 0.1% . Also percentage amount of households using freezers was changed - decreasing by 0.45% every year. Data for years 1995 – 2006 also was changed, because previously there was made mistake in multiplication – every year the same percentage amount was used (percentage amount of households using refrigerators and freezers), even though it is changing every year.

In the sector 2.IIA.F.1.6 – Mobile Air-Conditioning statistical data of "trucks and buses manufactured after 1995" was changed for all years (1995-2009), because previously only statistical data of trucks was used.

According to previously mentioned changes data of whole sector 2.F was recalculated.

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.

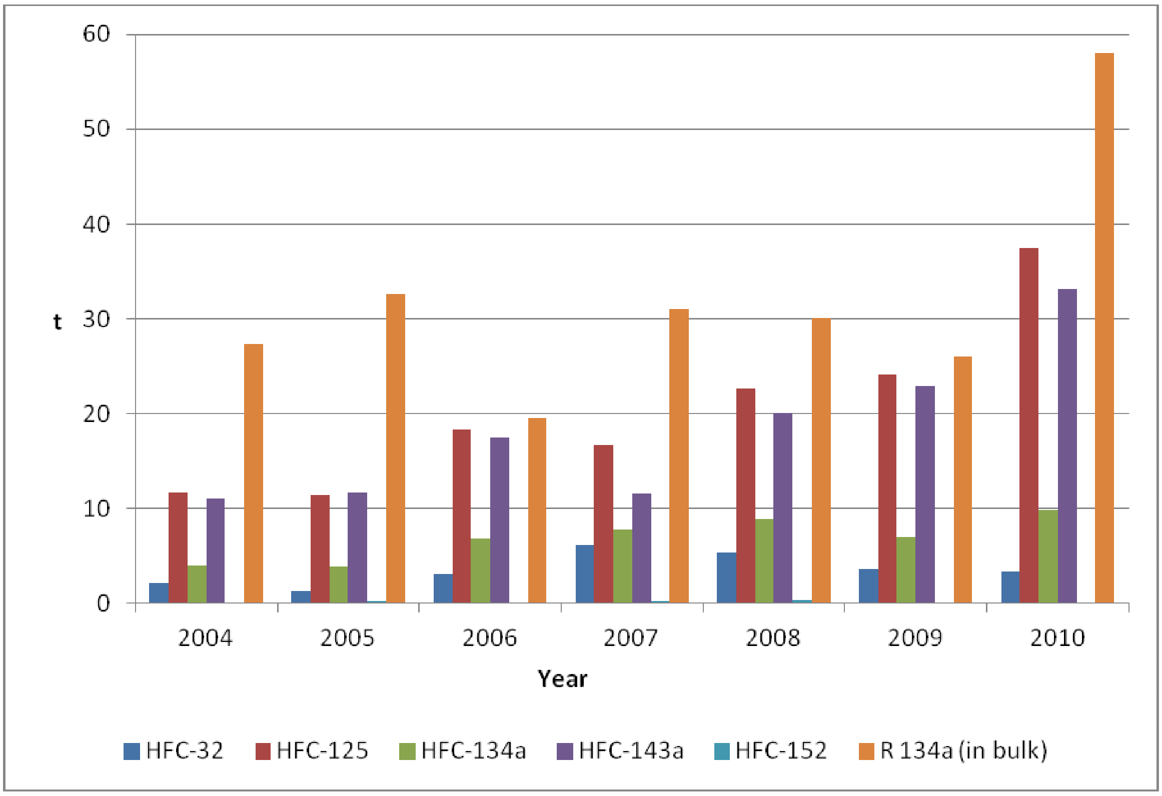


Figure 4.8 Total potential emissions of f-gases in 2004–2010 (t)

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 4.33) of chemicals in imported freezing substances amount of chemicals were estimated and reported as potential emissions.

Table 4.33 Percentage amounts of chemicals in imported products 2004–2010 (%)

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%			

Chemicals, products	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea
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.

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.

4.7.5 Source-specific recalculations

No recalculations were done ini the sector since last submission.

4.7.6 Source-specific planned improvements

It is necessary to perform Tier2 QA/QC procedure for the sector as third part revision of the used activity data and used emission estimation methodology is needed. The verification of the sector is planned to do for next submissions.

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 and N_2O emissions from Aerosol Cans are not estimated due to unavailability of statistical data.

Table 5.1 Reported emissions from Solvents and other product use in Latvia in 2010

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	
N2O emissions from Aerosol Cans (CRF 3.D.3)		NE	
Other Use of N2O (CRF 3.D.4)		NE	
Printing (CRF 3.D.5/3.D.1)	√	NO	√
Domestic solvent use including fungicides (CRF 3.D.5/3.D.1)	√	NO	√
Other product use (CRF 3.D.5/3.D.1)	√	NO	√

5.1.2 Description

Solvent and Other Product Use sector GHG emissions contribute only about 0.3% of the total GHG emissions in Latvia (
Table **5.2**).

Table 5.2 Emissions from Solvent and Other Product use in 1990–2010 (Gg)

	CO2	A. Paint Application	B. Degreasing and Dry Cleaning	C. Chemical Products, Manufacture and Processing	3.D.5.1 Printing	3.D.5.2 Domestic Solvent Use	3.D.5.3 Other Product Use	N2O	1. Use of N2O for Anaesthesia	NMVOC	A. Paint Application	B. Degreasing and Dry Cleaning	C. Chemical Products, Manufacture and Processing	3.D.5.1 Printing	3.D.5.2 Domestic Solvent Use	3.D.5.3 Other Product Use
1990	50,70	23,23	7,08	NE	5,41	14,98	NE	NA,NE,NO	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	NA,NE,NO	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	NA,NE,NO	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	NA,NE,NO	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	NA,NE,NO	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
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	30,77	2,84	6,22	0,29	4,76	2,16	14,49	0,02	0,02	10,27	0,97	1,99	0,10	1,52	0,74	4,94
2003	23,72	3,88	0,03	0,33	0,03	3,85	15,60	0,02	0,02	8,09	1,32	0,01	0,11	0,01	1,31	5,32
2004	30,03	6,22	0,09	0,38	0,03	6,12	17,19	0,02	0,02	10,24	2,12	0,03	0,13	0,01	2,09	5,86
2005	33,00	6,10	0,03	0,55	0,05	7,68	18,59	0,01	0,01	11,26	2,08	0,01	0,19	0,02	2,62	6,34
2006	44,13	9,14	0,03	0,85	0,07	13,53	20,50	0,04	0,04	15,05	3,12	0,01	0,29	0,03	4,62	6,99
2007	60,69	12,14	0,37	2,50	0,18	21,13	24,37	0,01	0,01	20,70	4,14	0,13	0,85	0,06	7,21	8,32
2008	39,63	7,18	0,22	1,65	0,24	15,95	14,38	0,01	0,01	13,52	2,45	0,08	0,56	0,08	5,44	4,91
2009	23,03	4,63	0,16	0,90	0,20	5,38	11,75	0,01	0,01	7,86	1,58	0,05	0,31	0,07	1,84	4,01
2010	37,30	11,46	0,02	0,85	0,71	6,64	17,62	0,02	0,02	12,72	3,91	0,01	0,29	0,24	2,26	6,01

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.

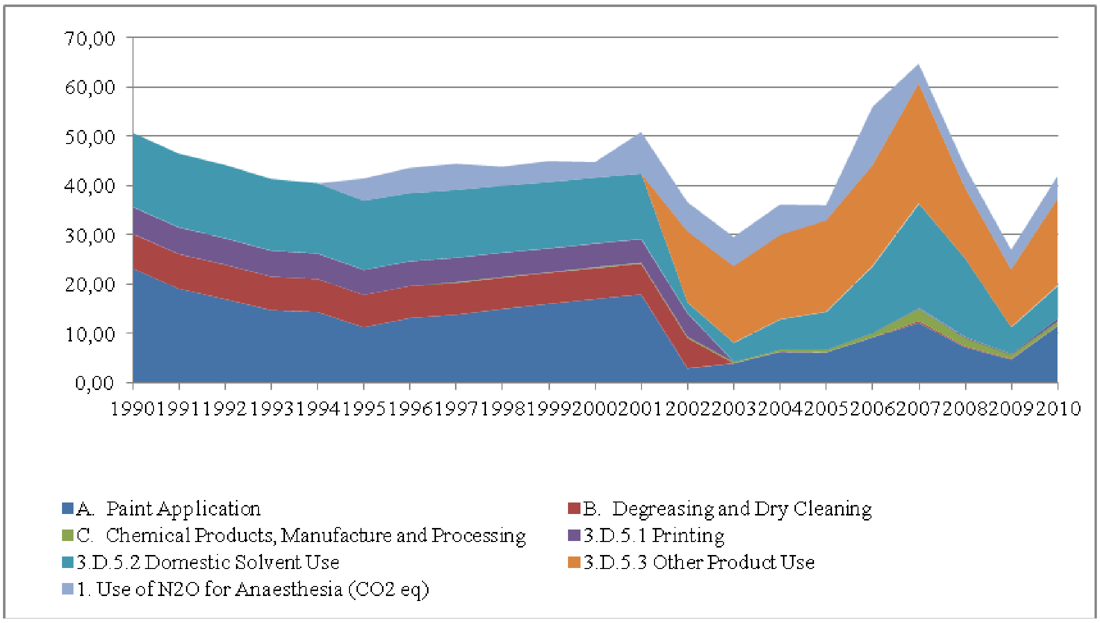


Figure 5.1 Emission from Solvent and Other Product Use in 1990-2010, CO_2 eq Gg

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 emission factors are used. For CRF 3.A Paint Application sector the paint use data are determined in national expert research and default emission factors for solvent and water based paints 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 2002-2010 are obtained from national database "2-AIR" from paint, perfumery, pharmacy and other chemicals producers have reported their emissions. For 2002-2010 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 2003-2010 the emissions have increasing tendency. This increase is explained with better statistical information.

Solvent and Other Product Use generates 19.6% from total Latvia's NMVOC emissions in 2010.

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 30.7% of total this sector's CO_2 emissions.

Table 5.3 Emissions from Paint Application use in 1990–2010 (Gg)

	CO_2	NMVOC
1990	23.235	7.447
1991	19.126	6.130
1992	16.992	5.446
1993	14.733	4.722
1994	14.361	4.603
1995	11.229	3.599
1996	13.123	4.206
1997	13.809	4.426
1998	14.976	4.800
1999	16.012	5.132
2000	17.010	5.452
2001	17.959	5.756
2002	2.84	0.97
2003	3.88	1.32
2004	6.22	2.12
2005	6.10	2.08
2006	9.14	3.12
2007	12.14	4.14
2008	7.18	2.45
2009	4.63	1.58
2010	11.46	3.91

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 2.33 Gg compare with 2009 (Table 5.3).

The NMVOC emissions from production of paints, solvents, thinners, primers, hardeners, lacquers are reported under sector CRF 3.C according to EMEP/EEA 2009.

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 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 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 2002-2010 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.

$$E_{NMVOC} = \sum \left(AD_{PA} \times p_{NMVOC} \right)$$

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 2002-2010 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 shown in Table 5.4.

Table 5.4 Emission factors for paint application

Paint type	Emission factor, t/t
Paint on water base	0.2
Paint on solvent base	0.5

For 2002-2010 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 5.5).

Table 5.5 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

[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

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 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 2002-2010 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 2002-2010 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 2002-2010 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) – 2010 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 to quality control procedures mistakes in database of emission calculation were found and therefore emissions were recalculated (Figure 5.2). In the database incorrect location of activity data were found for time period 2002 – 2009. It was corrected therefore % difference of activity data varies from +1.39 % (2003) and -33.2% (2006).

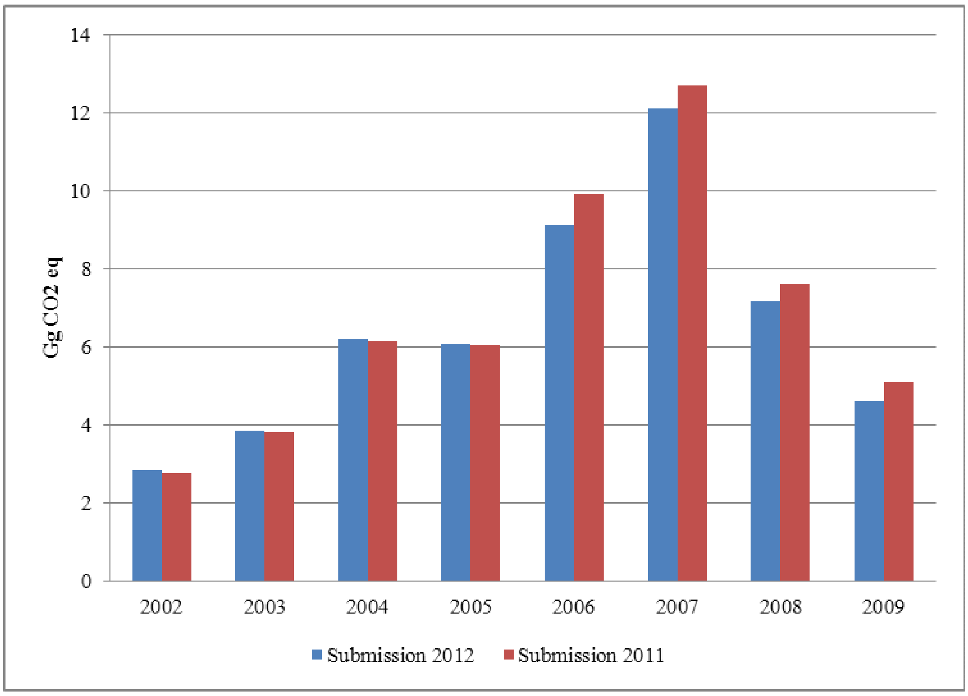


Figure 5.2 Difference of CO_2 emissions in Submission 2011 and 2012, Gg CO_2 eq

5.2.6 *Source-specific planned improvements*

In 2012, during the database improvement project, quality of databses in LEGMC is planned to improve. Accordingly for submission 2013 activity data and emissions will be checked for consistency purposes.

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 0.75% of total Solvent and Other Products Use sector CO_2 emissions.

Table 5.6 Emissions from Degreasing and Dry Cleaning in 1990–2010 (Gg)

	CO_2	NMVOC
1990	7.075	2.268
1991	7.048	2.259
1992	7.008	2.246
1993	6.855	2.197
1994	6.736	2.159
1995	6.628	2.124
1996	6.546	2.098
1997	6.480	2.077
1998	6.416	2.056

	CO_2	NMVOC
1999	6.358	2.038
2000	6.299	2.019
2001	6.270	2.010
2002	6.22	1.99
2003	0.03	0.01
2004	0.09	0.03
2005	0.03	0.01
2006	0.03	0.01
2007	0.37	0.13
2008	0.22	0.08
2009	0.16	0.05
2010	0.02	0.01

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 emission factors are used but for 2003-2010 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.

Since 2007, emissions from Degreasing and Dry Cleaning sector are decreasing due to economical crisis and the aspects that lead to brake-down of national economy (Table 5.6).

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 2003-2010 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 2003-2010 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

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 5.7.

Table 5.7 Emission factor for CRF 3.B Degreasing and dry cleaning sector

Sectors	Emission factor, kg/cap/year
Industrial Degreasing	0.85

For year 2003-2010 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:

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

where
EF_{CO2} – CO_2 emission factor (Gg/Gg)
80% – the average amount of carbon in NMVOC

[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

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 5.8).

Table 5.8 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
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 2003-2010 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 5.9 Activity data for degreasing emissions estimation in 2003-2010 (Gg)

	production / import of NMVOC containing 3.B sector products
2003	0.034
2004	0.085
2005	0.046
2006	0.025
2007	0.17
2008	0.116
2009	0.092
2010	0.082

The activity data in 2003-2010 (Table 5.9) 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 1990-2001 is estimated by using Tier1 method taking into account expert's data and expert's emission factors. In 2002-2010 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 to quality control procedures mistakes in database of emission calculation were found and therefore emissions were recalculated (Figure 5.3). In the latest submission emissions are slightly lover (for example, for year 2009 emissions decreased by 1.4 % in 2012 submission comparing with submission 2011).

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 +33 % (2003) and -3% (2009) between Submission 2011 and 2012.

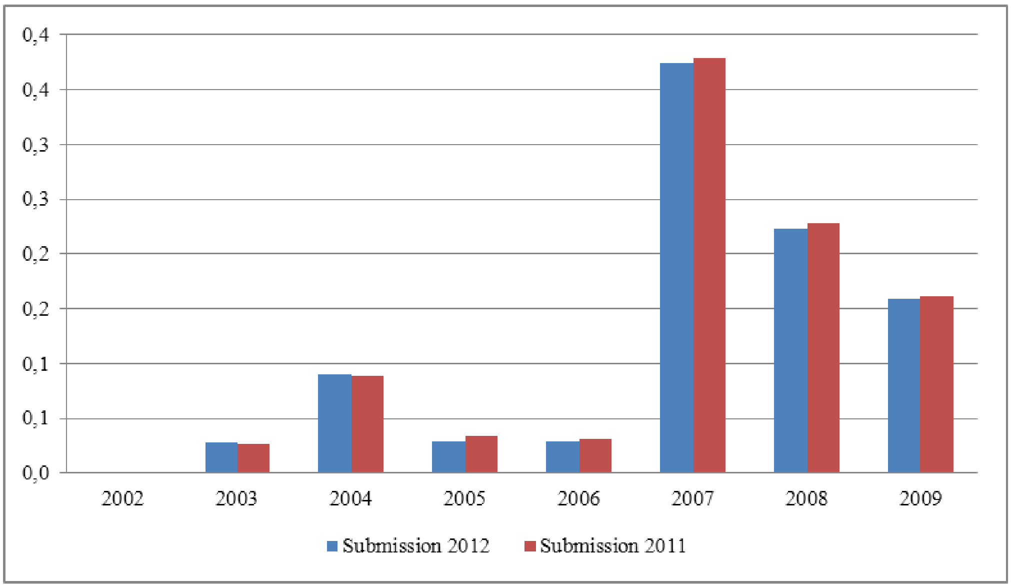


Figure 5.3 Difference of CO_2 emissions in Submission 2011 and 2012, Gg

5.3.6 Source-specific planned improvements

In 2012, during the databases improvement project, quality of databases in LEGMC is planned to improve. Accordingly for submission 2013 activity data and emissions will be checked for consistency purposes.

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 2.3% of total CO_2 emissions from Solvents and Other Product Use sector.

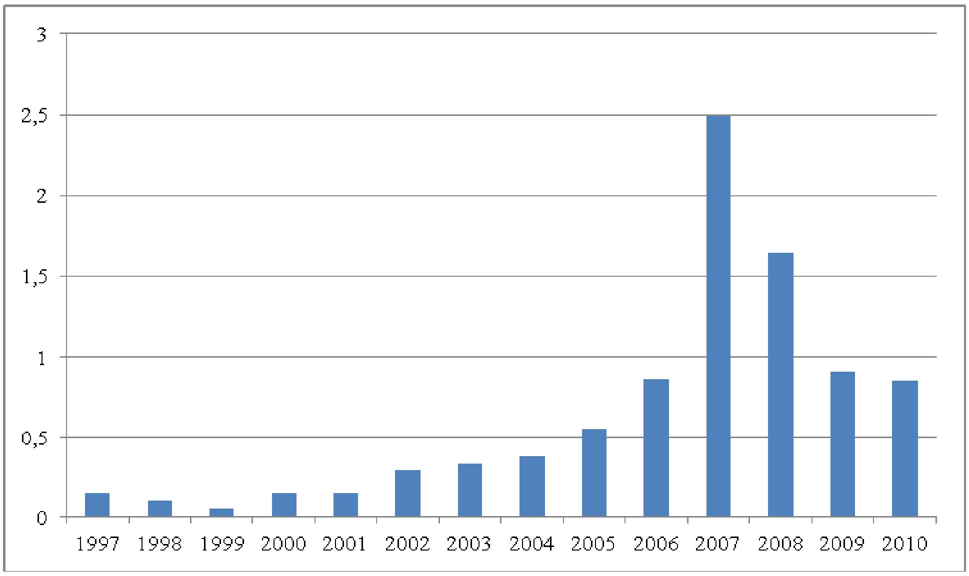


Figure 5.4 CO_2 emissions Chemical Products, Manufacture and Processing sector in 1997–2010 (Gg)

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 2003-2010 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 2002-2010 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:

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

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 5.10 Activity data for estimation in 2003-2010 (Gg)

	production / import of NMVOC containing 3.C sector products
2002	0.07039
2003	0.266
2004	0.077
2005	0.411
2006	1.469
2007	4.286
2008	1.866
2009	1.017
2010	3.589

The activity data in 2002-2009 has increased by more than 14 times due to improvement of population well-being and construction and building sector in total (Table 5.10). As well as data collection is improving form year to year. Since 2007, the activity data is decreasing due

[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

to economical and financial crisis that affected of purchasing power of population and estate property sector that was left still.

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 2002-2010 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 2002-2010 the additional data is just reported together with the data from 1997-2010 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 to quality control procedures mistakes in database of emission calculation were found and therefore emissions were recalculated (Figure 5.5). In the database incorrect location of activity data were found for time period 2002 – 2009. It was corrected therefore % difference of activity data varies from - 61 % (2004) and -0.06% (2009) between Submission 2011 and 2012.

In the latest submission emissions are larger as incorrect formula in calulations was found (for example, for year 2009 emissions increased by 6 % in 2012 submission comparing with submission 2011).

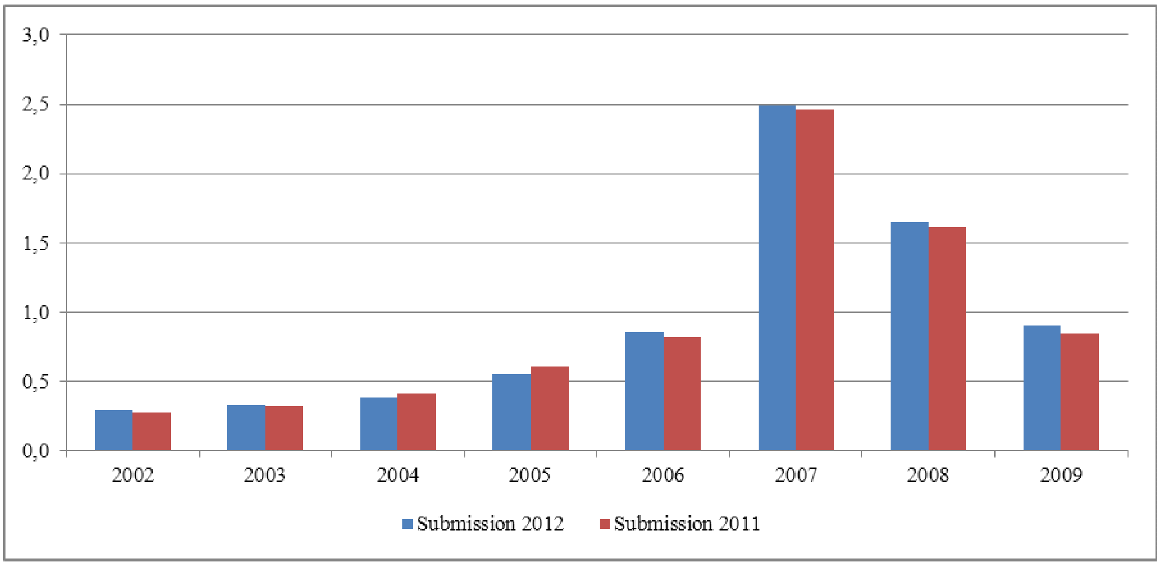


Figure 5.5 Difference of CO_2 emissions in Submission 2011 and 2012, Gg

5.4.6 Source-specific planned improvements

In 2012, during the data base improvment project, quality of databses in LEGMC is planned to improve. Accordingly for submission 2013 activity data and emissions will be checked for consistency purposes.

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).

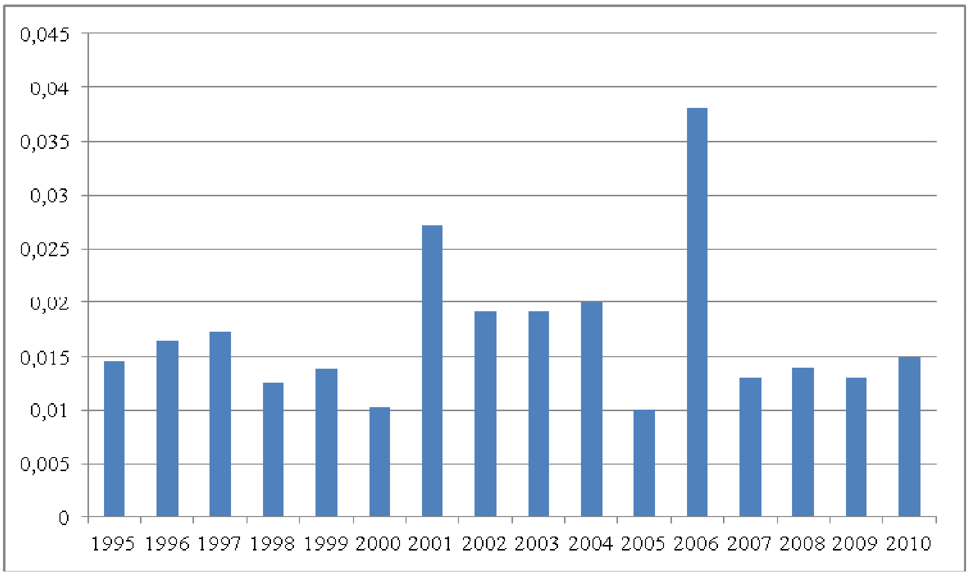


Figure 5.6 N_2O emissions from N_2O for anaesthesia 1995–2010 (Gg)

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 1995-2010. 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) – 2010 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 66.9% from total CRF 3 Solvents and Other Product Use emissions (Table 5.11).

Table 5.11 Emissions from 3.D.5 Other sectors in 1990–2010 (Gg)

	CO_2			NMVOC		
	Printing	Domestic Solvent Use	Other Product Use	Printing	Domestic Solvent Use	Other Product Use
1990	5.411	14.983	NE	1.734	4.802	NE
1991	5.390	14.926	NE	1.728	4.784	NE
1992	5.359	14.840	NE	1.718	4.756	NE
1993	5.242	14.516	NE	1.680	4.653	NE

	CO_2			NMVOC		
	Printing	**Domestic Solvent Use**	**Other Product Use**	**Printing**	**Domestic Solvent Use**	**Other Product Use**
1994	5.151	14.260	NE	1.651	4.572	NE
1995	5.069	14.036	NE	1.625	4.499	NE
1996	5.005	13.861	NE	1.604	4.443	NE
1997	4.955	13.722	NE	1.588	4.398	NE
1998	4.906	13.586	NE	1.572	4.355	NE
1999	4.862	13.465	NE	1.558	4.316	NE
2000	4.817	13.340	NE	1.544	4.276	NE
2001	4.795	13.28	NE	1.537	4.26	NE
2002	4.76	2.16	14.49	1.52	0.74	4.94
2003	0.03	3.85	15.60	0.01	1.31	5.32
2004	0.03	6.12	17.19	0.01	2.09	5.86
2005	0.05	7.68	18.59	0.02	2.62	6.34
2006	0.07	13.53	20.50	0.03	4.62	6.99
2007	0.18	21.13	24.37	0.06	7.21	8.32
2008	0.24	15.95	14.38	0.08	5.44	4.91
2009	0.20	5.38	11.75	0.07	1.84	4.01
2010	0.71	6.64	17.62	0.24	2.26	6.01

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 emission factors are used), but for 2002 (2003) – 2010 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) – 2010 the data from Chemical Register of imported amounts of NMVOC containing products that could be used for printing or as domestic and other solvents 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)–2010 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 5.12.

Table 5.12 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 5.13).

Table 5.13 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 2003-2010 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.

[78] Basing of the most often used average carbon conversion factor

Table 5.14 Activity data for emissions estimation in 2002-2010 (Gg)

	production / import of NMVOC containing 3.D.5 sector products
2002	21.570
2003	64.019
2004	70.139
2005	109.250
2006	142.273
2007	268.491
2008	139.037
2009	80.71
2010	107.702

The activity data in 2002 (2003)–2010 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 (by 69.79%) 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 5.14).

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 2002-2010 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 to quality control procedures mistakes in database of emission calculation were found and therefore emissions were recalculated (Figure 5.7). In the database incorrect location of activity data were found for time period 2002 – 2009. It was corrected, the % difference of activity data varies from -61 % (2004) and -0.06% (2009) between Submission 2011 and 2012.

In the latest submission emissions are larger as incorrect formula in calulations was found (for example, for year 2009 emissions increased by 6 % in 2012 submission comparing with submission 2011).

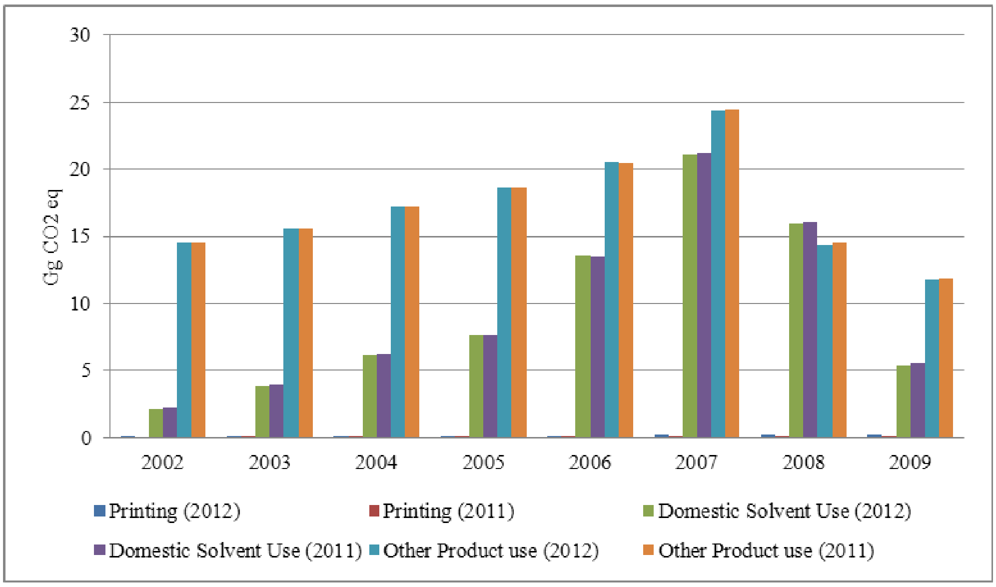


Figure 5.7 Difference of CO_2 emissions in Submission 2011 and 2012, Gg

5.6.6 *Source-specific planned improvements*

In 2012, during the data base improvment project, quality of databses in LEGMC is planned to improve. Accordingly for submission 2013 activity data and emissions will be checked for consistency purposes.

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

In 2010, the Agriculture sector contributes 19.2% from total national emissions and is the second largest source of GHG emissions in Latvia. The major part of the emission is related to livestock production, especially by the production of cattle. 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 2010.

Total GHG emissions from agriculture have declined approximately by 61.4% over the period of 1990 – 2010 (Table 6.1). The total N_2O emission (Gg) from 1990-2010 has decreased by 57.2%, but CH_4 emissions (Gg) by 68.6 %.

Table 6.1 Greenhouse gas emission in the agricultural sector in 1990 – 2010

	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	726.67	1226.19	1952.86
2001	766.69	1333.57	2100.26
2002	763.99	1302.59	2066.58
2003	745.63	1377.15	2122.78
2004	736.80	1348.56	2085.53
2005	758.65	1421.02	2179.67
2006	750.86	1425.90	2176.75
2007	783.93	1482.84	2266.77
2008	761.61	1476.93	2238.55
2009	761.70	1513.63	2275.33
2010	768.34	1561.23	2329.57

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 2010 according to IPCC GPG 2000 Tier 1 method are summarized in Table 6.2.

Table 6.2 Key categories in Agriculture in 2010 (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[79].

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 2010, methane emissions from Enteric Fermentation of domestic livestock comprised 28% of total agricultural emission, expressed in CO_2 equivalents. CH_4 emissions were 32.01 Gg and decreased 68.7% since 1990 generally due to decreasing number of cattle (Table 6.4).

[79] IPCC 2000, page 4.23.

Table 6.4 Methane emissions from Enteric Fermentation by animal type in 1990–2010 (Gg)

	DC	NDC	Sh	G	H	Sw	Total CH4 Gg	Total, Gg CO2 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	652.26
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	667.80
Share of total % in 2010	60.28%	35.09%	1.91%	0.22%	0.69%	1.81%	100%	

DC=Dairy cows, NDC- Non-Dairy cattle, Sh=Sheep, G=Goats, H=Horses, Sw=Swine, P=Poultry.

6.2.2 Methodological issues

Methods

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 4.1:

$$CH_4(Gg/year) = EF(kg/animal/year) \bullet population/(10^6 kg/Gg)$$

The total emission is the sum of emissions from each category, IPCC 2000, equation 4.2:

$$CH_4 = \sum_i E_i$$

The contribution of emissions from horses, swine, sheep and goats to the total emissions from Enteric Fermentation is not 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 4.3 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 4.4 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
NEl = 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:

$$NEm = Cfi * (Weight)^{0.75}$$

$$NEa = [Cap * tp/365 + Cao * (1-(tp/365)) * NEm$$

$$NEl = My/365 * (1.47 + 0.40 * Fat)$$

$$NEp = Cp * NEm \quad NEg = 4.18*\{0.0635*[0.891*(BW*0.96)*(478/(C*MW))]^{0.75} * (WG * 0.92)^{1.097}\}$$

$$NEma/DE = 1.123 - (4.092 * 10^{-3} * DE) + [1.126 * 10^{-5} * (DE)^2] - (25.4/DE)$$

$$NEga/DE = 1.164 - (5.160 * 10^{-3} * DE) + (1.308 * 10^{-5} * (DE)^2) - (37.4/DE)$$

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, %

	Average milk yield (kg/year) according to information from CSB	Fat content, %
1990	3437	3.5*
1991	3205	3.5*
1992	2793	3.5*
1993	2741	3.5*
1994	2923	3.5*
1995	3074	3.5*

	Average milk yield (kg/year) according to information from CSB	Fat content, %
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	4234	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

*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 CH_4 emission factors for dairy cattle and non-dairy cattle from Enteric Fermentation, (kg/head/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	
2004	108.20	
2005	110.00	
2006	111.54	52.16

	Dairy cattle	Non-Dairy cattle
2007	113.51	
2008	115.53	
2009	116.48	
2010	117.56	52.16

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 -2010 at the end of the year (thousand heads)

	Dairy cattle	Non - Dairy cattle	Sheep	Goats	Horses	Swine	Poultry
1990	535	904	165	5	31	1401	10321
1991	531	852	184	6	30	1247	10395
1992	482	662	165	6	28	867	5438
1993	351	327	114	6	26	482	4124
1994	311.9	239.1	86.3	7.4	26.8	500.7	3700
1995	291.9	245.1	72.1	8.9	27.2	552.8	4198
1996	275	234	55.5	8.4	25.8	459.6	3790.7
1997	263	214	41	9	23	430	3551
1998	242	192	29	10.5	22	421	3209
1999	206	172	27	8.1	19	405	3237
2000	204.5	162.2	28.6	10.4	19.9	393.5	3104.6
2001	209	176	29	11.5	20	429	3621
2002	205	183	32	13	19	453	3882
2003	186	193	39	15	15	444.4	4003
2004	186.2	184.9	38.6	14.7	15.5	435.7	4049.5
2005	185.2	200	41.6	14.9	13.9	427.9	4092.3
2006	182	195	41	14	14	417	4488
2007	180	219	54	13	13	414	4757
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

The source of data on the number of livestock (till the end of 2007) is sample survey of agricultural farms.[80] 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, 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.

[80] CSB. Agricultural farms of Latvia 2010 (2011) and www.csb.gov.lv .

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:

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%81. Emission factor estimates using the Tier 2 method are likely to be in the order of ± 20% 82. 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.

Tier 2 QC for activity data:

The data on domestic animals used for emission calculation for submission 2011, are compared with data reported to the FAO. Due to discrepancies in the data, in order to find the correct data the Central Statistical Bureau (CSB) are approached. According to information received from the CSB has found that the correct data on the number of animals is reflected in the NIR in 2011 (Table 68) namely CSB data. For 2011th annual GHG inventory data is the end of the year data used, but for the FAO reporting - data on the beginning of the year. Therefore, there is a shift of data over the years. Data reported to FAO (Annex 3.4.2) will be adjusted by CSB.

Tier 2 QC for emission factors:

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. A difference between country specific emission factors (EF) and default factors is occurred.

Previously default EF for Eastern Europe (81 kg/head/year) for CH4 emissions from enteric fermentation from dairy cattle for the whole time - series was used. This EF was estimated on an average annual milk yield of 2550 kg/head/year. As the milk yield is higher (according to national statistic) then ERT (2009) recommended using higher tier method for estimating emissions for dairy cattle. Latvia provided ERT with some background information available in country and therefore ERT recommended that Latvia utilize the available information to estimate the country specific EF that permit the use of a higher tier method in order to improve the accuracy of estimates.

In previous submissions EF for Eastern Europe (56 kg/head/year) from non - dairy cattle from CH4 emissions from enteric fermentation for the whole time - series was used. According to nationally available information the EF was recalculated.

EF is presented in the Table 6.7.

[81] IPCC GPG 2000, p. 4.27
[82] IPCC GPG 2000, p. 4.28

External review by independent expert was carried out in 2011 January and February months. According to this review CH_4 EF were corrected for dairy cattle and for non-dairy cattle. In the process of GE estimation:

1. parameter of calf birth weight was recalculated according to equation 7 from Revised 1996 IPCC page 4.19;
2. the equation 4.8 for NE pregnancy was used according to IPCC GPG 2000, page 4.18.
3. NE pregnancy was corrected, taken into account the portion of mature females that give birth in a year (80% for Eastern Europe according to Revised 1996 IPCC, page 4.31).

6.2.5 Source-specific recalculations

No recalculations were done.

6.2.6 Source-specific planned improvements

No improvements planned to elaborate for next inventory.

6.3 MANURE MANAGEMENT (CRF 4.B)

6.3.1 Source category description

Total emissions from Manure Management of domestic livestock consisted approximately 9.7% of total agricultural emissions (expressed in CO_2 equivalents) in 2010. Methane emissions from Manure Management were 4.58 Gg and nitrous oxide emissions 0.42 Gg. 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
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.[83] Nitrous oxide emissions from manure management have decreased by 77%, but Methane emissions by 65% over the time period 1990-2010 (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 1990-2010 by animal type*

	Dairy cattle	Non-Dairy cattle	Sheep	Goats	Horses	Swine	Poultry	Total, Gg	Total Gg CO2 eq
1990	0.68	0.75	0.02	0.00	0.02	0.25	0.12	1.84	569.68

[83] Jun et al., 2002

	Dairy cattle	Non-Dairy cattle	Sheep	Goats	Horses	Swine	Poultry	Total, Gg	Total Gg CO2 eq
1991	0.67	0.71	0.02	0.00	0.02	0.22	0.12	1.76	547.01
1992	0.61	0.55	0.02	0.00	0.02	0.15	0.06	1.42	438.76
1993	0.44	0.27	0.01	0.00	0.02	0.09	0.05	0.88	273.12
1994	0.39	0.20	0.01	0.00	0.02	0.09	0.04	0.75	233.94
1995	0.37	0.20	0.01	0.00	0.02	0.10	0.05	0.75	231.99
1996	0.35	0.19	0.01	0.00	0.02	0.08	0.04	0.69	215.01
1997	0.33	0.18	0.00	0.00	0.02	0.08	0.04	0.65	201.57
1998	0.31	0.16	0.00	0.00	0.02	0.07	0.04	0.60	185.35
1999	0.26	0.14	0.00	0.00	0.01	0.07	0.04	0.53	164.51
2000	0.26	0.15	0.00	0.00	0.01	0.07	0.05	0.54	164.16
2001	0.26	0.15	0.00	0.00	0.01	0.08	0.04	0.55	171.11
2002	0.26	0.15	0.00	0.00	0.01	0.08	0.05	0.56	172.29
2003	0.24	0.16	0.00	0.00	0.01	0.08	0.05	0.54	166.80
2004	0.23	0.15	0.00	0.00	0.01	0.08	0.05	0.52	161.90
2005	0.23	0.16	0.01	0.00	0.01	0.07	0.05	0.53	165.59
2006	0.22	0.16	0.01	0.00	0.01	0.07	0.05	0.53	164.29
2007	0.22	0.18	0.01	0.00	0.01	0.07	0.06	0.55	171.02
2008	0.20	0.17	0.02	0.00	0.01	0.07	0.06	0.52	162.23
2009	0.19	0.17	0.02	0.00	0.01	0.06	0.06	0.52	160.50
2010	0.19	0.11	0.01	0.00	0.01	0.02	0.06	0.42	130.20
Share of total % in 2010	47.50%	27.50%	2.50%	0.00%	2.50%	5.00%	15.00%	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 1990-2010 by animal type

	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	0.65	0.01	0.00	0.03	1.57	0.24	3.66	76.86
2001	1.27	0.70	0.01	0.00	0.03	1.72	0.28	4.01	84.21
2002	1.18	0.73	0.01	0.00	0.03	1.81	0.30	4.07	85.47
2003	1.14	0.77	0.01	0.00	0.02	1.78	0.31	4.03	84.63
2004	1.20	0.74	0.01	0.00	0.02	1.74	0.32	4.03	84.63
2005	1.29	0.80	0.01	0.00	0.02	1.71	0.32	4.15	87.15
2006	1.52	0.78	0.01	0.00	0.02	1.67	0.35	4.34	91.14
2007	1.58	0.88	0.01	0.00	0.02	1.66	0.37	4.52	94.92
2008	1.64	0.84	0.01	0.00	0.02	1.53	0.36	4.40	92.4
2009	1.67	0.85	0.01	0.00	0.02	1.51	0.38	4.44	93.24

	Dairy cattle	Non-Dairy cattle	Sheep	Goats	Horses	Swine	Poultry	CH_4 Manure Management Gg	Total Gg CO_2 eq
2010	1.74	0.86	0.01	0.00	0.02	1.56	0.39	4.58	96.18
Share of total % in 2010	37.99%	18.78%	0.22%	0.00%	0.44%	34.06%	8.52%	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).[84]

For 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[85]. N excretion during the year per each animal type and the distribution of manure management systems are national calculated values.

For emission calculation was used IPCC Tool and then data was put in the CRF Reporter.

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 for *cool* climate region were chosen (Table 6.12) because annual temperature in Latvia is 6.0 ºC (reference period 1971-2000).

Table 6.12 CH_4 emission factors from Manure Management

Types of animals	EF (kg/head/year)
Other cattle	4
Sheep	0.19
Goats	0.12
Horses	1.4
Swine	4
Poultry	0.078

Tier 2 emission factors were developed for dairy cattle (Table 6.13) according to IPCC GPG 2000, Equation 4.16.

[84] IPCC GPG 2000, Equation. 4.15
[85] GHG Emissions from Agriculture. Latvian State Institute of Agrarian Economics. Working papers 2(16)/2006.

Table 6.13 CH_4 emission factors for dairy cattle from manure Management

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	
5.5	5.3	5.1	5.1	5.2	5.3	5.4	5.8	5.8	5.8	
2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
5.7	6.1	5.8	6.1	6.4	6.9	8.3	8.8	9.6	10.1	10.6

Calculation of nitrous oxide emissions from Manure Management is also based on the Revised 1996 (2000?) 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 CSB (Table 6.8) and directly, statistical bulletins for each year. The distribution of different manure management systems is shown in the Table 6.15- Table 6.26 and used according to national studies.[86,87]

Forecast is that in the future not only pasture period of livestock could become longer, but possibly also percentage of liquid manure in manure management systems could increase.

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	

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

[86] Ruža A. u.c. Lauksaimniecības rādītāju prognoze 2015. un 2020. gadam. 2011
[87] Research during the Project „CORINAIR – Institutional strengthening of National Air Emissions Inventories in Latvia", R. Sudārs. Nitrogen Separation

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
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

Data about annual N excretion per animal until 2004 (Table 6.27) obtained from national studies [*LSIAE; Melece*]. 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 (Annex 3.4.1).

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 corrected livestock units are given in national regulations No. 33 but manure normative in home page of Ministry of Agriculture of Latvia *(*www.zm.gov.lv*)*

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[98] regarding average Nex for sheep and goats (Table 6.27) in Latvia there was very low level of produced nitrogen (6 kg/animal/yr) in difference from IPCC default (13 kg/animal/yr)[88] 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. Wherewith the 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 6.27 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 (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*

There are some inconsistencies between statistical data and pig production practice in Latvia.

The Central Statistical Bureau 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.

[88] Revised 1996 IPCC, Table 4-20, page 4.99.

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:

The review of AWMS and Nex was carried out by LSIAE in the 2005 -2006. The new information was elaborated in GHG inventory.

It will be checked annually if new data for updating emission factors has been published.

6.3.5 Source-specific recalculations

For 2012 submission AWMS was corrected for 2000-2009.

6.3.6 Source-specific planned improvements

It is planned to make it more precise Animal Waste Management Systems according to the information from Latvia University of Agriculture, which will be available in the end of 2012.

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 6.28). Direct N_2O emissions include emissions from synthetic fertilizers, animal manure, biological nitrogen fixation, crop residues and cultivation of Histosols. 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 6.28 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

N_2O emissions from Agricultural Soils contribute 61% of total agricultural emissions (expressed in CO_2 equivalents) in 2010. Nitrous oxide emissions from Agricultural Soils were 4.58 Gg in 2010. Emissions have decreased in 2010 by 53% comparing with 1990 (Table 6.29). 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 6.29 Direct and indirect nitrous oxide emissions from agricultural soils by source category (Gg)

	SF	MS	N	C	H	MP	A	L	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	0.3	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	0.00	0.06	1.64	0.32	0.13	0.62	3.50
2001	0.56	0.34	0.00	0.06	1.63	0.33	0.15	0.74	3.81
2002	0.49	0.35	0.00	0.07	1.62	0.33	0.14	0.7	3.70
2003	0.66	0.33	0.00	0.06	1.62	0.32	0.16	0.8	3.96
2004	0.62	0.33	0.00	0.08	1.61	0.32	0.15	0.77	3.88
2005	0.72	0.34	0.00	0.10	1.6	0.33	0.16	0.85	4.10
2006	0.75	0.34	0.00	0.09	1.59	0.33	0.16	0.87	4.13
2007	0.81	0.35	0.00	0.12	1.58	0.34	0.17	0.92	4.29
2008	0.84	0.34	0.00	0.13	1.57	0.33	0.17	0.92	4.30
2009	0.92	0.34	0.00	0.13	1.57	0.33	0.18	0.97	4.44
2010	1.05	0.35	0.00	0.11	1.57	0.27	0.19	1.06	4.61
Share of total % in 2010	22.79%	7.60%	0.06%	2.49%	34.08%	5.86%	4.12%	23.01%	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:

$$F_{SN} = N_{FERT} * (1-Frac_{GASF})$$

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 6.33)
$Frac_{GASF}$ – 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:

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

F_{AW} - animal manure nitrogen used as fertiliser, adjusted for volatilisation
$\sum_T (N_{(T)} \bullet Nex_{(T)})$ - total amount of animal manure nitrogen produced annually, kg/Nyr
$Frac_{FUEL-AM}$ – amount of animal manure that is burned for fuel, such activities not occurred im 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 4.26:

$$F_{BN} = \sum_i (Crop_{BF_i} \bullet (1 + Res_{BFi} / Crop_{BFi}) \bullet Frac_{DM} \bullet Frac_{NCRBFi}) \bullet EF \bullet 44/28$$

$Crop_{BFi}$ – seed yield of pulses (peas and beans) (Table 6.34);
$Res_{BFi}/Crop_{BFi}$ – Residue to crop product ratio (
);
$Frac_{DM}$ – Dry Matter Fraction (
);
$Frac_{NCRBFi}$ – Nitrogen Fraction (
);
EF – emission factor (**0.0125** kg N_2O –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:

$$F_{CR} = \sum_i [(Crop_{Oi} \bullet Res_{Oi} / Crop_{Oi} \bullet Frac_{DM} \bullet Frac_{NCROi}) \bullet (1 - Frac_r) + \sum_i [Crop_{BFj} \bullet Res_{BFj} \bullet / Crop_{BFj} \bullet Frac_{DM} \bullet Frac_{NCRBFj}) \bullet (1 - Frac_R)] \bullet EF \bullet 44/28$$

$Cropo_i$ – Crop production (crop type i) (Table 6.28);
$Crop_{BFj}$ - Crop production (each nitrogen-fixing crop type) (Table 6.34);
$Res_i/Crop_i$; $Res_{BFj}/ Crop_{BFj}$ - Residue to crop product ratio) (Table 6.32);
$Frac_{DM}$ – Dry Matter Fraction) (Table 6.32);
$Frac_{NCRBFj}$; $Frac_{NCRROi}$ – Nitrogen Fraction) (Table 6.32);
$Frac_R$ – 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 F_{OS} as the area of organic soils cultivated annually. For Submission 2012, areas of cultivated Histosols were reassessed (Table 6.30) according to newest available information[89]. Detailed description is included under LULUCF chapter.

[89] SIA „L.U. Consulting. PROJEKTS:„AUGŠŅU UN RELJEFA IZEJAS DATU SAGATAVOŠANA UN EIROPAS KOMISIJAS IZSTRĀDĀTO AUGSNES UN RELJEFA KRITĒRIJU MAZĀK LABVĒLĪGO APVIDU NOTEIKŠANAI PIEMĒROŠANAS SIMULĀCIJA"

Table 6.30 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	130230.42
2001	129557.82
2002	129070.22
2003	128548.82
2004	127931.34
2005	127294.67
2006	126638.98
2007	125964.15
2008	125270.24
2009	124542.23
2010	124540.00

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[90].

The default IPCC Tier1 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 6.33);
$Frac_{GASF}$ – 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 6.31).

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[91].

The default IPCC Tier1 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 6.31).

Emission factors and other parameters

[90] IPCC GPG 2000, page 4.68.
[91] IPCC GPG 2000, page 4.70.

IPCC default emission factors, national values and other parameters have been used. Emission factors and other parameters are presented in Table 6.31.

Table 6.31 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
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 6.27).

Values of dry matter fraction, nitrogen fraction and residue/crop production ratio are presented in the Table 6.32.

Table 6.32 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
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
Mixed cereals and pulses*	0.86	0.01	1.1
Buckwheat**	0.86	0.0106	2
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 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 synthetic fertilizers (Table 6.33) and productions of crops (Table 6.34). Other data sources are LSIAE (distribution of different manure management systems are shown in the Tables 6.15 - 6.20.

Table 6.33 Amount of use of N synthetic fertilizers

Year	N synthetic fertilizers (thsd.t)
1990	131.4
1991	112.4
1992	66
1993	39.7
1994	29
1995	11.5
1996	14.5
1997	19.4
1998	19.6
1999	19
2000	23
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

Table 6.34 Crops production (thsd.t) used for calculation of N_2O emissions

	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
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

Activity data is taken from Central Statistical Bureau. Statistical surveys are the source of data on crop in commercial companies, private farms and individual merchants. Crop grouping tables involve farms with more than 1 ha of agricultural land area. 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). During this check some incorrectness for activity data were found. All findings were corrected.

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 2012, following recalculations were done:

- Emissions from Nitrogen input from manure applied to soils were recalculated for 2000-2009 as AWMS were corrected.

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.

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 2010 was 3 349 kha (52 % of total country area). Forest area is estimated using the National forest inventory (NFI) data. Total area of afforested lands from 1990 to 2009 is 218.7 ± 3.7 kha. Due to the fact that the lands afforested in 1990 already completed the 20 years transition period, reported area of afforested lands in 2010 is 213.5± 3.7 kha[92]. The difference is reported under forest land remaining forest. The afforestation occurs on grasslands being grasslands since 1990 or converted from croplands to grassland. No physical land use changes to forest land are reported in 2010, because of the earlier decision to use field measurement data of the second round of the NFI for the land use change reporting in 2009-2012. Deforestation is calculated using the extrapolation method, assuming that deforestation to croplands and to settlements will follow to linear regression. Considering that the full 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.

Forest area and deforietrested area were estimated in 2009 using remote sensing approach – vegetation index were estimated in all of 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 croplands[93]. Similar approach will be used in 2012 to build up land use change chart for croplands. 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 croplands. Losses in living biomass are already included into accounting as commercially harvested wood. In the accounting of the activities under the Article 3.3 and 3.4 of the Kyoto protocol losses in living biomass due to deforestation were separated from commercial felling assuming that average harvesting rate prior to deforestation corresponds to average harvesting rate in all types of felling. Instant oxidation considered for all carbon pools in case of commercial harvesting; in case of deforestation – carbon stock changes in soil are accounted considering transition period of 20 years.

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

[92] Different approach is used under the Kyoto protocol reporting – it is considered that afforested or deforested areas will always remain under these categories, respectively, will be reported under the activities relevant to the Kyoto protocol Article 3, paragraph 3.

[93] Andis Lazdiņš, "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 International Scientific Conference Students on Their Way to Science, Jelgava: Latvia University of Agriculture, Faculty of Social Sciences, Faculty of Engineering, Forest Faculty, 2011), 10.

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 annual conference "Research for rural development 2011". Changes in dead wood, litter and soil carbon pools assumed to be zero according to Tier 1 approach by the IPCC GPG LULUCF 2003. As soon as reliable data on carbon stock difference in forest and farmland soils will be available, removals due to afforestation in soil, litter and dead wood will be recalculated. Methodology for evaluation of these pools according to Tier 2 is under implementation stage within the scope of several national research projects. Missing points, which will be solved in 2012 and 2013, are reference level of carbon stock in grassland and cropland, as well as actual carbon stock in living and dead wood (there are no the NFI specific equations to convert volume of living or dead wood to biomass and carbon stock, so the default values are used).

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 available wood increment data.

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 2012, for 1990-2010 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 Tier 1 and Tier 2 approach and country specific activity data on increment and harvesting figures, 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[94]. Emissions from deforestation (living and dead wood, litter and soil carbon pools) were introduced in 2011. They are reported, consequently, under forest land converted to croplands and settlements. Country specific activity data including average carbon stock in dead wood (expert judgement based on Tier 1 conversion factors from volume to biomass and carbon stock), average figures of carbon stock in litter and soil according to the research data[95] were used in calculations. Down to 10 cm deep soil layer is considered for instant oxidation of the organic carbon in case of conversion to croplands and settlements. Estimation of conversion of land use from croplands to grasslands was introduced in 2011 to represent land use changes associated with reduction of area of croplands; however, due to limited knowledge of carbon stock changes no removals in soil were considered in for category. The study on comparison of carbon stock in soil and litter is supposed to be completed during 2012.

Removals and emissions of GHG from forest fires in LULUCF sector in this report are calculated using data about areas of forest fires provided by the State forest service (SFS)[96].

[94] Jim Ed. Penman, ed., *Good Practice Guidancefor Land Use, Land-Use Change and Forestry* (2108 -11, Kamiyamaguchi, Hayama, Kanagawa, Japan: Institute for Global Environmental Strategies (IGES), 2003), http://www.ipcc-nggip.iges.or.jp.

[95] 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)" 20 (53) (2009): 105-124.

[96] CSB, "Environmental indicators in 2010" (CSB, 2011), http://www.csb.gov.lv/dati/informativie-apskati-28307.html.

Default values for incinerated biomass were used in calculation. 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 submission excludes removals in the grasslands, croplands and settlements, where available data about carbon stock changes contains considerably high level of uncertainty. Considering the constant increase in the living biomass pool this pool is reported as not a source.

In the previous submission National division of the land categories utilized in the NFI were applied to the GHG inventory to secure conformity to the IPCC GPG LULUCF 2003. Land use categories 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	Internal category code
1	Yards And Gardens	Cropland	72
2	Cropland	Cropland	60
3	Animal feeding glade	Cropland	32
4	Sparse Forest In Farmland	Forest land	64
5	Forest in farmland	Forest land	62
6	Clear-cut area	Forest land	14
7	Windblown area	Forest land	13
8	Forest fire area	Forest land	12
9	Decayed stand	Forest land	11
10	Forest	Forest land	10
11	Grassland	Grassland	61
12	Glade	Grassland	31
13	Recultivated Land	Other land	542
14	Sands and dunes	Other land	34
15	Moorland	Other land	33
16	Other Special Purpose Land	Settlements	545
17	Resting-Place	Settlements	544
18	Seed Orchard	Settlements	541
19	Ditch	Settlements	532
20	Mineralized Band, Fire-Break	Settlements	522
21	Forest Compartment Break	Settlements	521
22	Industrial Networks	Settlements	74
23	Cities	Settlements	73
24	Quarry, Fresh	Settlements	70
25	Quarry, Abandoned	Settlements	69
26	Railway	Settlements	68
27	Road	Settlements	67
28	Fire-break	Settlements	52
29	Forest road	Settlements	51
30	Channel	Wetlands	531
31	Alluvial Land	Wetlands	71
32	Ditch In Farmlands	Wetlands	66
33	Lake, Pond	Wetlands	65
34	River	Wetlands	63
35	Forest ditch	Wetlands	53
36	Flood land	Wetlands	40

No.	Land use categories in NFI	Relevant land use category in IPCC GPG LULUCF 2003	Internal category code
37	Transitional swamp	Wetlands	23
38	Grass swamp	Wetlands	22
39	Moss swamp	Wetlands	21

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 (afforestation and deforestation) are estimated using satellite images (the project mentioned above). Conversion of croplands to grasslands 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 2010 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 1990-2010, kilo ha

Year	Total area[97]	Forests	Cropland	Grassland	Wetland	Settlement	Other lands
1990	6 456,80	3 168,60	1 751,41	844,7	448,3	239,4	4,3
1991	6 456,80	3 175,00	1 719,35	869,8	448,3	240	4,3
1992	6 456,80	3 179,00	1 687,29	897,2	448,3	240,6	4,3
1993	6 456,80	3 185,60	1 655,22	922,1	448,3	241,2	4,3
1994	6 456,80	3 192,70	1 623,16	946,5	448,3	241,8	4,3
1995	6 456,80	3 200,00	1 591,10	970,6	448,3	242,4	4,3
1996	6 456,80	3 210,10	1 559,04	992,1	448,3	242,8	4,3
1997	6 456,80	3 220,10	1 526,97	1 013,70	448,3	243,3	4,3
1998	6 456,80	3 227,90	1 494,91	1 037,60	448,3	243,8	4,3
1999	6 456,80	3 238,70	1 462,85	1 058,30	448,3	244,3	4,3
2000	6 456,80	3 247,70	1 430,79	1 080,90	448,3	244,7	4,3
2001	6 456,80	3 259,80	1 398,72	1 100,00	448,3	245,6	4,3
2002	6 456,80	3 268,30	1 366,66	1 122,60	448,3	246,5	4,3
2003	6 456,80	3 277,50	1 334,60	1 144,60	448,3	247,4	4,3
2004	6 456,80	3 288,50	1 302,54	1 164,80	448,3	248,3	4,3
2005	6 456,80	3 299,90	1 270,47	1 184,60	448,3	249,2	4,3
2006	6 456,80	3 311,60	1 238,41	1 204,00	448,3	250,1	4,3
2007	6 456,80	3 323,80	1 206,35	1 223,00	448,3	251	4,3
2008	6 456,80	3 336,30	1 174,29	1 241,70	448,3	251,8	4,3
2009	6 456,80	3 349,40	1 142,22	1 259,70	448,3	252,7	4,3
2010	6 456,80	3 348,30	1 142,42	1 259,70	448,3	253,7	4,3

Net emissions of aggregated GHGs (CO_2, CH_4 and N_2O) in LULUCF sector in 2010 were -17147 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 increased by 7 % in 2010 compare to 1990. Considerable drop in difference is associated with growth of harvesting stock in 2010.

[97] 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.

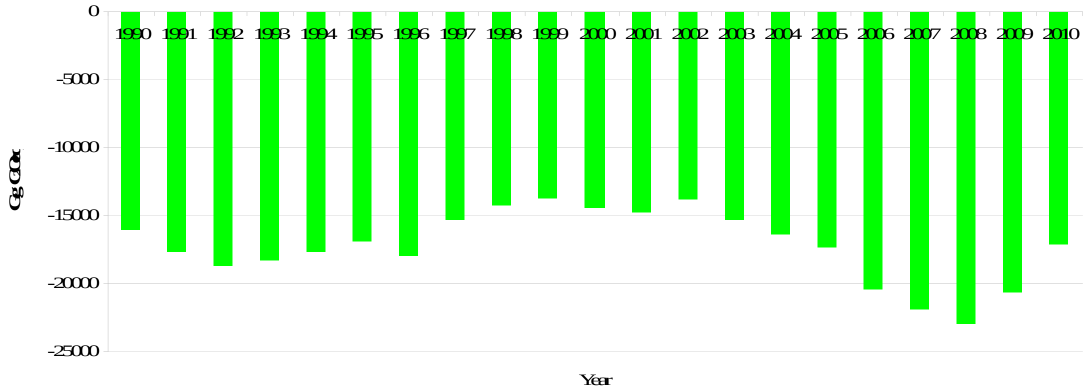


Figure 7.1 Net emissions of CO_2, CH_4 and N_2O in the LULUCF sector

In 2010, the LULUCF sector in Latvia is a sink because the total sector emissions are significantly smaller than removals; generally, due to accumulation of carbon in living biomass in forest lands (Table 7.3). Emissions increased during the reporting period in grasslands and settlements category. 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 land	Cropland	Grassland	Wetland	Settlement	Other land
1990	-16759,1	624,4	40,15	21,1	62	-
1991	-18414,8	643,5	41,34167	21,1	65,3	-
1992	-19533,3	662,6	42,64333	21,1	68,6	-
1993	-19163,4	681,6	43,86539	21,1	71,9	-
1994	-18489,9	700,7	45,17491	21,1	75,1	-
1995	-17789,1	719,8	47,12737	21,1	78,4	-
1996	-18664,1	569,5	49,46126	21,1	69,1	-
1997	-16061,5	571,7	49,26615	21,1	71,7	-
1998	-15014,5	576,8	51,6823	21,1	74,3	-
1999	-14498,3	581,2	55,35994	21,1	76,9	-
2000	-15233,5	587,8	55,63343	21,1	79,5	-
2001	-15583,6	572,9	61,32716	21,1	126,3	-
2002	-14617,7	590,1	75,12846	21,1	131,2	-
2003	-16120,1	602,3	81,42859	21,1	136,1	-
2004	-17234,6	582,6	68,02044	21,1	141,1	-
2005	-18181,1	586,1	60,23962	21,1	146	-
2006	-21331,5	589	105,877	21,1	151	-
2007	-22720,1	595,4	65,75735	21,1	155,9	-
2008	-23767,9	596,4	61,2078	21,1	160,8	-
2009	-21377,1	532,2	68,27737	21,1	166,8	-
2010	-17879,1	473,3	64,48781	21,1	173,3	-
Changes from 1990	7%[98]	-24%	61%	0%	179%	-

Area of organic soils in croplands and grasslands is updated according to the inventory of historical data about farmlands implemented in 2009[99]. Area of organic soils in cropland and grassland represented in the inventory characterizes situation before 1990. It is assumed that

98 Increase of net removals.

99 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.

the share of organic soils in cropland and grassland is equal and do not changes in time, because no better data are available. Detailed land use change matrices are provided in Table 7.4. Area of cropland and grassland in LULUCF reporting is synchronized with Agriculture reporting, including recalculation of cultivated organic soils. According to expert judgement it is assumed that all afforested lands pass through the grassland's stage before they become forest. It is considered that all forest land, grassland, cropland and settlements are managed.

Figure 7.2 demonstrates equation used for linear interpolation of cropland area between 1990 and 2009. Grassland is calculated from total area of grasslands and croplands (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 croplands. 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[99].

Data on increment of aboveground biomass are taken from the NFI. Recalculation to the total aboveground and underground biomass is done using national activity data on the stock increments and forest area and default factors in the IPCC GPG LULUCF 2003 Tier 1 method, which fits to actual recalculation factors (average density of biomass) according to expert estimation. No changes in emission factors are done since the last reporting. Regionally verified equations for recalculation of biomass are under preparation.

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

Changes	Forest	Cropland	Grassland	Wetland	Settlements	Other lands
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	
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						

Changes	Forest	Cropland	Grassland	Wetland	Settlements	Other lands
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						
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			

Changes	Forest	Cropland	Grassland	Wetland	Settlements	Other lands
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						
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						
2010	**3348.3**	**1 142.4**	**1259.7**	**448.3**	**253.1**	**4.3**

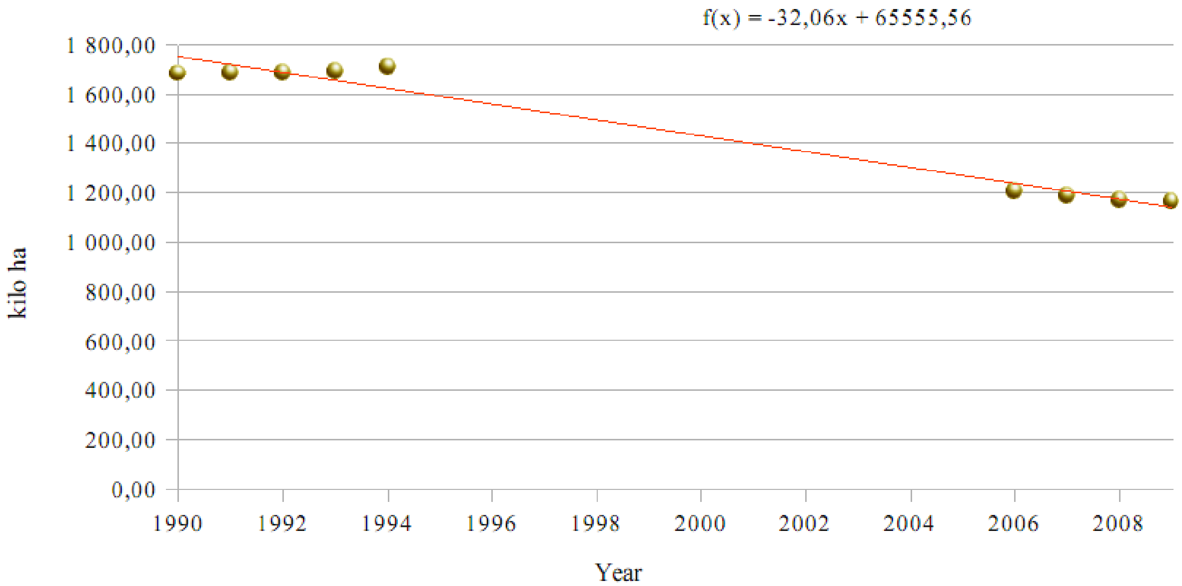


Figure 7.2 Chart used for linear interpolation of area of cropland using statistical data for 1990-1994 and 2006-2009

Emissions from living biomass due to deforestation in the convention reporting are included in emissions related to commercial felling as they can't be separated due to possible offset in time between harvesting and following deforestation. In Kyoto protocol reporting emissions from living biomass due to commercial felling following by deforestation are accounted under the deforested areas assuming that harvesting stock in deforested areas is equal to average harvesting stock in all types of final felling in the corresponding year. Additionally it is assumed that all dead wood and litter instantly converts to CO_2 in the deforested area, respectively, 22 and 77.6 tons ha^{-1}. 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[100]. Average stock of dead wood is estimated from the NFI database[101].

Considering that risk of double accounting exists in calculation of increment of living biomass and dead wood in forest lands, dead wood category is excluded from calculation of removals as not a source. Comparison of different sources of information about dead wood (NFI and reports to the Timber Committee[102]) demonstrates constant increase of dead wood stock in forests, particularly because of introduction of regulations prohibiting extraction of large fractions of dead wood, reduction of incineration of harvesting residues on-site and also due to several natural calamities (wind storms) during the last decade.

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 default emission factors (0.68 tons C ha^{-1} annually).
The key categories in LULUCF sector in 2010 in Latvia are summarised in Table 7.5. The most significant key category in the NIR is Forest land remaining forest land contributing to 58 % of level of the emissions and 59 % to the trend.

Table 7.5 Key categories in LULUCF sector

IPCC GHG Source and Sink Categories	Gas	% Level Assessment	% Contribution to trend	Identification criteria
5.A.1 Forest Land remaining Forest Land	CO_2	57,183%	58,355%	LA/TA
5.A.2 Land converted to Forest Land	CO_2	1,609%	1,212%	LA/TA
5.B.2 Land converted to Cropland	CO_2	0,826%	0,972%	LA/TA
5.B.1 Cropland remaining Cropland	CO_2	0,714%	2,597%	LA/TA
5.E.2 Land converted to Settlements	CO_2	0,564%	0,349%	LA/TA
5.A.1 Forest Land remaining Forest Land	N_2O	0,479%	0,474%	LA/TA
5.C.1 Grassland remaining Grassland	CO_2	0,209%	0,617%	TA

[100] 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)."
[101] http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls
[102] 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).

7.2 FOREST LAND (CRF 5)

7.2.1 Source category description

There are 3 IPCC GHG 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 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)[103]. 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, increment of growing stock and tree biomass. 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. It is assumed that all lands converted to forest land arise from grasslands category, which is transitional stage between cropland to forest land in natural conditions. It was also a requirement to receive state subsidies for artificial afforestation of farmlands until recent years. 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 biomass are reported in the 2009 submission and are accounted as removals. Carbon stock changes in dead wood are exuded from the GHG inventory as not a source to avoid overlapping with accounting of living biomass (natural mortality) and to avoid temporary effect of mathematical increase of dead biomass stock due calamity in 2005 (regression analysis used earlier to extrapolate dead wood stock in forest showed considerable annual increase of dead wood stock after 2005). 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. Carbon stock changes are reported separately on naturally dry and wet mineral and organic soils and drained mineral and organic soils. Organic soils are considered peatlands as defined in the NFI: a site is classified as peat-land if the organic layer is peat with at least 30 cm deep peat layer (H horizon) below the litter layer. Additionally to CO_2 also emissions of N_2O from drained organic and mineral soil are reported. Distribution of the forest site types according to the NFI is shown in Figure 7.3.

[103] http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls

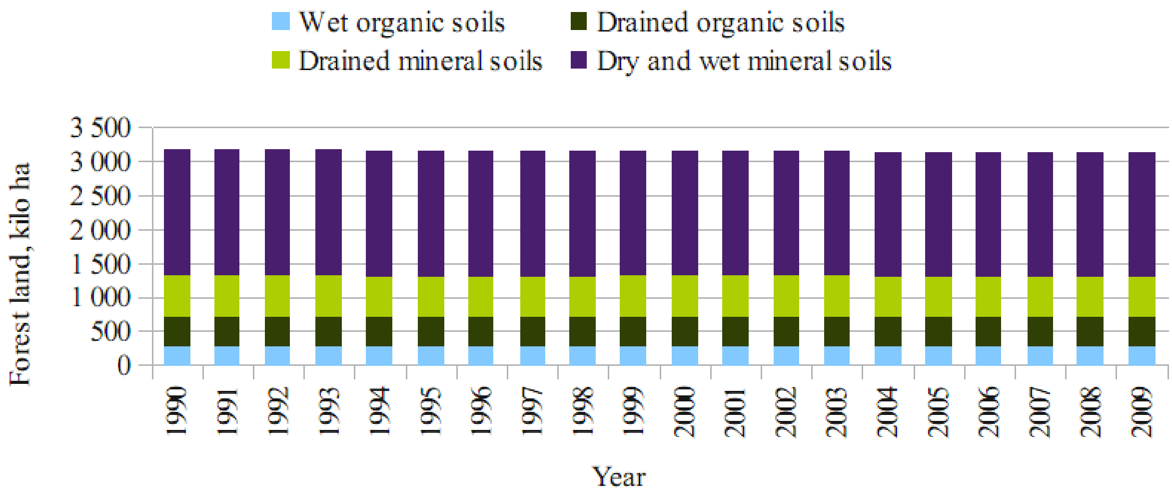


Figure 7.3 Distribution of drained, naturally dry and wet mineral and organic soils in Latvia's forests[104]

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 growing stock correspond to the mean annual increment of forest growing stock and annual harvesting of trees. Considerable part of non-CO_2 emissions is associated with incineration of harvesting residues in clear-cuts. The activity data for this calculation is based on an outdated study[105].

The time series for annual increment of growing stock of trees on a forest land remaining forest are given in Figure 7.4 Figure 7.4 and in the Land converted to forest – in Figure 7.5. The annual increment of growing stock of trees in a forest land per area increased by 52 % in 2010 in a compare to 1990, total annual increment increased by 51 % in 2010 in a compare to 1990. That comes from the increased growth of trees due to productivity targeted management of forests in 70ths and 80ths 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, which, consequently, is fluctuating very much because of the global market situation. 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 7.6). However, increment of growing stock in forests, especially premature forest stands were considerably higher, securing constantly growing removals of CO_2 in living biomass of trees.

The Land converted to forest land provides considerably smaller 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) are moved to the forest land remaining forest land category. Therefore, area of afforested lands is decreasing because of completion of 20 years transition period in certain areas.

No afforestation is reported in 2010 to avoid overestimation of removals, because the NFI field measurement data are not available yet. This category will be recalculated in 2013 (after

104 http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls

105 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.

at least 80 % of the NFI field measurement data from the second cycle will be entered into the data base).

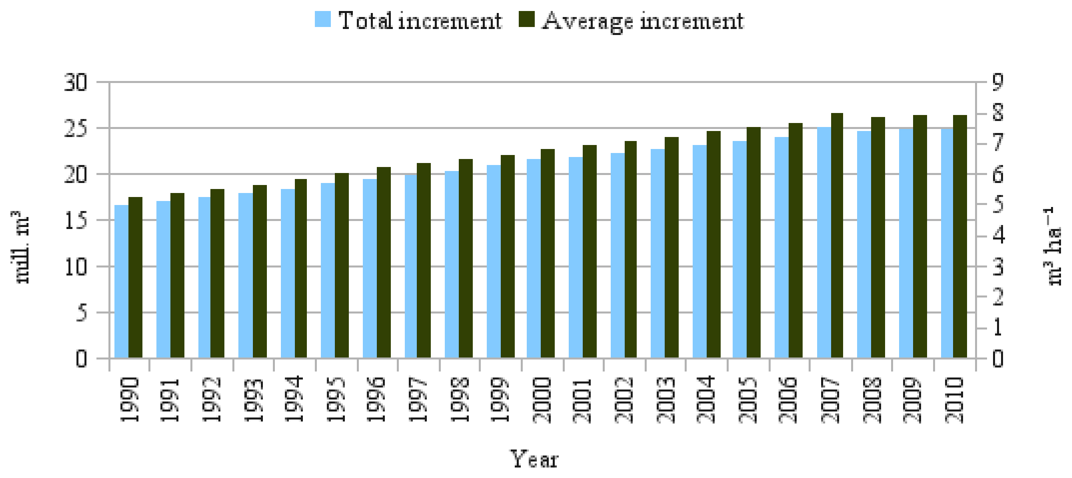


Figure 7.4 Annual increment of growing stock of trees on the Forest land remaining forest

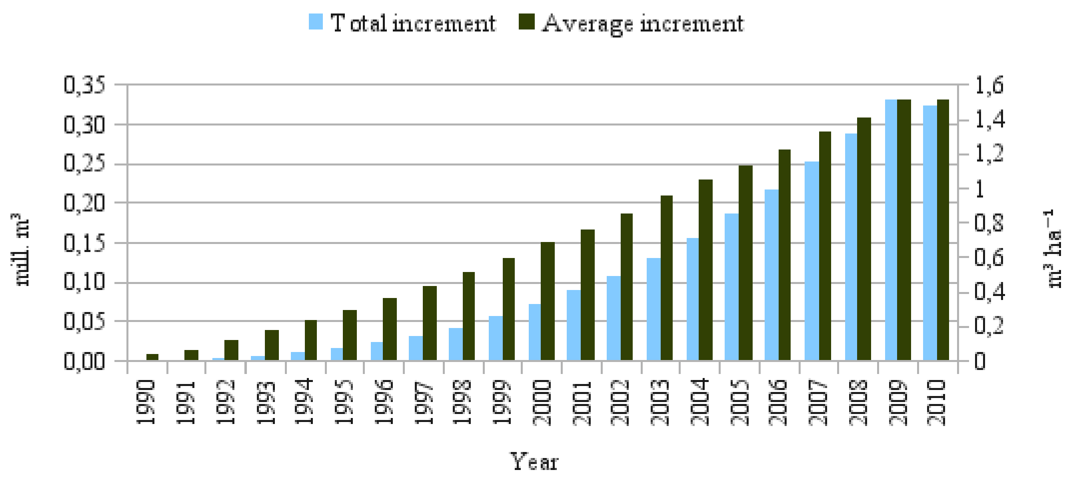


Figure 7.5 Increment of growing stock of timber on the Land converted to forest[106]

106 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).

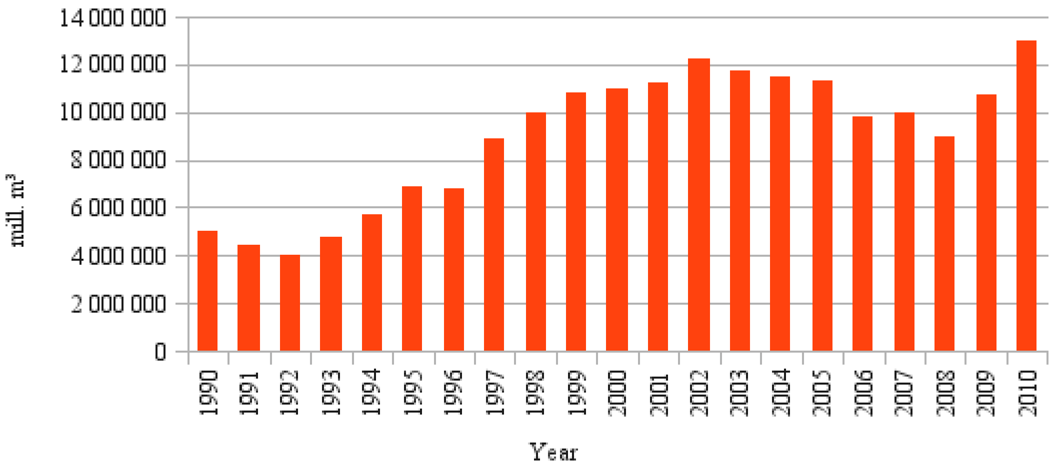


Figure 7.6 Annual harvesting stock of roundwood[107]

The aggregated net emissions from forest lands were -17879 Gg of CO_2 equivalents in Latvia in 2010. The most of the emissions are associated with commercial felling (Figure 7.6). Both, the harvesting related emissions and removals in living biomass increased during the reporting period (Figure 7.7).

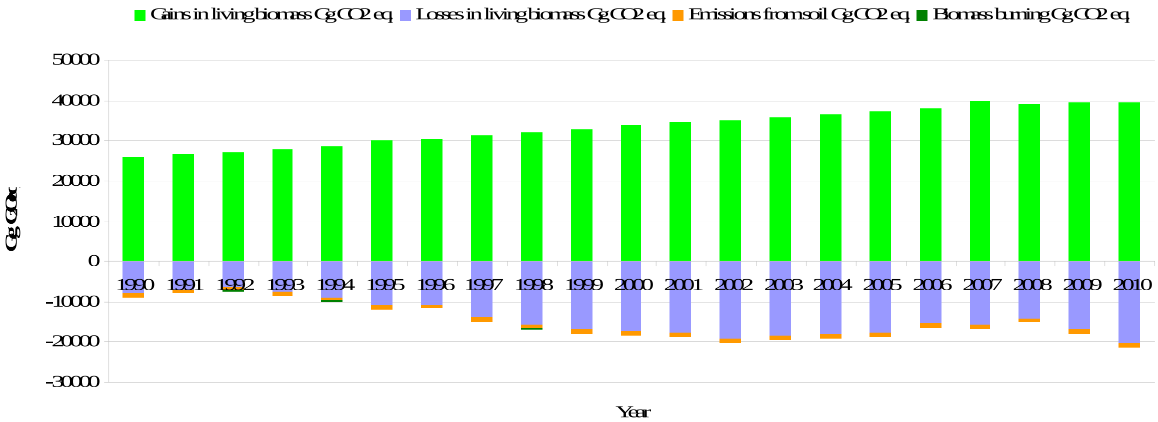


Figure 7.7 Structure of net removals in the forest lands

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 is based on study, that about 50 %[108] of harvesting residues is left for incineration and 66 % of them are actually incinerated[109]. Fraction of biomass oxidized on-site is assumed 90 % in average. Amount of the harvesting residues according to different studies on forest biofuel production is assumed 20.2 % of harvesting stock. As soon

107 https://sites.google.com/site/lvlulucf/activity/nir-1990-2010/Mezizstrade1991-2010.html?attredirects=0&d=1

108 30 % after 2001.

109 Līpiņš, "Assessment of wood resources and efficiency of wood utilization (Koksnes izejvielu resersu un to izmantošanas efektivitātes novērtējums)."

as activity data from the NFI will be available, calculations of emissions associated with incineration of harvesting residues will be improved.

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 of 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 grasslands and croplands.

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 forest is shown in Figure 7.8.

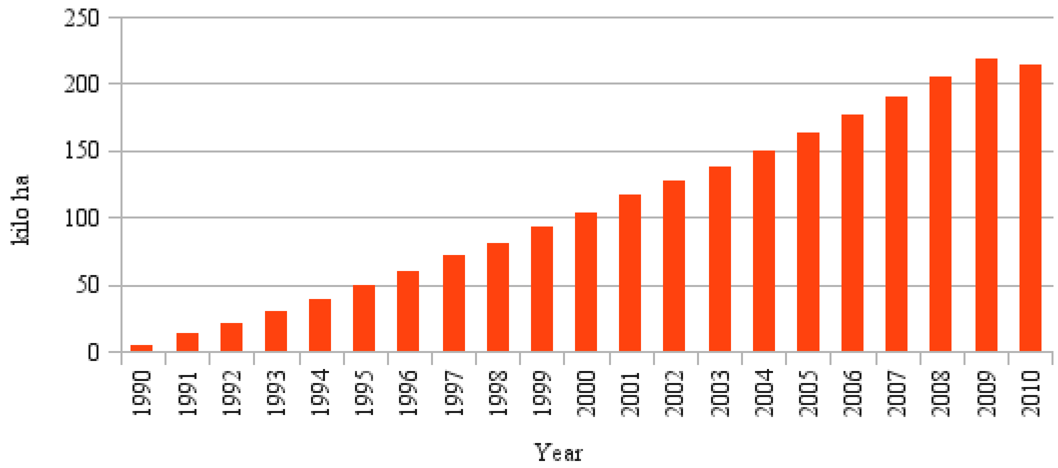


Figure 7.8 Total area of the land converted to forest

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, part of the poorly productive forest land and forest roads. Area estimates are derived from the NFI data[110].

[110] http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls

Land use categories of the NFI included into the forest land category are No. 10, 11, 12, 13, 14 and partially 62 and 64[111] according to Table 7.1.

7.2.4 Methodological issues

Changes in carbon stock and GHG emissions are estimated according to the IPCC GPG LULUCF 2003 Tier 1 and 2 methods. Default method (the carbon loss to be subtracted from the carbon removals for the reporting year) is used in calculations of removals and emissions of CO_2 in living biomass according to the Equation 3.2.2 of the IPCC GPG LULUCF 2003.

CO_2 removals and emissions from burning on-site in the forest are described more detailed in the Chapter Biomass burning 7.8.4 Methodological issues.

Emissions of CO_2 from drained soils are calculated according to a Tier 1 method provided in the IPCC GPG LULUF (Equation 3.2.15). Emissions of N_2O from drained organic forest soils were calculated according to Equation 3a.2.1 and Table 3a.2.1. Emission factor of 0.6 kg N_2O-N ha^{-1} yearly was applied to organic soils and emission factor of 0.06 kg N_2O-N ha^{-1} yearly was applied to mineral soils for calculations N_2O emissions. Emission factor 0.68 t C ha^{-1} yearly (Table 3.2.3 of the IPCC GPG LULUCF 2003) was assumed for calculations of carbon stock changes in drained organic forest soils. Methodology on estimation and monitoring of carbon stock changes in naturally dry and drained mineral forest soils is under development.

After finalization of second round of the NFI it will be possible to switch to second method (according to Equation 3.2.3 of the IPCC GPG LULUCF 2003[112]). This method doesn't provide information about a current year, but it's much more precise because of simpler calculation and smaller level of uncertainties. It will be also harmonized with 5 years cycle of the NFI.

Assumptions on wood densities that have been made for calculations of increment of living biomass and emissions associated with the timber extraction and annual gross increment on the base of dominant tree species are shown in Table 7.6. Where national research data are not available, the default values from the IPCC GPG LULUF 2003 Table 3A.1.9[113] were utilized. The work on elaboration of scientifically verified biomass expansion factors for the most common tree species (Scots pine, Norway spruce, silver birch and common aspen) is under way now. The preliminary results will be available at the end of 2013.

Table 7.6 Average density of wood of different tree species

No.	Species	Basic density of wood
1	Pine (A. Treimanis 2007)	0.49
2	Spruce (A. Treimanis 2007)	0.42
3	Birch (U. Viesturs 2006)	0.62
4	Black alder (IPCC GPG LULUCF 2003 2003)	0.45
5	Grey alder (O. Miezīte 2007)	0.46
6	Aspen (A. Gailis n.d.)	0.39
7	Oak (IPCC GPG LULUCF 2003 2003)	0.65

[111] Plots where diameter of trees at breast height is more than 2 cm.
[112] Annual change in carbon stocks in living biomass
In forest land remaining forest land (stock change method).
[113] Basic wood densities of stem wood for boreal and temperate species.

Biomass expansion factor for conversion of merchantable volume to above-ground tree biomass was taken from the IPCC GPG LULUF 2003 Table 3A.1.10[114]. BEFs to be used in connection to growing stock increment data (Equation 3.2.5) according to the IPCC GPG LULUF 2003 Table 3A.1.10 were not used in calculations due to an expert judgement that these factors leads to considerable underestimation of the increment in historical data from 1990 to 2006, because recalculation of increment according to the methodology applied in the NFI is based on estimation of diameter of tree with following calculation of height and other secondary forest inventory values. Therefore, there is no difference between calculations of above-ground biomass from increment or growing stock.

Root-to-shoot ratio appropriate to increments was taken from the IPCC GPG LULUF 2003 Table 3A.1.8[115] (Table 7.7). This value according to an expert judgement and available literature references is the most relevant to the practice. However, as soon as biomass equations will be elaborated and verified these values will be revised. The methodology of elaboration of biomass equations for the most common tree species is under implementation stage in the LSFRI Silava.

Table 7.7 Factors and parameters used for calculations of change in carbon stock in living biomass

No.	Parameter	Value
1	Basic wood density (weighted average 1990-2008)	0.5 (td.m. m^{-3})
2	Biomass expansion factor for conversion of merchantable volume to above-ground tree biomass	1.30 (dimensionless)
3	Root-to-shoot ratio appropriate to increments	0.32 (dimensionless)
4	Fraction of carbon in dry matter	0.5 (t C $td.m^{-1}$)

Harvesting stock was recalculated to emissions using the same BEFs as increment (Table 7.7). Left to decay factor was excluded from calculation because statistical data about merchantable timber already considers harvesting losses; therefore, use of left to decay factor leads to overestimations of removals and living biomass.

Total forest area was changed in the reporting 1990-2009[116] 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.

In earlier reports forest stands on non-forest lands were moved to lands remaining forests category only after reaching 20 years age, even if the area was afforested before 1990. Since reporting 1990-2009 the afforested lands are considered the land remaining forest land, if forest grew in particular place before 1990. This is done to harmonize Kyoto protocol and the Convention reporting. 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

[114] Default values of biomass expansion factors (BEFs), value corresponding to the Boreal broadleaved forest to be used in connection to growing stock biomass data (Equation 3.2.3 of the IPCC GPG LULUCF 2003).

[115] Average below-ground to above-ground biomass ratio (root-to-shoot ratio) in natural regeneration by a broad category, value corresponding to conifer forest & plantation.

[116] 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).

area of forests was updated in already in 1990-2009 reporting according to research data on land use structure according to the NFI[117].

Gains in living biomass were updated in the reporting 1990-2009 according to actual information about forest area and increment figures by the NFI. No changes in the increment figures were done in 2010 assuming that average increment in forest lands is the same as in 2009 (average value of the first round of the NFI). The removals in living biomass will be recalculated after receiving results of the second round of the NFI.

A net change of carbon stock in dead organic matter is notated as NE. The results of the first round of the NFI demonstrates that stock of dead wood is constantly growing in forest stands of the most common tree species until they reach maturity (the most common age for final felling). Results for pine, spruce and birch are shown in Figure 7.9, Figure 7.10 and Figure 7.11. After reaching this age stock of dead wood decreases (Figure 7.12, an example of pine) however correlation coefficient (R^2) of polynomial regression characterizing reduction of stock of dead wood is rather small, just like R^2 of exponential regressions characterizing increment of stock of dead wood before reaching maturity. Therefore stock changes in dead wood are not reported to avoid overestimation of removals in this carbon pool. The figures will be updated after completion of the second round of the NFI. The most probably is that this pool will be reported as not a source due to a high level of uncertainty of removals in dead wood.

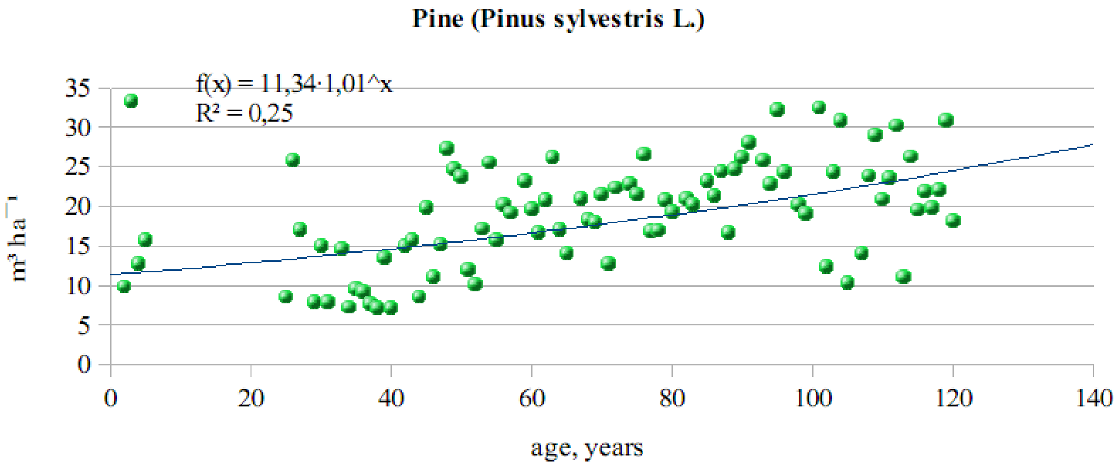
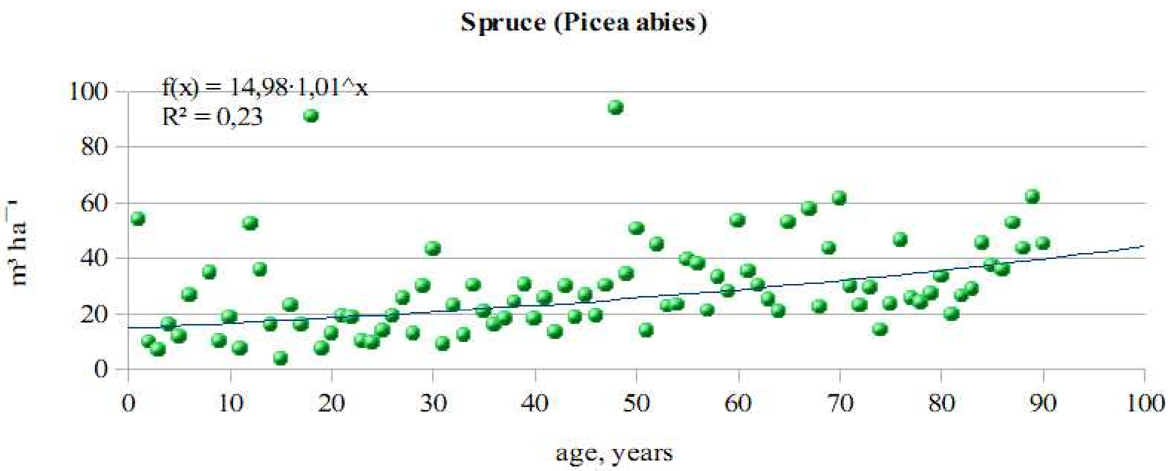


Figure 7.9 Stock of dead wood in pine forests at 0-120 years age



117 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 7.10 Stock of dead wood in spruce forests at 0-90 years age

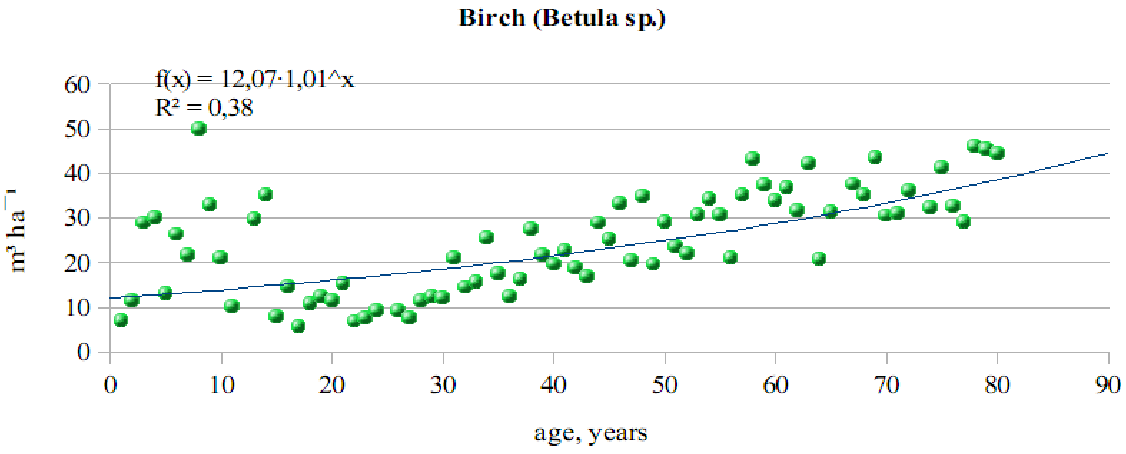


Figure 7.11 Stock of dead wood in birch forests at 0-80 years.

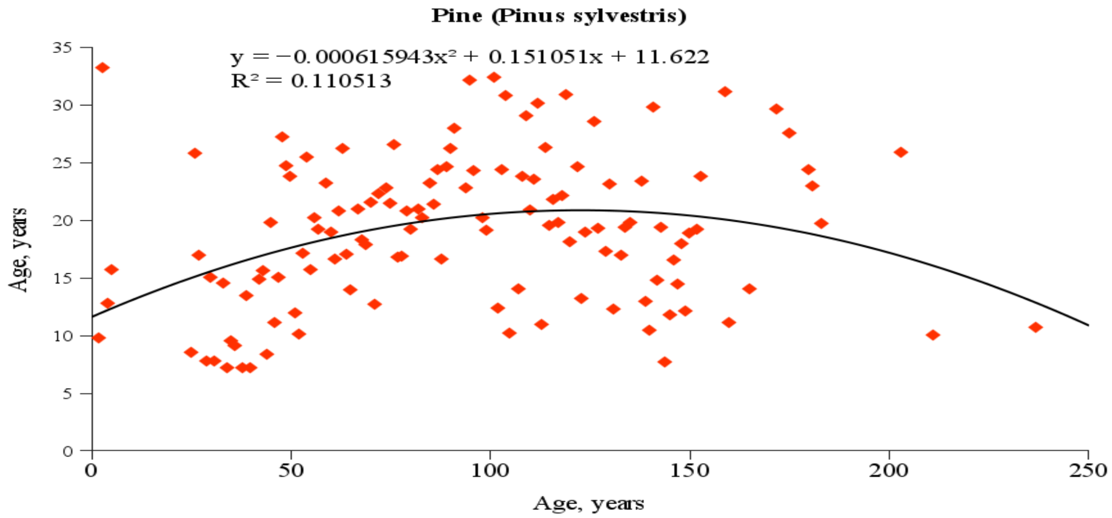


Figure 7.12 Stock of dead wood in pine forests of all age groups

Emissions from organic soils are updated according to information about total area of forests on drained organic soils[118]. The same study data were used to update N_2O emissions from drained mineral and organic soils[119].

In the controlled burning section (category – land remaining forest) CO_2 emissions are notated as IE because they are already accounted as losses in living biomass due to commercial harvesting.

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 field measurement year. 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 7.13. No afforestation is considered for 2010 to avoid potential overestimation of removals. In 2013

[118] Ibid.
[119] Ibid.

after revisiting of 80 % of all the NFI plots second time extrapolated figures will be replaced with actual land use change figures.

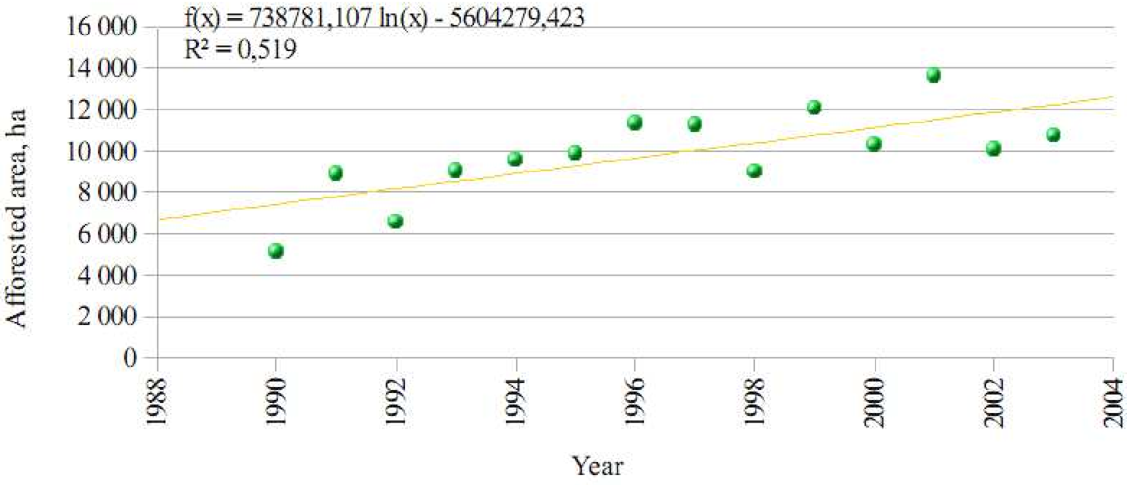


Figure 7.13 Logarithmic regression for extrapolation of areas afforested after 2004

Area of organic soils estimated using actual figures about afforested areas on drained organic soils for historical data (1990-2003) and extrapolated figures for 2004-2009. It is assumed that structure of forest stand types (sites on wet mineral soils, drained mineral soils and grained organic soils) follows to logarithmic regression (Figure 7.14).

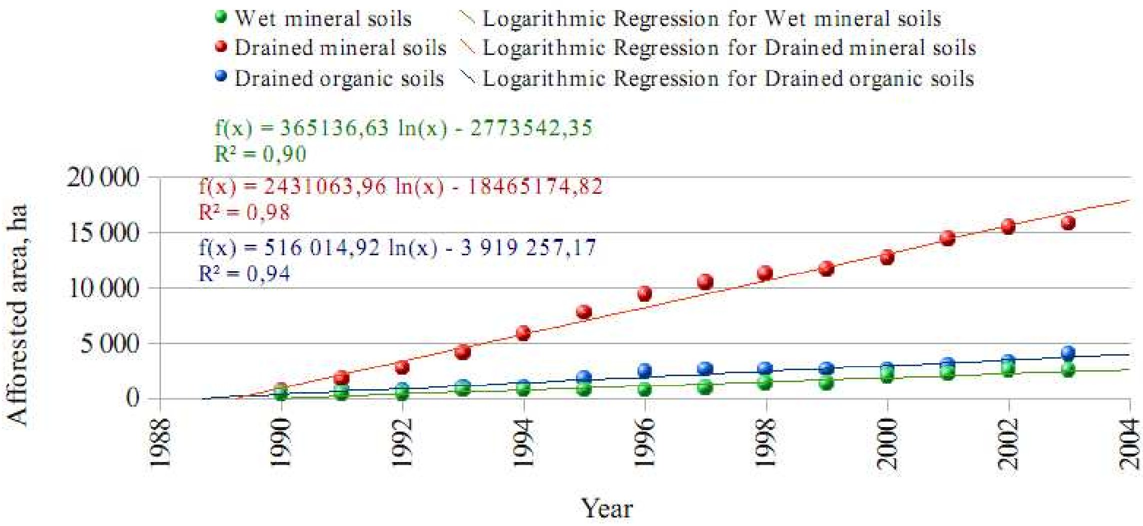


Figure 7.14 Logarithmic regression for extrapolation of different forest stand types

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)[120].

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).

[120] 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.

Emissions from organic soils in afforested lands calculated using the same approach as for emissions from drained organic soils on lands remaining forest.

7.2.5 Uncertainties and time-series consistency

Uncertainties are estimated on the base of the 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 soil is 90 %.

Uncertainty level (standard error of mean) of the forest area is 0.3 %, uncertainty of afforested area is 1.7 %, and 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 about 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[121].

[121] Zemkopības ministrija, "Meža statistiskās inventarizācijas veikšanas un mežaudzes sekundāro parametru aprēķināšanas metodika (instrukcija Nr. 10 no 17.03.2004.)" (Latvijas Republikas Zemkopības ministrija, 2004), https://sites.google.com/site/lvlulucf/literature/MSI_metodika_Instrukcija_%282004%29.pdf?attredirects=0&d=1; LSFRI Silava, "Methods utilized to recalculate historical forest increment data" (LSFRI Silava, 2007), https://sites.google.com/site/lvlulucf/literature/Recalculationsofhystoricalremovals2007.pdf?attredirects=0&d=1.

The data based on forest statistics were produced by the LSFRI Silava[122]. 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

No recalculations were done in this category except minor updates in the notation keys.

7.2.8 Category-specific planned improvements

The most important planned improvements:

- elaboration of living biomass equations for the most common tree species (until report 1990-2013);
- elaboration of dead wood expansion factors 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 (until report 1990-2013);
- 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, consequently, carbon stock changes in afforested lands and croplands converted to grasslands will be calculated (until report 1990-2013);
- introduction of natural mortality into calculation of increment of living biomass and stock change in dead biomass (until report 1990-2012);

update of afforested areas according to empiric data from the second round of the NFI (report 1990-2013).

7.3 CROPLAND (CRF 5.B)

7.3.1 Source category description

Under Two 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 croplands are reported (Figure 7.15). Net aggregated emissions from croplands were 473 Gg of CO_2 eq. in Latvia in 2010. Lime applications were quite constant during the reporting period[123], except 2002 and 2003, when due to regulatory reasons (support for liming of farmlands) use of liming material considerably increased (Figure 7.16).

[122] http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls
[123] https://sites.google.com/site/lvlulucf/activity/nir-1990-2010/Augsneskalkosana1995-2010.html?attredirects=0&d=1

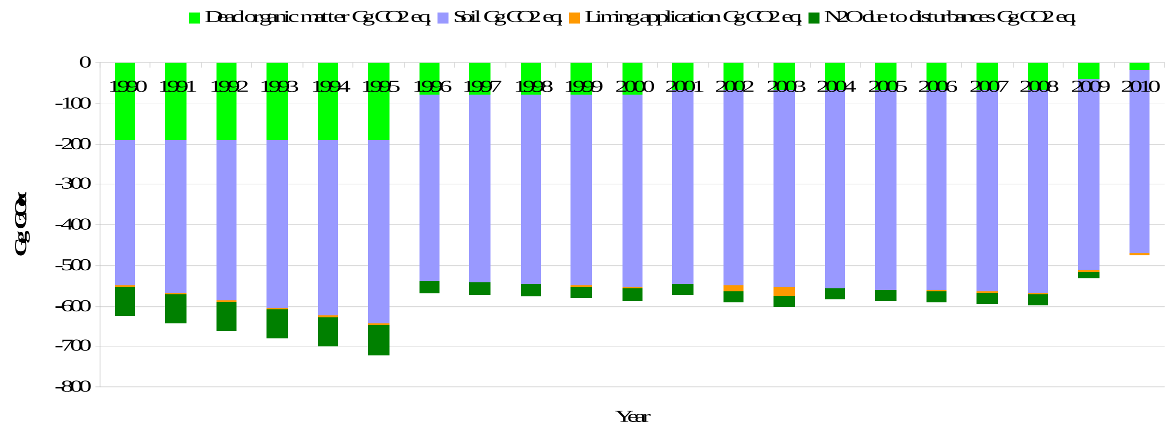


Figure 7.15 Aggregate GHGs in croplands

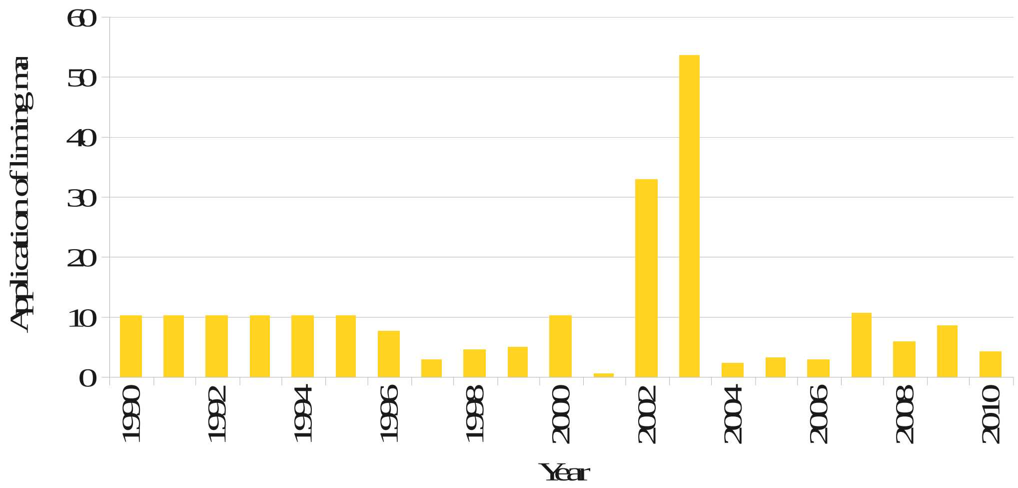


Figure 7.16 Application of liming material in croplands

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. Figures of annual increment of trees volume in this category provided by the NFI are shown in Figure 7.17 to verify that living biomass in this category is not a source. Data about area and increment of growing stock of woody biomass has very high level of uncertainty. 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. However, information provided by the NFI is sufficient to consider that removals in living biomass in the Cropland's category can be excluded from reporting as not a source already now.

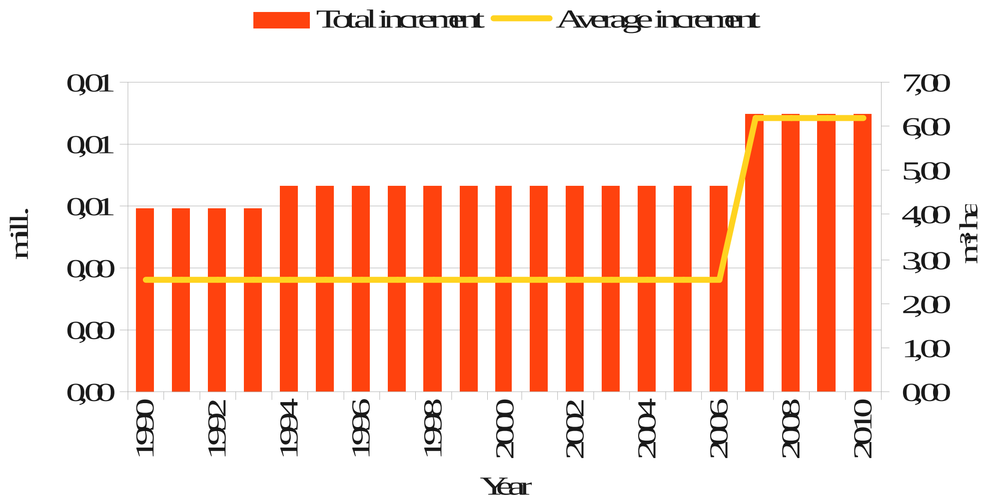


Figure 7.17 Increment of growing stock of woody biomass on croplands

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. 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. No deforestation is reported in 2010, because the NFI data are not available yet. Land use data will be recalculated in 2013, when at least 80 % of the data obtained in the second cycle of the NFI will be entered.

7.3.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

The croplands refer to the official area of arable land, including orchards. The area is reported by the Central statistical bureau on the base of information gathered by the State land service. According to the NFI data, which were used to estimate deforested areas converted to croplands and which will be used in further submissions to estimate land use conversions to and from croplands, croplands also includes animal feeding glades. Categories of the NFI according to the Table 7.1 included into croplands are No. 32, 60 and 72.

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. In both cases Tier 1 method is applied.

For calculation of emission from organic soils emission factor is taken from Table 3.3.5[124] 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 - 244 tons C ha^{-1} at 0-30 cm depth (average carbon stock

124 Annual emission factors (EF) for cultivated organic soils.

in mineral forest soil with standard deviation of 70 %). Coefficients for the carbon stock change calculations were taken from Table 3.3.4 –FLU 0.71 (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 175.5 tons C ha^{-1} at 0-30 cm depth; respectively net reduction of carbon stock in mineral soils is 70.8 tons ha^{-1} or 3.54 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's soil will be available. The project aimed to obtain missing data is initiated in 2012 and will provide statistically reliable information in 2013.

Activity data for calculations is taken from national statistics[125] (amount of liming material applied) and according to the national research data[126] (area of organic soils).

Area of land remaining cropland was estimated using interpolation method from data provided by CSB[127] and results of satellite image analysis[128]. Area of the croplands was calculated backwards from 2008 assuming[129] that statistical information about croplands area in 1990-1994 and 2006-2009 is correct and can be used to estimate starting and ending points of area of croplands. Remote sensing analysis of satellite images was used to estimate deforested area converted to croplands[130].

Extrapolation was used to estimate area of land remaining croplands in 2009. Linear regression, the same as for interpolation, used for calculations is shown in Figure 7.2. Cropland area in LULUCF reporting is harmonized with the cropland area used in agriculture reporting. No land use changes are reported in 2010. The information on land use changes will be updated and relevant emissions will be recalculated in 2013, when field measurement based data of at least 80 % of the NFI sample plots will be available.

According to the study data[131] area of organic soils in farmlands is 5.18 ± 0.5 %. It is assumed that proportion of organic soils in lands remaining croplands, lands converted to croplands and croplands converted to grasslands is equal. Therefore, the area of organic soils in cropland is linearly correlating in calculations with the total area of cropland. In 2010 according to this estimation there was 59 kha of organic soils in croplands. This assumption might be overestimated because the NFI shows that only 2.4 % of afforested areas are on organic soils. Normally organic soils are afforested in a first order due to a low land value and complicated working conditions. This leads to conclusion that area of organic croplands as well as grasslands is considerably smaller due to decomposition of organic material and

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125 https://sites.google.com/site/lvlulucf/activity/nir-1990-2010/Augsneskalkosana1995-2010.html?attredirects=0&d=1

126 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)."

127 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

128 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)."

129 Agriculture and statistics experts were involved in consultations to identify if these data can be used.

130 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)."

131 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)."

afforestation of non-forest lands before 1990; however, no empiric evidences exists to verify this assumption. The project on estimation of actual area of cropland and grassland on organic soils is initiated in 2012 by the LSFRI Silava in conjunction with the NFI activities. Statistically verifiable results will be available at the end of 2013. The rationale of the project is estimation of carbon content and texture of soil (where necessary) in the NFI plots fitting to the cropland's or grassland's category and being located on wetlands according to topographic maps developed at the beginning of the last century.

Area of organic soils in croplands used to estimate emissions from soil in this report is shown in Figure 7.18.

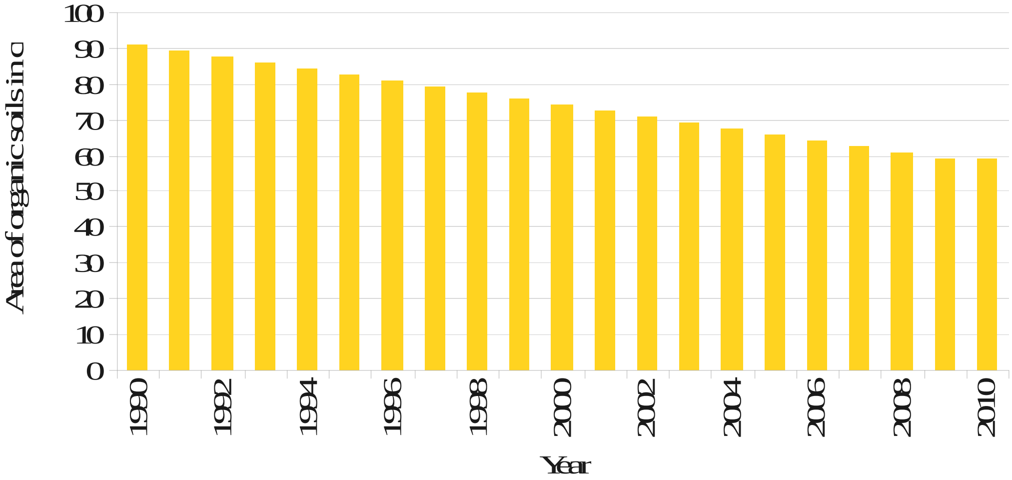

Figure 7.18 Total area of drained organic soils in croplands

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 croplands is negligible and do not result in actual emissions or removals. Exception is forest lands converted to croplands where losses in living biomass are noted as included elsewhere (reported under land remaining forest as emissions related to commercial harvesting[132]). Net carbon stock changes in mineral soils in croplands are reported as not occurring because according to IPCC GPG LULUCF 2003[133] these emissions should be reported in case of changes in land management practice. Exception is forest land converted to cropland, where instant oxidation method is applied to living biomass, dead wood and litter layer.

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).

Research data[134] on average carbon stock in litter in forest lands (78 tons of CO_2) and average figures of dead wood stock in forest lands (relevant to 22 tons of CO_2) according to results of the first round of the NFI[135] are used in calculations. The same conversion factors as for living biomass are considered for dead wood – average density 0.5 tons m^3, average carbon stock – 0.5 tons C per ton of biomass (Equation 3.2.11).

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132 In the Kyoto protocol reporting these emissions are reported under the deforestation, splitting of harvested volume is done on the base of expert judgement – average harvesting stock in commercial felling in a particular year.

133 Section 3.3.1.2.1.1 Choice of Method.

134 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)."

135 http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls

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 croplands 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 croplands in 2010 according to the NFI was 0.3 % (3.4 kha), uncertainty of area of organic soils in croplands in 2010 was 30 % based on expert judgement (will be updated with actual figures after implementation. 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 15 % based on expert judgement (standard approach by the CSB considers uncertainty level of 10 % for the activity data, 15 % is assumed more realistic taking in account that share of different liming materials and their quality is not known).

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 6.1 %, uncertainty of carbon stock in mineral soil in forest land at 0-30 cm is 70 %, 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, the total uncertainty of carbon stock in dead wood is 30 %. All values are expressed as standard error of mean.

Uncertainty of N_2O emissions due to disturbance of land following to transformation to cropland according to expert estimation is 90 % summarizing uncertainty level 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 croplands' area instead of usage of statistical data which fluctuated a lot due to changing methods and definitions without actual changes of the croplands' area. Recent figures of croplands area is validated against actual figures provided by the NFI which will be used as the main source of information starting with 2013 when second round of the NFI will be completed.

7.3.6 Category-specific QA/QC and verification

The QA/QC plans for the croplands' 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

No recalculations were done in the cropland remaining cropland category. Major changes were introduced into the calculations of emissions in the land converted to cropland category:

- area of transformed land is slightly updated using updated coefficients, mineral and organic soils are separated assuming that the share of organic soils in transformed lands is the same as in cropland remaining cropland;
- losses in dead wood and litter are update according to the new data on transformed lands;
- losses in carbon stock in soil are calculated separately for organic and mineral soils, transition period is used in calculations of annual losses instead of instant oxidation;
- N_2O emissions are recalculated according to the updated data on carbon stock change in soil.

7.3.8 Category-specific planned improvements

In 2013 when data from second round of the NFI will be available croplands' area and land use changes from and to croplands since 2004 will be recalculated using empiric data from the NFI plots. Satellite image analysis will be done in 2012 to estimate historical croplands' area and to estimate those plots which fit to fallow definition. Results of interpolation applied in this reporting will be used to validate obtained results. Actual carbon stock in soil in cropland will be determined during 2012 and 2013. These values will be used in calculation of land use change related emissions and emissions on N_2O due to disturbances.

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 grasslands in Latvia in 2010 was 1 260 kha, including 631 kha of grasslands remaining grasslands and 629 kha of lands converted to grassland[136]. Emissions from organic soils and biomass burning are reported under the grassland's category (Figure 7.19). The net emissions from grasslands were 64.5 Gg in Latvia in 2010. 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 7.20).

No removals are reported in this category to avoid an overestimation.

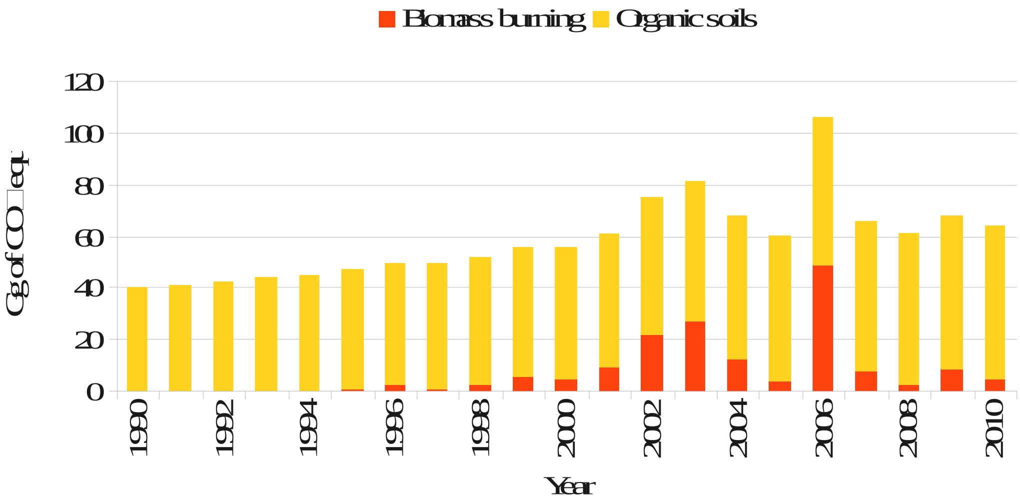

Figure 7.19 Aggregate GHGs (CO_2, CH_4, N_2O) in grasslands

[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)"; Lazdiņš, "Harmonization of land use matrix in Latvia according to requirements of international greenhouse gas reporting system - extending outputs of National Forest inventory program."

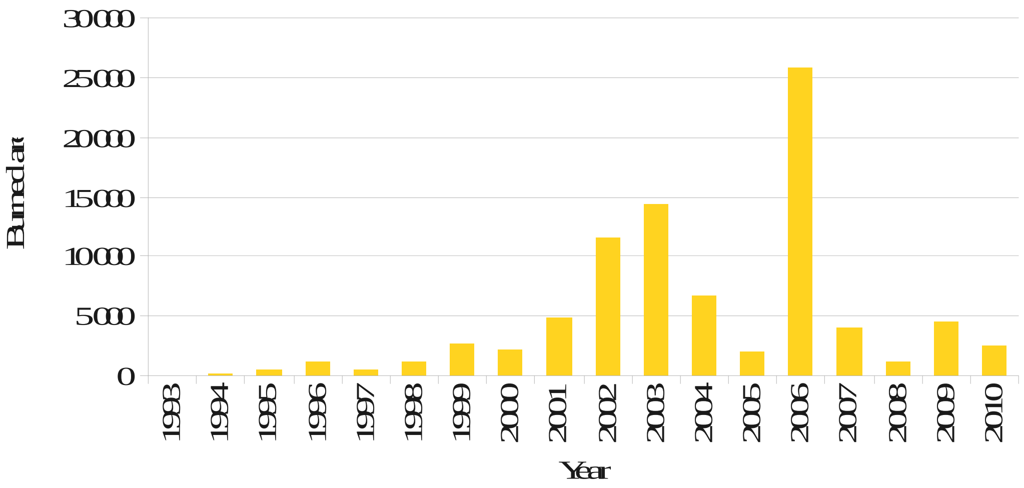

Figure 7.20 Statistics of artificial biomass burning in grasslands

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)[137] and the NFI field measurement data[138]. The latest data corresponds to actual area of grasslands determined by the NFI, historical data are recalculated backwards using this formula:

$$G_{-1} = G_0 - G_{gf} + G_{cg}\text{; where}$$

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 ± 0.5 % of total area of farmlands)[139]. These figures are based on soil mapping data and characterizes situation before 1990 (data utilized in calculation were obtained from 60[ths] to late 80[ths]); therefore, there is no risk of underestimation of emissions in 2010 and previous years. Dynamics of area of organic soils in grassland's according to the expert assumptions is shown in Figure 7.21. Increase of the area of organic soils is associated with massive conversion of cropland to grassland during 90ths of the previous century and during the last decade.

137 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

138 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)."

139 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)."

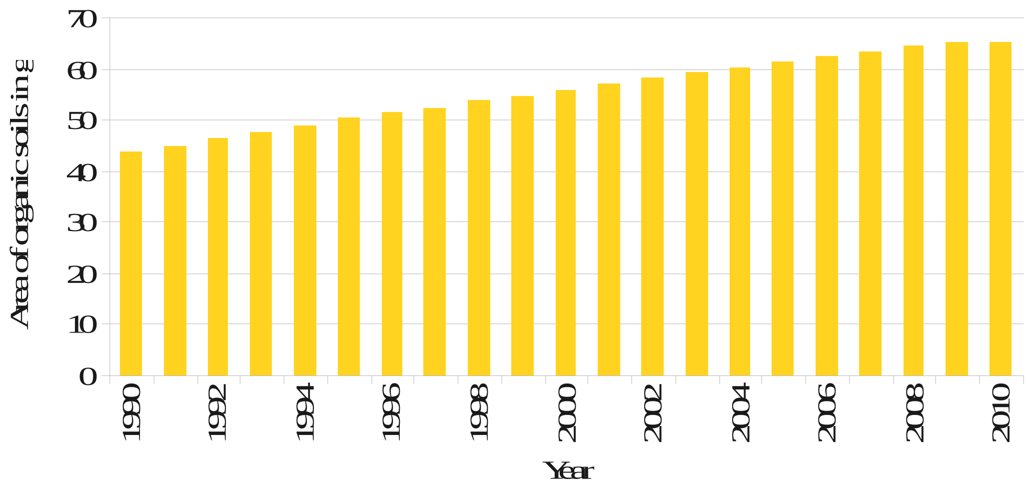

Figure 7.21 Area of organic soils in grasslands

A net carbon stock change in dead biomass in grasslands is reported as NO, taking in account that there is no existing 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[140]; 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 croplands. All grasslands are reported in the managed lands category. Total area of croplands converted to grasslands in 2010 was 629 kha (35 % of croplands' area in 1990). The area reduction in 2010 in compare to 2009 is associated with moving of lands converted in 1990 to the category grassland remaining grassland[141]. The NFI do not provide information about historical changes between grasslands and croplands categories; therefore, interpolation method is used to calculate reduction of area of cropland due to conversion to grassland. National statistics is used as input data for the interpolation. Conversion prognosis for 2009 is elaborated using the same data and extrapolation approach. Information about cropland's area in 1990 is trustful according to the expert estimation. 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 statistics was 6-11 %[142], therefore difference between the NFI and interpolated data is about 10 %.

Area of organic soils under cropland converted to grassland is noted as IE just like the net carbon stock changes in organic soils. They are reported under grassland remaining grassland

140 http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls

141 These lands already completed 20 years transition period.

142 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%EClonos+%28t%FBkst%2E+ha%29++&path=../DATABASE/lauks/Ikgad%E7jie%20statistikas%20dati/Lauksaimniec%EEbas%20strukt%FBra/&lang=16

as sum of all organic soils in this category. Carbon stock changes in mineral soils in croplands converted to grasslands is reported as not estimated because of lack of reliable data about increment of carbon stock due to conversion to grasslands.

No land use changes in this category are reported in 2010. These values will be recalculated in 2013 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 biomass increment data.

The NFI categories No 31, 61, and, partially, 62 and 64 (Table 7.1) are reported under the grasslands' category.

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[143] (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[144]. Emission factors corresponding to moist-infertile grassland from IPCC GPG LULUCF 2003 Table 3A.1.16[145] were used to calculate emissions (Table 7.8).

Table 7.8 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[146]. Factor for peat-lands (0.5) was applied in the calculations.

CO_2 emissions from drained organic soils were estimated according to the IPCC GPG LULUCF 2003 Table 3.4.6[147]. Emission factor for cold temperate climate (0.25 tonnes C ha^{-1} yearly) was used.

[143] Default estimates for standing biomass grassland (as dry matter) and aboveground net primary production, classified by IPCC climate zones.

[144] https://sites.google.com/site/lvlulucf/activity/nir-1990-2010/kula.pdf?attredirects=0&d=1

[145] Emission factors (g kg^{-1} dry matter combusted) applicable to fuels combusted in various types of vegetation fires.

[146] Combustion factor values (proportion of prefire biomass consumed) for fires in a range of vegetation types, dimensionless.

[147] Annual emission factors (EF) for managed grassland organic soils.

7.4.4 Uncertainties and time-series consistency

Uncertainty in the area of organic grassland was estimated at 50 %[148] based on expert judgement. 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.

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. Experts assumes that area of drained organic soils in the grassland's category should be considerably smaller because of decomposition of organics and abandonment of wet a low valued grasslands during last 20 years. Therefore the most of organic soils actually belong to wetland's or forest land's category. Area of organic soils in afforested grasslands is 2.4 % of total area of grasslands converted to forests according to the NFI[149]. This number seems to be more realistic than 5.15 % obtained from historical data. Estimation of actual area of organic soils is a part of the improvement plan.

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

No recalculations are done in this category.

7.4.7 Category-specific planned improvements

Soil carbon stock changes associated with conversion from cropland to grassland will be estimated comparing average carbon stock in croplands remaining croplands and grasslands remaining grasslands since 1990 and accounted for the reporting period 1990-2012. Statistical approach (sampling at 0-30 cm depth, at least, and carbon stock analyses in selected, equally distributed NFI plots) will be used to identify potential carbon stock changes. It is assumed that the equality between those land use types occurs within 20 years.

Representation of land use changes up to 2012 will be based on actual figures obtained in the NFI plots – difference in land use between the first (2004-2008) and second (2009-2012) round of the NFI in 2013. Before that land use changes in this category will not be reported after 2009.

Actual carbon stock in soil in grassland will be estimated until the end of 2013 within the scope of the research initiated by the LSFRI Silava in 2012 and will be used to estimate removals in soil carbon stock due to land use change from cropland to grassland as well as from grassland to forest land. Stock change data of living biomass growing on grassland will be available at the end of 2013 and will be used to estimate removals or emissions from living biomass in grassland.

7.5 WETLANDS (CRF 5.D)

7.5.1 Source category description

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,

[148] Mostly due to lack of knowledge about remaining area of organic soils and distribution of organic soils between grasslands and croplands.
[149] http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls

cropland, and grassland or settlement categories[150]. Total area of wetlands (448.3 kha) is reported according to the research results[151].

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[152] 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. t 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 7.22.

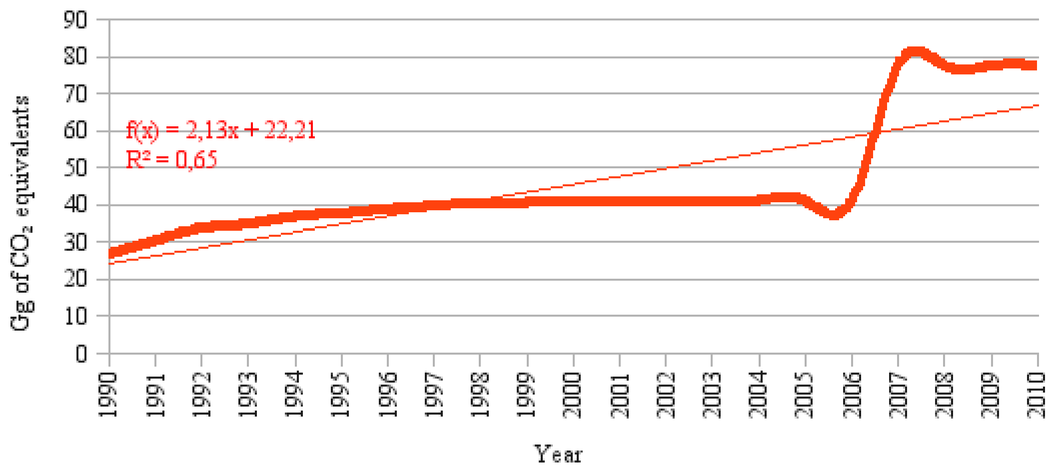

Figure 7.22 Increment of growing stock of trees on the wetland

150 Ed. Penman, *Good Practice Guidance for Land Use, Land-Use Change and Forestry*.

151 Lazdiņš, "Harmonization of land use matrix in Latvia according to requirements of international greenhouse gas reporting system - extending outputs of National Forest inventory program."

152 Estimates of peatland areas and use for Tier 1 in 1000 hectares, 27 kilo ha.

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[153]. 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).

Categories of the NFI accounted under wetlands are No. 21, 22, 23, 40, 53, 63, 65, 66, 71 and 531 (Table 7.1).

7.5.4 Methodological issues

Activity data – area of peatlands prepared for extraction – is taken from TABLE 3a.3.3[154] of the IPCC GPG LULUCF 2003. Emission factor for carbon stock changes due to drainage is taken from Table 3A.3.2[155] of the IPCC GPG LULUCF 2003. Emission factor for N_2O emissions due to drainage is taken from Table 3A.3.4[156] 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 %[157] 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[158] 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.

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[153] Lazdiņš, "Harmonization of land use matrix in Latvia according to requirements of international greenhouse gas reporting system - extending outputs of National Forest inventory program."

[154] Estimates of peatland areas and use for tier 1 in 1000 hectares

[155] 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.

[156] Default emission factors for N_2O emissions from wetlands, coefficient for nutrient poor soils – 0.2 tons N_2O-N ha^{-1} yearly.

[157] According to log-normal distribution.

[158] 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

7.5.7 Category-specific recalculations

There are no recalculations done in the wetland's category.

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[159] 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.

Note that considerable part of wetlands (ponds, ditches, river banks) are managed lands actually and therefore carbon stock changes can be reported in the inventory is spite it is contradiction to the IPCC GPG LULUCF 2003 where all wetlands are considered non-managed. There is ongoing discussion to include removals on artificial wetlands, mostly ditch sides, into the GHG accounting, especially because losses in living biomass from this category is already accounted as losses due to commercial felling under the forest remaining forest category. Net increment of growing stock of tree on wetlands is 0.7 % of increment growing stock of tree in the forest remaining forest land category.

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 associated with deforestation. Afforestation of farmlands at the same time is much more intensive; however, young forests on farmlands cannot fully compensate emissions due to the deforestation.

Under the settlements' category emissions from soils, litter and dead biomass due to conversion of land use type are reported. The estimations on the last year will be updated as soon as field measurement based information will be delivered by the NFI (in 2013 on the base of 80 % of the NFI plots). Summary of emissions due to conversion of forest lands to settlements are shown in Figure 7.23.

The total area of settlements is estimated according to the information provided by the NFI[160]. 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 forest road construction. In this reporting forest roads are moved to the settlements category; therefore, the deforested area is considerably higher than official statistics.

159 The first update in 2013 will be based on 4 years data.

160 Lazdiņš, "Harmonization of land use matrix in Latvia according to requirements of international greenhouse gas reporting system - extending outputs of National Forest inventory program."

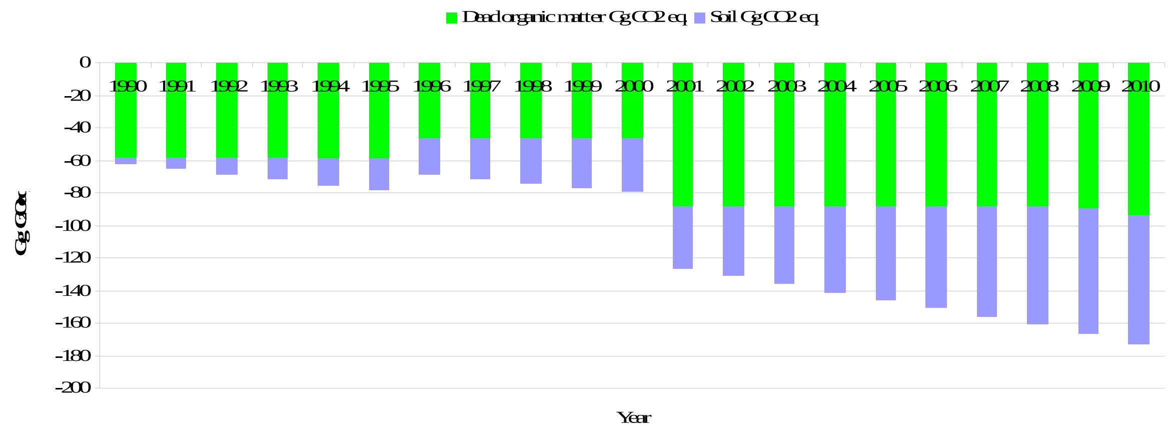

Figure 7.23 Net carbon stock changes in settlements

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"[161].

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.

The NFI categories No 51, 52, 67, 68, 69, 70, 73, 74, 521, 522, 532, 541, 544 and 545 (Table 7.1) are accounted as settlements.

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 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,

[161] 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)."

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 7.24). 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.

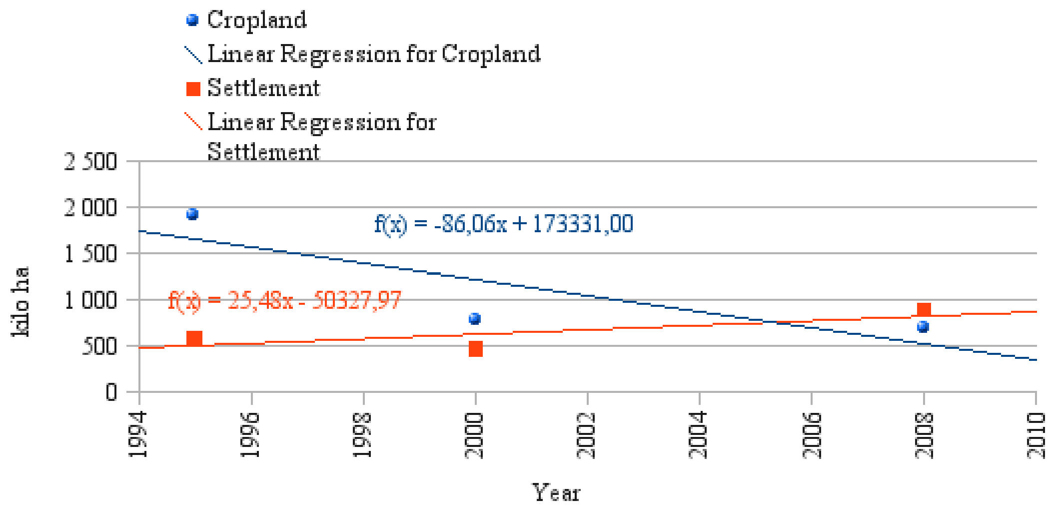

Figure 7.24 Linear regression used to elaborate prognosis of deforestation

Area of land remaining settlements is assumed constant until 2009 (238.8 kha) according to the NFI data. In 2010 areas converted to settlements in 1990 are moved from the temporary land use category to the settlements remaining settlements. Area of land converted to settlement since 1990 is estimated using satellite image analysis[162]. Total area of land converted to settlements in 2010 is 14.3 kha. No land use changes in this category, except the noted above are reported in this category in 2010. The category will be updated in 2013, when the NFI field measurement data characterizing land use changes between 2009 and 2012 will be available. Dynamics of area of settlements is shown in Figure 7.25.

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[163]. 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

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[162] 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.

[163] 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.

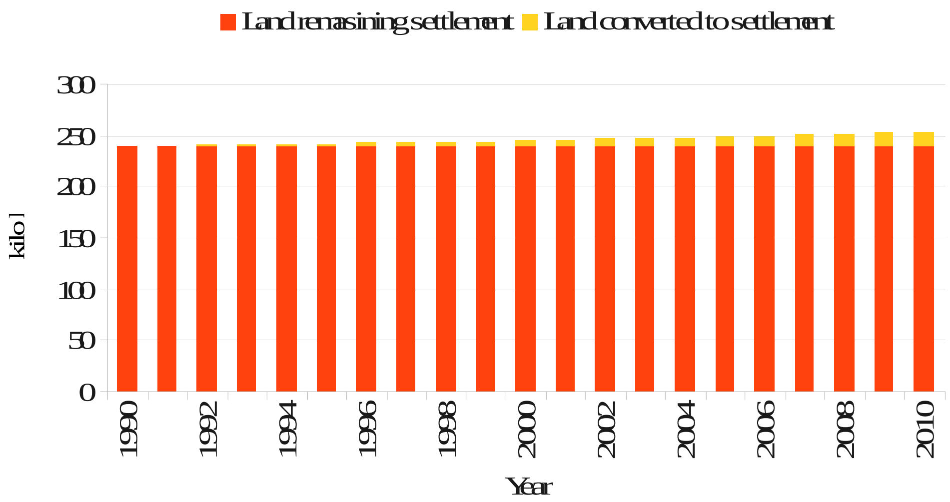

Figure 7.25 Area of settlements

Research data on average carbon stock in litter in forest lands (78 tons of CO_2)[164] and average figures of dead wood stock in forest lands (relevant to 22 tons of CO_2) according to the first round of the NFI[165] were used to estimate carbon losses in dead biomass pool due to deforestation. The same conversion factors as for living biomass are considered for dead wood – average density 0.5 tons m^3, average carbon stock – 0.5 tons C per ton of biomass[166].

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 (2009-2012[167]) round of the NFI.

7.6.5 Category-specific planned improvements

Settlements particularly forest infrastructure is considerable sink due to increment in living biomass (Figure 7.26); however, uncertainty level is very high (3 % for vegetated area and

164 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)."

165 http://www.silava.lv/userfiles/file/2010%20nov%20MRM_visi%20mezi_04-08g.xls

166 Ed. Penman, *Good Practice Guidancefor Land Use, Land-Use Change and Forestry*.

167 The last year (2013) data of the NFI will not be used as they will be available after completion of the first reporting period of the Kyoto protocol.

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 2013) 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.

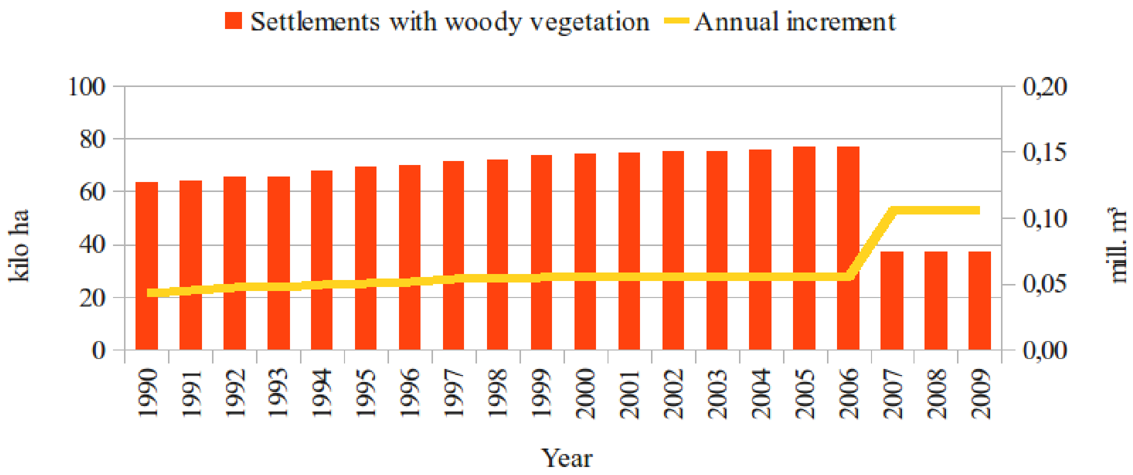

Figure 7.26 Area of settlements covered by woody vegetation and annual increment of living biomass

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

No recalculations were done in the category settlements remaining settlements. Losses in carbon stock in dead wood and soil carbon pools due to deforestation are recalculated. Switching from instant oxidation method to transition period is done to estimate losses in soil carbon stock and slight changes in the coefficient of carbon stock in the dead wood pool are done according to recent data of the NFI.

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. The categories can also be used to harmonize total country area. 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"[168].

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.

[168] 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)."

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. At the moment complete statistics on burned biomass are not available. The area statistics on 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. Similarly it's not possible to separate biomass burning on Grassland and Other land. Classifying land area by IPCC land-use category, forest fires can happen on Forest land, Wetlands and Other land. All wildfires are reported under the category Forest land remaining Forest land.

Emissions from biomass burning are represented by incineration of harvesting residues during forest logging operations. The information is based on the study[169] and it is outdated for the moment, because on-site biomass burning is used very rear nowadays in logging operations due to a high labour intensity; however, we don't have better verified data and these emissions are still reported in the inventory.

Total aggregated emissions from biomass burning in 2010 were 56 Gg of CO_2 equivalents (Figure 7.27).

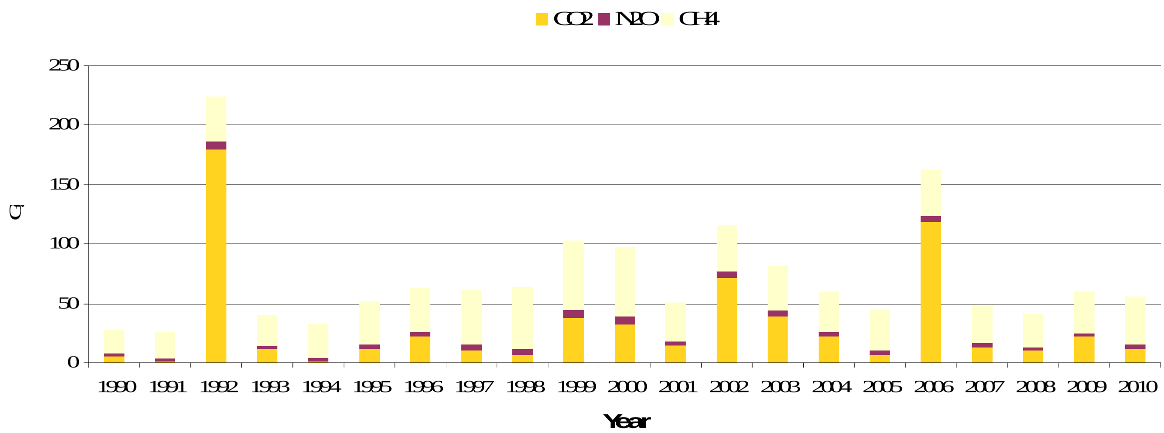

Figure 7.27 Aggregated emissions from biomass burning

Significant linear regression found between area of forest wildfires and grassland burning ($R^2 = 0.58$, Figure 7.28), which indirectly shows that both data collected by independent institutions are trustful.

[169] Līpiņš, "Assessment of wood resources and efficiency of wood utilization (Koksnes izejvielu resersu un to izmantošanas efektivitātes novērtējums)."

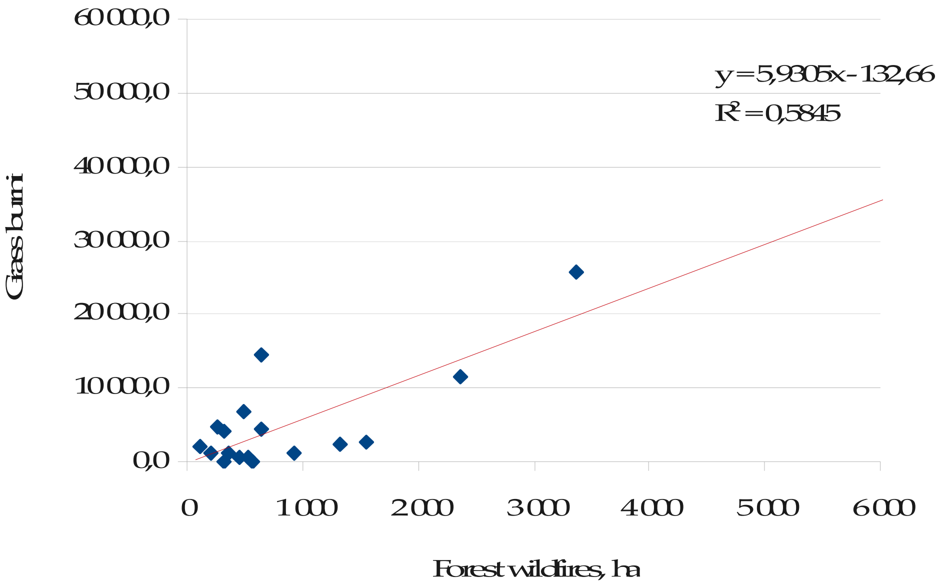

Figure 7.28 Emissions from biomass burning and correlation between areas of forest wildfires and areas of grassland burning

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 2010 is provided by the SFS[170], area of grassland burning is provided by the State fire safety service (SFSS)[171].

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[172].
Amount of burned biomass is considered according to – 41 tons ha^{-1} in forest wildfires[173]. 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 **7.9**).

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[170] https://sites.google.com/site/lvlulucf/activity/nir-1990-2010/2010_uguni.pdf?attredirects=0&d=1
[171] https://sites.google.com/site/lvlulucf/activity/nir-1990-2010/kula.pdf?attredirects=0&d=1
[172] Ed. Penman, *Good Practice Guidancefor Land Use, Land-Use Change and Forestry*.
[173] IPCC GPG LULUCF 2003 – TABLE 3A.1.13 Biomass consumption *(t ha^{-1})* values for fires in a range of vegetation types.

Table 7.9 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[174]. 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 **Error! Reference source not found.**.

Table 7.10 Factors and parameters used for calculations of change in carbon stock in living biomass

Weighted average wood density	0.5 (td.m. m^{-3})
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[175]. 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[176] (Table 7.10).

Table 7.11 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.

174 Līpiņš, "Assessment of wood resources and efficiency of wood utilization (Koksnes izejvielu resersu un to izmantošanas efektivitātes novērtējums)."

175 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.

176 Emission Factors (g kg^{-1} dry matter combusted) applicable to fuels combusted in various types of vegetation fires.

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. 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. Actual amount of harvesting residues incinerated on-site will be estimated within the NFI be extending number of observations in clear-felling areas.

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 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[177]. 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

[177] Lazdiņš, "Harmonization of land use matrix in Latvia according to requirements of international greenhouse gas reporting system - extending outputs of National Forest inventory program."

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

Instant oxidation is considered for accounting of commercially harvested wood including harvesting residues and underground part of trees therefore harvested wood products (HWP) are reported as included elsewhere (IE). Methodology to evaluate carbon stock change in the HWP pool is going to be elaborated for the State forest company managing about 50 % of forest lands in Latvia, however due to complicated structure and mixing of imported and internally originated timber during processing it is complicated to follow up to the wood product flows. Note that the most of forest goods are exported therefore the approach "internally originated and internally consumed" wood might lead to results similar to instant oxidation.

7.10.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Not applicable.

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 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

Not applicable.

7.10.6 Category-specific QA/QC and verification

Not applicable.

7.10.7 Category-specific recalculations, if applicable, including changes made in response to the review process

Not applicable.

7.10.8 Category-specific planned improvements

Introduction of the HWP worksheet model of the 2006 IPCC Guidelines into calculations of the HWP related emissions was planned for 2013 however it's still unclear if it will be possible to secure consistence of the time series and which method is the most favourable in terms of availability and reliability of the input data. Tier 2 method (First order decay) is going to be evaluated for the HWP reporting. If the results of the testing will end up in high uncertainties instant oxidation will be used instead during the first reporting period.

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"[178], "2-Water"[179] 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 1990-2010. In 2010, emissions were approximately 17 % lower than in 1990. In 2010, emissions from the Waste sector were 666.08 Gg CO_2 equivalents; it contributes about 6 % of total GHG emissions (excluding LULUCF).

[178] http://oas.vdc.lv:7779/la/atkr/red/mar$www_atkr.atkr_la
[179] http://oas.vdc.lv:7779/la/udens/skat/pls

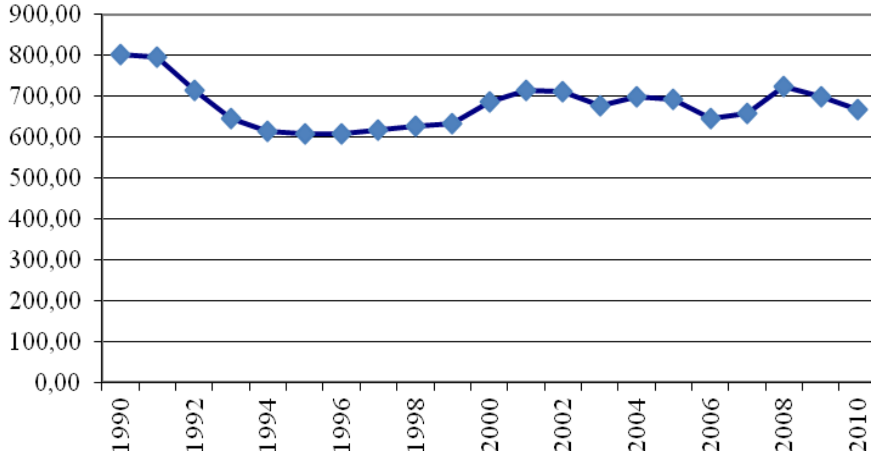

Figure 8.1 Total emissions from Waste sector in CO_2 equivalent (Gg)

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. Biggest influence to total emission trend gives GHG emissions from Waste water handling.

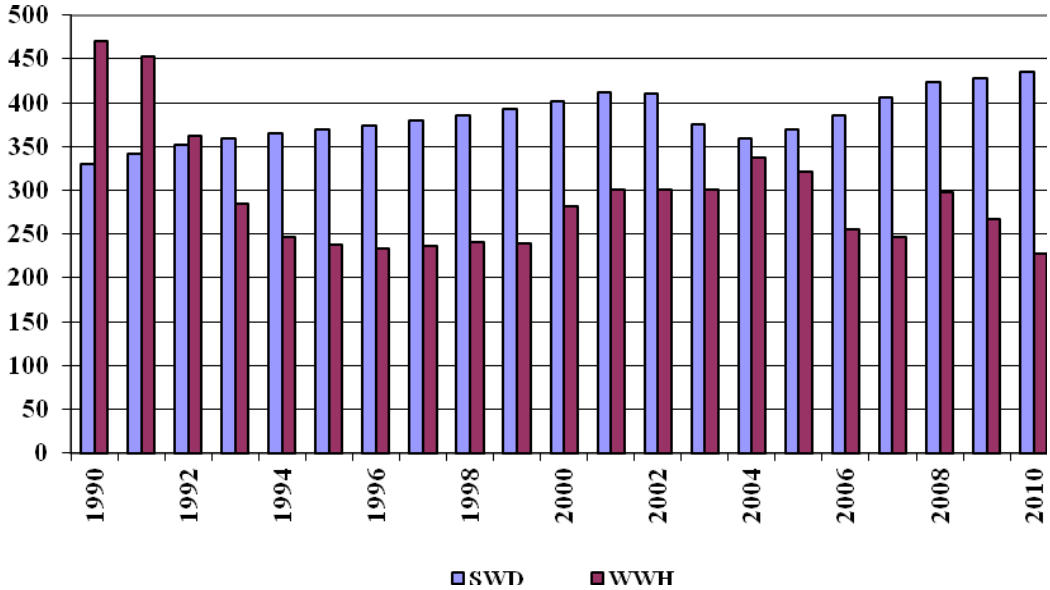

Figure 8.2 Emissions from SWD and WWH sectors in CO2 equivalent (Gg)

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).

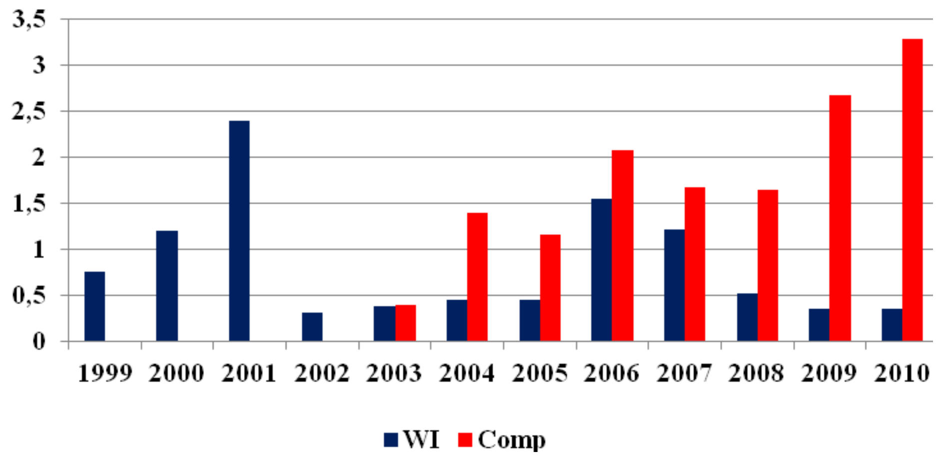

Figure 8.3 Emissions from WI and composting sectors in CO_2 equivalent (Gg)

According to the information from LEGMC[180] 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**

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

[180] 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[181] 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[182] (Table 8.3). All other years are estimated according to these figures. Disposed amount are estimated according to GDP and

[181] "Research about solid waste management in Latvia", 1998, Ltd GEO Consultants
[182] 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[183]. 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 - 2010 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 (2002-2010) in polygons disposed amount are determine according to disposing site profile from "3-Wastes" data base.

Table 8.4 Disposed solid waste amounts from 2002-2010 (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

According to information in landfill research, number of active waste disposal sites decreased from 558 in 1997 to 24 in 2010. 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 will be only 11 waste disposing polygons, all other waste disposal sites are planned to close. In 2010 – 10 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.

[183] "Degradable organic carbon in disposed wastes", 2011, Ltd Virsma

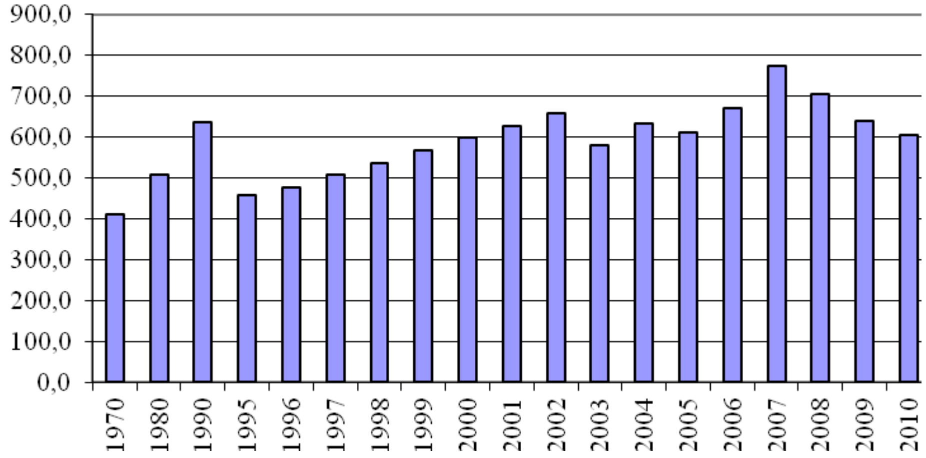

Figure 8.4 Disposed waste amounts in Latvia (Gg)

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 6.173 Gg of CH_4 was collected and recovered in 2010. Recovered methane amount is presented in Figure 8.5.

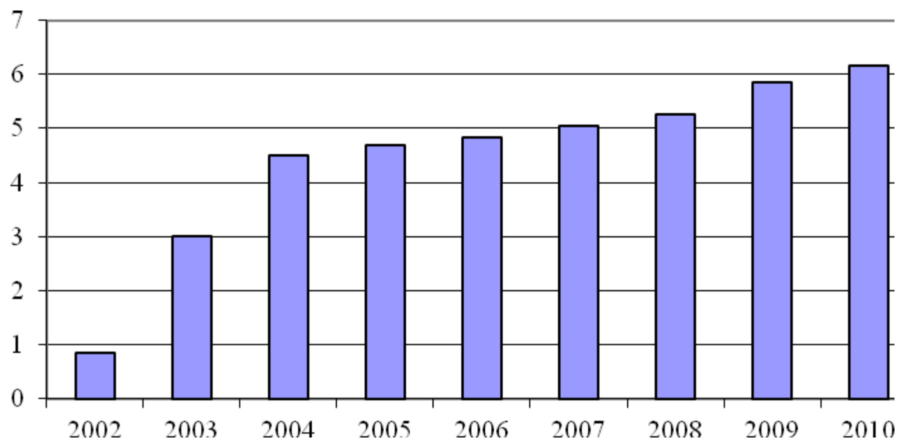

Figure 8.5 Recovered CH_4 from waste disposing (Gg)

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.

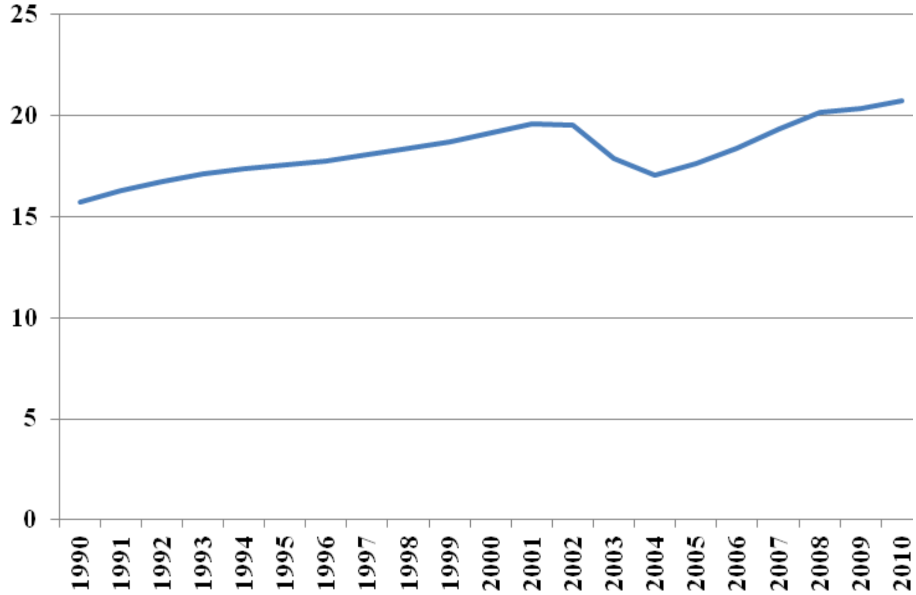

Figure 8.6 CH_4 emissions from waste disposing (Gg)

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

Recalculation is done for all years, because new research was available about DOC and landfills types in Latvia (Table 8.5).

Table 8.5 Changes according to recalculations

Year	Reported emissions from SWD in 15.01.2011. (CH_4 Gg)	Reported emissions from SWD in 15.01.2012. (CH_4 Gg)	Changes, %
1990	18.86	15.71	-16.70
1995	23.05	17.57	-23.77
2000	26.54	19.15	-27.84
2006	26.59	18.38	-30.88
2007	27.56	19.36	-29.75
2008	28.25	20.16	-28.64
2009	28.39	20.34	-28.36

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)

8.3.1 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 8.6).

Table 8.6 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 240 million m³ of wastewater in 2010 was discharged, from which 197 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.

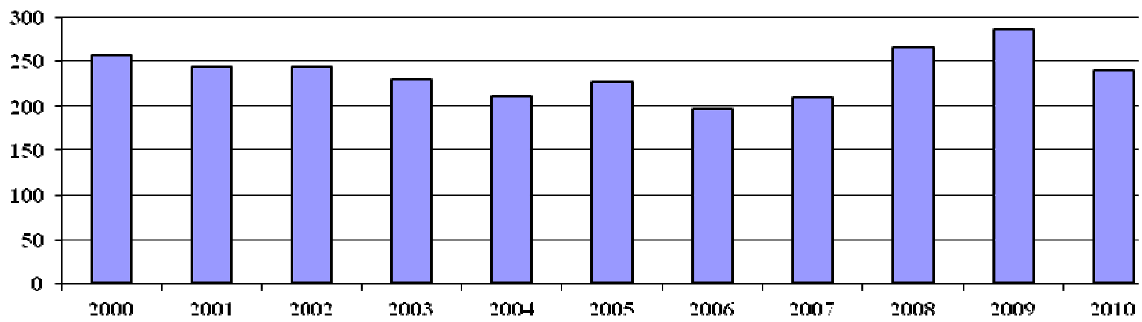

Figure 8.7 Amount of discharged waste water in last ten years (mio m^3)

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.

The Industrial Waste Water Handling is the main source of the CH_4 emissions from Wastewater Handling sector. Emission from Domestic Waste Water Handling is lower, reaching ~35 % (2010) from total CH_4 emission from Waste Water Handling sector (Figure 8.8).

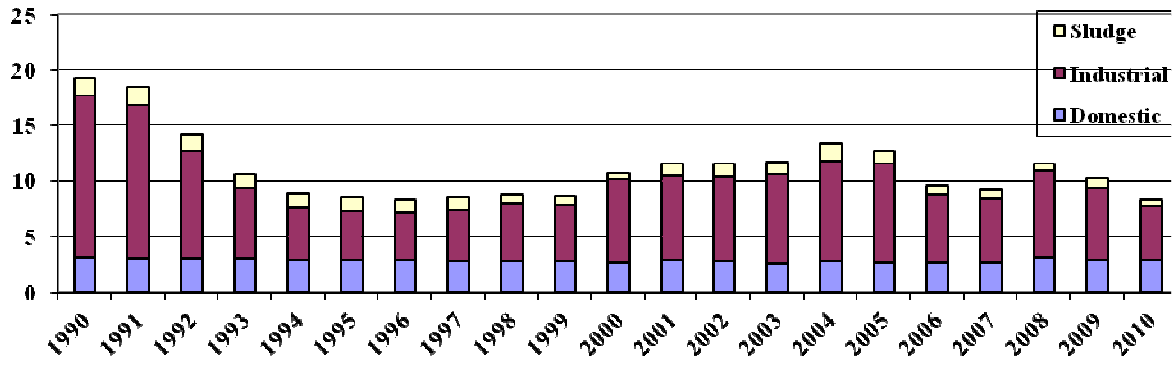

Figure 8.8 Emissions of methane from Waste Water Handling (total), Gg

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.

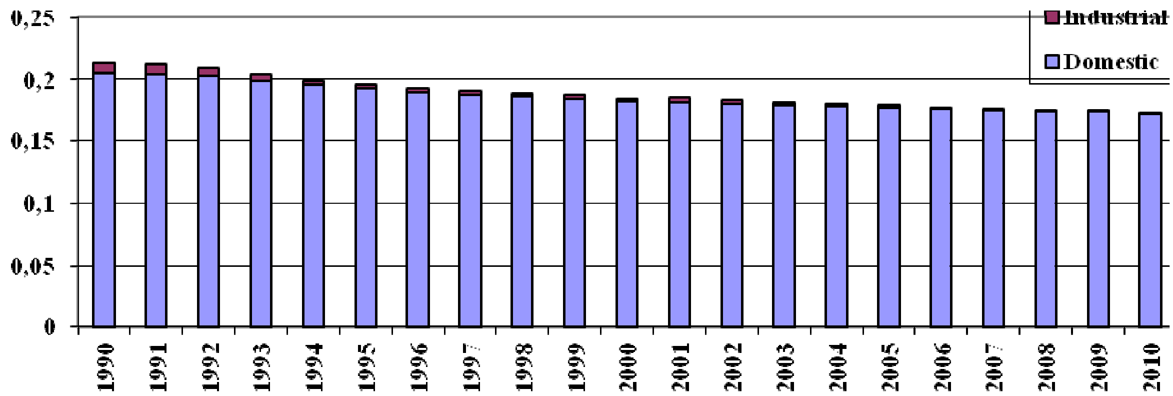

Figure 8.9 Emissions of N_2O from Waste Water Handling (total), Gg

8.3.2 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:

$$WM = \sum_i P_i \bullet D \bullet SBF \bullet EF \bullet MCF_i \bullet 365 \bullet 10^{-9} \text{ Gg of } CH_4,$$

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 8.7 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
MCF applied	**0**	**0.3**	**0.8**	**0.5**

Methane Conversion Factors (MCFs) were applied depending of treatment type and level (Table 8.7). 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":

$$WM = \sum_i P_i \bullet V_i \bullet C_i \bullet PFM \bullet 10^{-6} \text{ Gg } CH_4,$$

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 8.8 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

However, amount of waste water generated and its organic load in terms of COD regarding production of paper and pulp were taken from national water statistics (data base "2-Water") as well for other sectors where production data were not available Table 8.8.

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	Emission of CH_4, t/a
	a	b	c = a*b	d	e = c*d	f	g = e*f
Milk	197	7	1376	2.7	3714	0.25	928
Meat	120	13	1557	4.1	6385	0.25	1596
Fish	56	13	732	2.5	1830	0.25	457

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[184], 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).

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 0.172 Gg of N_2O (2010).

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

[184] Latvian State Institute of Agrarian Economy

"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 – 0.0008 Gg/a (i.e. 0.793 Mg/a (2010)).

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 (2010).

8.3.3 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.

8.3.4 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).

8.3.5 Source specific recalculations

Amount of methane emissions was recalculated due to following factors:

- Methane emission from Domestic Waste Water Handling was recalculated for year 2008 due to update of activity data.
- Data on NMVOC emission was recalculated for year 2008 due to update of activity data.

8.3.6 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.

8.4 WASTE INCINERATION (CRF 6.C)

8.4.1 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

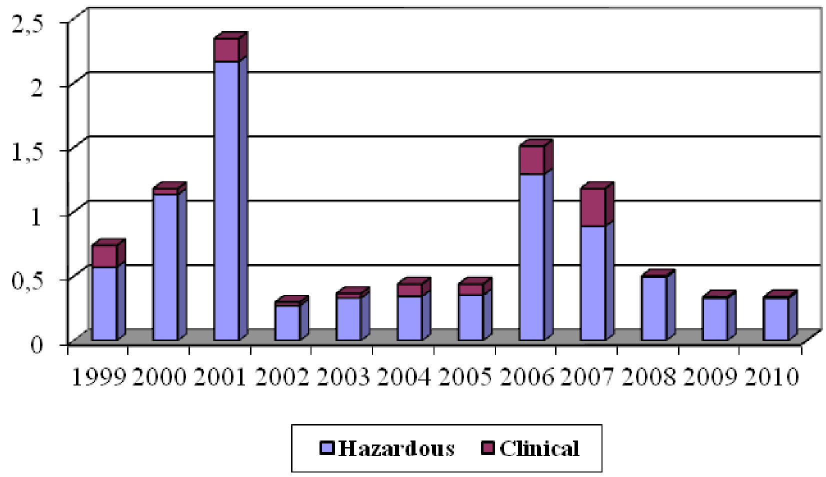

Figure 8.10 CO_2 emissions from Waste Incineration by waste type (Gg)

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
2003	1389
2004	1391
2005	1529
2006	1630
2007	1959
2008	2227
2009	1977
2010	2102

8.4.2 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:

$$\mathbf{CO_2}_{\text{ emissions}} = \Sigma_i[\ IW_{ix} \text{ x } CCW_i \text{ x } FCF_i \text{ x } EF_i \text{ x } 44/12\ ] \text{ Gg/year,}$$

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
2010	0.20000	0.012843	0.212843

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

Indirect GHG	Emission factor (kg/body)
SO_2	0.544
NOx	0.309

8.4.3 *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.

8.4.4 *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.

8.4.5 *Source-specific recalculations*

Recalculations are done for indirect GHG from cremation, because more correct information about burned bodies became available.

8.4.6 *Source specific planned improvements*

No planned improvements

8.5 OTHER (CRF 6.D) – COMPOST PRODUCTION

8.5.1 *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).

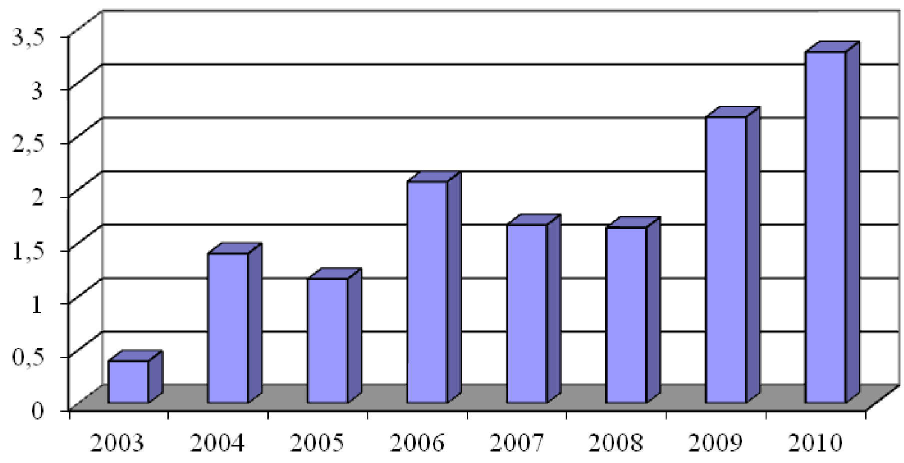

Figure 8.11 Total emissions from waste composting in CO_2 equivalent (Gg)

8.5.2 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

8.5.3 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.

8.5.4 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.

8.5.5 Source-specific recalculations

No recalculations.

8.5.6 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 (15.04.2011; 25.10.2011) were done according to:

- IPCC Good Practice Guidance's (IPCC 2000; IPCC 2003);
- recommendations by ERT during Centralized review (2011);
- corrections of activity data by CSB;
- 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 CO2 Eq Emissions with LULUCF	11 424.95	10 544.13	-880.83	-7.71
	Total CO2 Eq Emissions without LULUCF	26 621.37	26 555.52	-65.85	-0.25
1991	Total CO2 Eq Emissions with LULUCF	7 835.63	6 970.51	-865.12	-11.04
	Total CO2 Eq Emissions without LULUCF	24 692.63	24 614.03	-78.60	-0.32
1992	Total CO2 Eq Emissions with LULUCF	1 893.56	1 045.57	-847.99	-44.78
	Total CO2 Eq Emissions without LULUCF	19 873.82	19 783.90	-89.92	-0.45
1993	Total CO2 Eq Emissions with LULUCF	-1 568.48	-2 397.86	-829.38	52.88
	Total CO2 Eq Emissions without LULUCF	16 046.85	15 947.12	-99.73	-0.62
1994	Total CO2 Eq Emissions with LULUCF	-2 850.81	-3 659.98	-809.17	28.38
	Total CO2 Eq Emissions without LULUCF	14 095.77	13 987.80	-107.98	-0.77
1995	Total CO2 Eq Emissions with LULUCF	-3 532.80	-4 320.40	-787.59	22.29
	Total CO2 Eq Emissions without LULUCF	12 717.10	12 602.21	-114.89	-0.90
1996	Total CO2 Eq Emissions with LULUCF	-4 966.26	-5 329.60	-363.34	7.32
	Total CO2 Eq Emissions without LULUCF	12 747.32	12 625.35	-121.97	-0.96
1997	Total CO2 Eq Emissions with LULUCF	-2 922.17	-3 279.16	-356.99	12.22
	Total CO2 Eq Emissions without LULUCF	12 197.17	12 068.54	-128.63	-1.05
1998	Total CO2 Eq Emissions with LULUCF	-2 392.46	-2 744.57	-352.11	14.72
	Total CO2 Eq Emissions without LULUCF	11 682.84	11 546.08	-136.77	-1.17
1999	Total CO2 Eq Emissions with LULUCF	-2 664.75	-3 003.66	-338.91	12.72
	Total CO2 Eq Emissions without LULUCF	10 896.63	10 760.04	-136.59	-1.25
2000	Total CO2 Eq Emissions with LULUCF	-3 970.24	-4 251.29	-281.05	7.08
	Total CO2 Eq Emissions without LULUCF	10 329.86	10 238.12	-91.74	-0.89
2001	Total CO2 Eq Emissions with LULUCF	-3 553.42	-3 991.55	-438.13	12.33
	Total CO2 Eq Emissions without LULUCF	10 965.25	10 810.36	-154.89	-1.41
2002	Total CO2 Eq Emissions with LULUCF	-2 595.09	-3 042.38	-447.29	17.24
	Total CO2 Eq Emissions without LULUCF	10 935.84	10 757.74	-178.09	-1.63
2003	Total CO2 Eq Emissions with LULUCF	-3 877.75	-4 316.39	-438.64	11.31
	Total CO2 Eq Emissions without LULUCF	11 146.20	10 962.71	-183.49	-1.65
2004	Total CO2 Eq Emissions with LULUCF	-4 869.17	-5 294.63	-425.46	8.74
	Total CO2 Eq Emissions without LULUCF	11 311.46	11 127.11	-184.35	-1.63
2005	Total CO2 Eq Emissions with LULUCF	-5 710.89	-6 120.65	-409.77	7.18
	Total CO2 Eq Emissions without LULUCF	11 429.64	11 246.94	-182.70	-1.60
2006	Total CO2 Eq Emissions with LULUCF	-8 400.17	-8 801.33	-401.16	4.78
	Total CO2 Eq Emissions without LULUCF	11 851.39	11 663.25	-188.14	-1.59
2007	Total CO2 Eq Emissions with LULUCF	-9 320.55	-9 706.29	-385.74	4.14
	Total CO2 Eq Emissions without LULUCF	12 362.37	12 175.57	-186.79	-1.51
2008	Total CO2 Eq Emissions with LULUCF	-10 812.36	-11 203.92	-391.56	3.62
	Total CO2 Eq Emissions without LULUCF	11 931.04	11 724.42	-206.63	-1.73
2009	Total CO2 Eq Emissions with LULUCF	-9 748.27	-9 626.84	121.43	-1.25
	Total CO2 Eq Emissions without LULUCF	10 735.47	10 961.90	226.43	2.11

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 2012 inventory submission

CRF category	Recalculation	Reason for recalculation	Implication to the CRF category level		Implication to the total emission level without LULUCF %	
			1990	2009	1990	2009
1. Energy				416.00		3.79
1.A.Fuel Combustion Activities				416.00		3.79
1.A.1.Energy Industries	Activity data was updated	Activity data was updated by CSB		-7.56		-0.07
1.A.2.Manufacturing Industries and Construction	Activity data was updated	Activity data was updated by CSB		-1.55		-0.01
1.A.3.Transport	Activity data was updated	Default CO_2 EF for LTO was corrected. Recalculation for year 2005-2009 have been done		369.57		3.37
1.A.4.Other Sectors	Activity data was updated	Activity data was updated by CSB		55.54		0.51
3. Solvent and Other Product Use	Activity data was updated	Activity data was updated by CSB		-0.51		0.00
4. Agriculture			0.29	-28.53	0.00	-0.26
4.B.Manure Management	AWMS	AWMS was corrected for 2000-2009.		-22.60		-0.21
4.D.Agricultural Soils (4)	Fraction of nitrogen in crop	Nitrogen fraction were corected for buckwheat, mixed cereals and pulses in 1990-2009. Wrong values previosly were used.	0.29	-5.93	0.00	-0.05
5. Land Use, Land-Use Change and Forestry (net)			-814.97	-105.00		
5.B.Cropland	Activity data was updated.	Area of land remaining cropland was estimated using interpolation method from data provided by CSB and results of satellite image analysis. Recalculation of area of organic soils in cropland is done according to the empiric data of soil monitoring since 60ths which were summarized in 2010 by the MOA.	-619.18	121.47		
5.E.Settlements	Activity data was updated.	Area of land converted to settlement since 1990 is estimated using satellite image analysis. Carbon losses in the category land remaining settlement is noted as included elsewhere to avoid overestimations of emissions in this category.	-195.79	-226.47		
6. Waste			-66.15	-166.04	-0.25	-1.51
6.A.Solid Waste Disposal on Land	Activity data was updated	Changes in activity data estimations. Also MCF factors are corrected for landfils type.	-66.15	-166.04	-0.25	-1.51
CO2 Emissions from Biomass	Activity data was updated			-11.26		-0.10

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)		√	Activity data was updated, Chapter 3.
1. Energy Industries		√	Activity data was updated, Chapter 3.
2. Manufacturing Industries and Construction		√	Activity data was updated, Chapter 3.
3. Transport	√	√	Civil aviation (A 3.a). Default CO2 EF for LTO was corrected. Recalculation for year 2005-2009 have been done . Chapter 3.
4. Other Sectors			
5. Other			
B. Fugitive Emissions from Fuels			
1. Solid Fuels			
2. Oil and Natural Gas			
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			
G. Other			
3. Solvent and Other Product Use			
4. Agriculture			
A. Enteric Fermentation			
B. Manure Management		√	Chapter 6
C. Rice Cultivation			
D. Agricultural Soils		√	Chapter 6
E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			
5. Land Use, Land-Use Change and Forestry			
A. Forest Land			
B. Cropland	√	√	Instant oxidation method for estimation of soil emissions due to land use change is replaced with 20 years transition period, emissions are estimated according to equation 3.3.3; N_2O emissions are

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	RECALCULATIONS Please tick where this is also reflected in recalculations compared to the previous year CRF	REFERENCE If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
			recalculated using new data on CO_2 emissions from soil
C. Grassland			
D. Wetlands			
E. Settlements	√	√	Instant oxidation method for estimation of soil emissions due to land use change is replaced with 20 years transition period, emissions are estimated according to equation 3.3.3
F. Other Land			
G. Other			
6. Waste			
A. Solid Waste Disposal on Land	√	√	Changes in activity data estimations. Also MCF factors are corrected for landfils type.
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 Please tick where the latest NIR includes major changes in descriptions compared to the previous year NIR		REFERENCE If ticked please provide some more detailed information for example reference to pages in the NIR
Chapter 1.2 Institutional arrangements	√		Page 25
Chapter 1.6 QA/QC plan			

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. 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
	Used Tier 2 for key category analysis	2012 -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
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
4D	To improve the accuracy of the inventory, conduct a specific research to identify exact histosol areas in the country.	2012-2013
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
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
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
6.B.2	Increasing accuracy for activity data for CH_4 emission from domestic waste water handling sector.	2012-2013
6.B.1	Increasing accuracy of activity data for CH_4 emission from industrial waste water handling sector.	2011-2012

CRF category	Planned improvement	Tentative time schedule
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 2011 inventory submission.

Table 10.5 Response to the review of the 2011 inventory submission[185]

CRF	Comment by ERT	Latvia's response	Where in NIR
Energy			
	CO_2 emissions from road transportation (gasoline) for the energy sector: The ERT recommends that Latvia provide support information justifying the used EFs and their trend, or revised CO_2 emission estimates using country-specific CO_2 EF for gasoline, which should be in accordance with the IPCC good practice guidance and reported in a transparent manner, or, if those are not available, use constant default CO_2 emission factors providing, to the ERT, explicit information on the CO_2 EF being used for gasoline in accordance with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance.	CO_2 emission factor for petrol in road transport are calculated based on the information available on the C and H content in gasoline. Taking into account the latest available information on the physical characteristics of gasoline (2004 study), which indicated that the C content is 83.13%, it is calculated NCV for gasoline (43.96 MJ/kg) and estimated CO_2 emission factor in accordance to Requirements from the IPCC Guidelines. Estimated Emission factor with oxidation factor is 68.6kg CO_2 kg/GJ. To restore the input information on the physical characteristics of gasoline was requested information from the competent national authority State Revenue Service (letter Valsts ieņēmumu dienests), to which there ply was received that the determining quality analysis of gasoline C and H content is not performed. Consequently, according to available information we have no reason to change the CO_2 emission factors for gasoline in road transport. We want to note that gasoline C content affects not only the CO_2 emission factors but it has to be harmonized with NCV estimation and change of fuel consumption. Latvia will consider the possibility to schedule the research on gasoline quality this year and the updated information inclusion into the inventory of 2011.	Chapter 3.
Agriculture			

[185] According to centralised review of the annual submission of Latvia submitted in 2011

CRF	Comment by ERT	Latvia's response	Where in NIR
	Direct N_2O emissions from agriculture soils *Synthetic fertilizers* The ERT recommends that Latvia, by 31 October 2011: Justifies the differences between the FAO and Latvian GHG Inventory N-synthetic fertilizer used data; or, alternatively, Provides revised N_2O emission estimates for Synthetic fertilizers category for 1990-2009 period, based on FAO data and on IPCC good practice guidance estimation method.	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. 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. CSB consider that no corrections should be made in the Latvian GHG Inventory N-synthetic fertilizer consumed data.	Chapter 6.
	Animal manure applied to soils: The ERT recommends the Party to provide revised AD and N_2O estimates for Animal manure applied to soils category, for 1990-2009 period, based on the IPCC good practice guidance Tier 1a approach.	Activity Data (AD) and N_2O emissions for 1990-2009 were revised according to the IPCC good practice guidance Tier 1a approach.	Chapter 6.

PART I: 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[186] 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[187].

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

[186] Published in 24.02.2000., the latest changes in 13.10.2011.
[187] Latvijas Republikas Saeima, "Meža likums, 2000."

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[188]. 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 m2 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 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). 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

[188] 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)."

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[189]. 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 (2010) (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		35.23			35.23
Art. 3.4	FM		1.15	2129.26		3130.41
Other					3071.87	3071.87
Total		218.70	36.38	2129.26	3071.87	6456.23

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).

[189] Lazdiņš, "Harmonization of land use matrix in Latvia according to requirements of international greenhouse gas reporting system - extending outputs of National Forest inventory program."

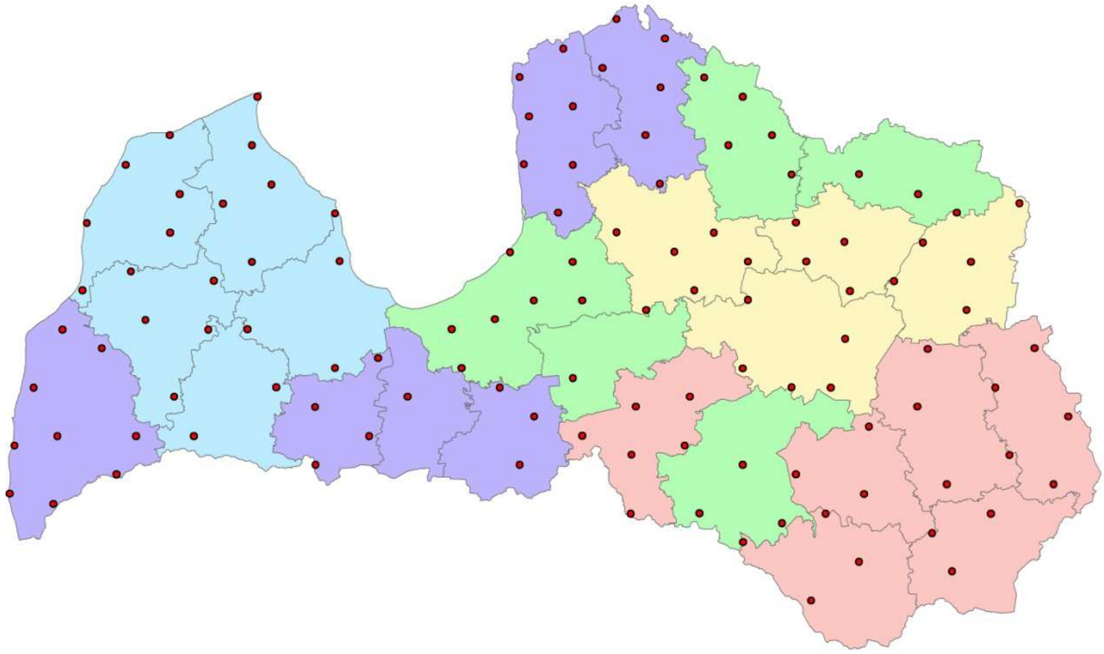

Figure 11.1 Permanent grid of the Level 1 forest monitoring plots

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 11.2). Average standard error of mean of the estimation at different ages is 35 %.

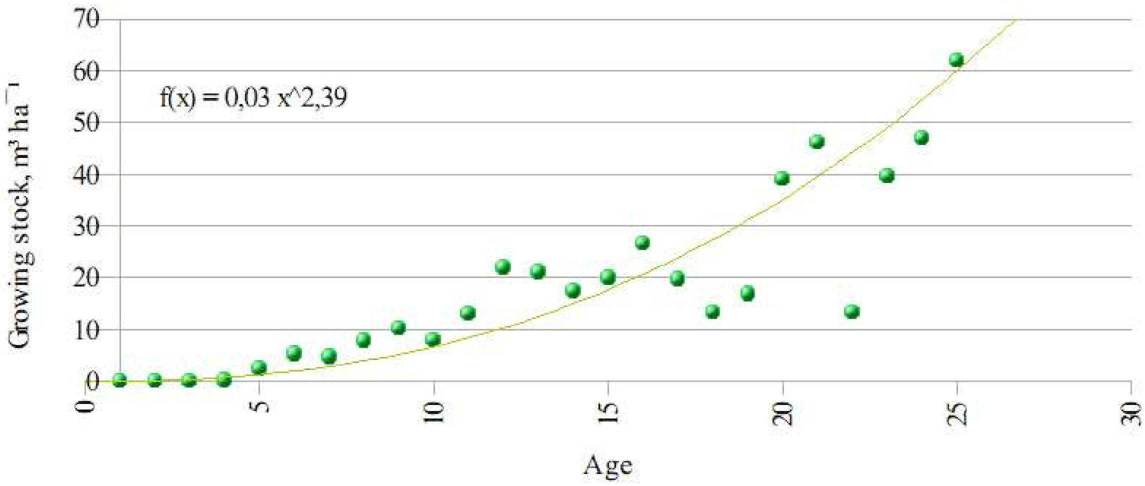

Figure 11.2 Average growing stock figures for afforested areas of different ages

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 11.3). 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.

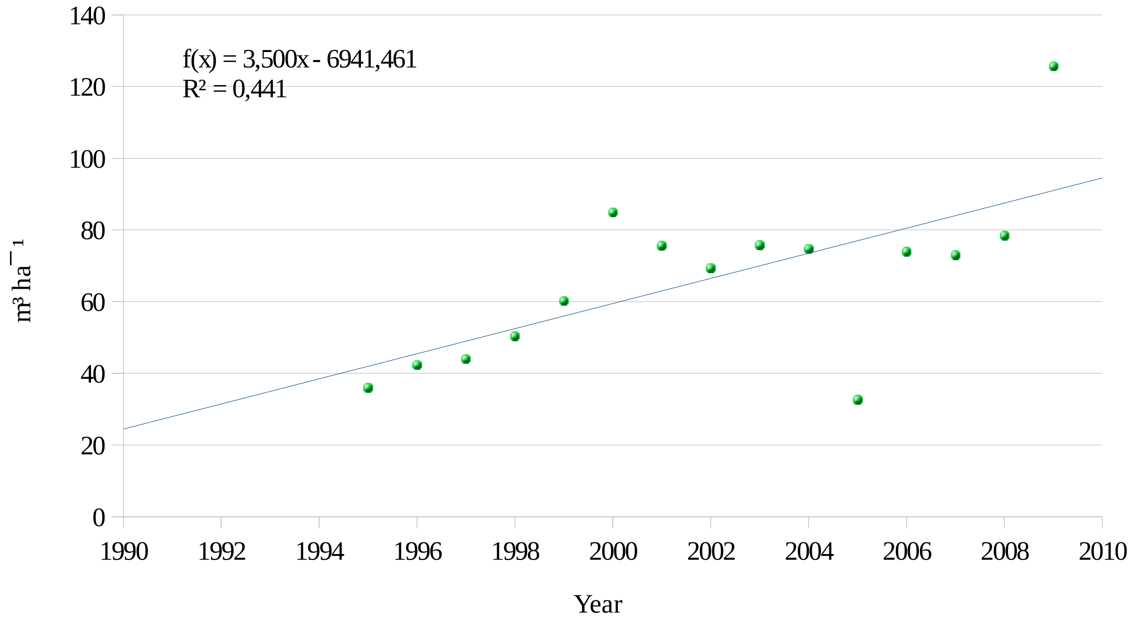

Figure 11.3 Historical figures of average harvesting stock

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[190] (71-115 tons C ha^{-1}). Therefore use of default reference levels for grasslands from TABLE 3.4.4[191] (the same values as for the forest lands) would lead to considerable overestimation of removals in soil due to afforestation. Similarly, changes in 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

[190] Default reference (under native vegetation) soil organic C stocks (SOCref) (tonnes C per ha for 0-30 cm depth).

[191] Default reference (under native vegetation) soil organic C stocks (SOCref) (tonnes C per ha for 0-30 cm depth).

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[192] 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

[192] 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 90ths.

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

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[193] 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	3 163.42	432.75	610.65	16 449.45	5.20
1991	3 160.92	432.41	610.17	16 900.80	5.35
1992	3 158.42	432.07	609.69	17 334.99	5.49
1993	3 155.92	431.73	609.21	17 780.77	5.63
1994	3 153.42	431.38	608.72	18 243.18	5.79
1995	3 150.92	431.04	608.24	19 004.80	6.03
1996	3 149.66	430.70	607.76	19 459.56	6.18
1997	3 148.40	430.53	607.52	19 896.31	6.32
1998	3 147.14	430.36	607.27	20 320.43	6.46
1999	3 145.88	430.18	607.03	20 801.15	6.61
2000	3 144.61	430.01	606.79	21 450.34	6.82
2001	3 143.03	429.84	606.54	21 823.03	6.94
2002	3 141.46	429.62	606.24	22 222.35	7.07
2003	3 139.88	429.41	605.93	22 630.04	7.21
2004	3 138.30	429.19	605.63	23 108.24	7.36
2005	3 136.72	428.98	605.33	23 477.42	7.48
2006	3 135.14	428.76	605.02	24 005.48	7.66
2007	3 133.57	428.54	604.72	25 005.86	7.98
2008	3 131.99	428.33	604.41	24 586.11	7.85
2009	3 130.69	428.15	604.16	24 798.18	7.92
2010	3 130.69	427.79	603.84	24 794.91	7.92

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 2009 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

193 Latvijas Republikas Saeima, "Meža likums, 2000."

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 categories in the UNFCCC key category.

11.7 INFORMATION RELATING TO ARTICLE 6

Latvia is not participating in any project under Article 6 (Joint Implementation).

CHAPTER 12: INFORMATION ON ACCOUNTING OF KYOTO UNITS

12.1 BACKGROUND INFORMATION

The standard electronic format tables are included in the submission for the third time (see "SEF_LV_2012_1_13-45-6 13-1-2012.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 31.12.2011 as well as information on transfers of the units in 2011 to and from other Parties of the Kyoto Protocol.

12.2 SUMMARY OF INFORMATION REPORTED IN THE SEF TABLES

At the beginning of the 2011 there were 78 193 510 AAUs in the Latvia's national holding account and 3 667 598 EUAs converted from AAUs in the entity holding accounts. In addition, 33 858 CERs were held in entity holding accounts. At the beginning of 2011 4 640 629 EUAs and 582 871 CERs and 9 215 ERUs were stored in Retirement account.

At the end of 2011 74 671 083 AAUs were left in National holding account, 2 756 343 EUAs_AAUs and 7 761 CERs and 8 299 ERUs were held in the entity holding accounts.

3 010 593 EUAs_AAUs, 18 007 ERUs and 211 580 CERs were surrendered by Latvia's operators and retired to Latvia's national retirement account during compliance period at the beginning of 2011 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 85 078 648 Kyoto protocol units were stored in the ETR accounts at the end of 2011.

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 2011 in Latvia's ETR.

No transactions in Latvia's ETR were cancelled and only 1 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

No CDM notifications – reversal of storage notifications, non-certification notifications were received in the reporting period 2011.

Latvia as Party and Latvia's ETS participants are not participate in any Kyoto mechanisms – joint implementation or Clean Development Mechanisms.

The report "R3: List of CDM notifications" is reported empty.

12.3.3 List of non-replacements

No non-replacement occurred during reporting period 2011.

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 2011 to 31st December 2010.

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 2011.

As cancelled and terminated transactions in 2011 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://etrlv.lvgmc.lv, (because of the higher-level authentication mechanism, at present for accessing the website for every company / authorized person / account is is mandatory to specify the registry administrator with the holder fixed Internet Protocol (IP)) as well as in the webpage of LEGMC - http://www.meteo.lv/public/30209.html.

12.5 CALCULATION OF THE COMMITMENT PERIOD RESERVE (CPR)

Latvia's assigned amount is 119 182 130 tonnes CO_2 eq.

National commitment period reserve for Latvia is estimated as 100 % the most recent inventory multiplied with 5 years:

$$CPR = 5 * 12\,077.0339350708\ CO_2\ eq. = 60385.1696753539\ Gg\ CO_2\ eq.$$
$$or\ 60385170\ tonnes\ CO_2\ eq.$$

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

Starting from 1st of January 2011 the name of Ministry of Environment was changed to the Ministry of the Environmental Protection and Regional Development. According to the Instruction of the Cabinet of Ministers No 676 (22.11.2010) „About ensuring liquidation of The Ministry of Regional Development and Local Government of the Republic of Latvia" Ministry of Regional Development and Local Government is incorporated in the Ministry of the Environment.

For submission 2012, firstly emission calculation from Agriculture sector was done by Latvia University of Agriculture.

Since 31.03.2012 is new Regulation of Cabinet of Ministers No 217 'Regulation on greenhouse gas emission inventory national system" in force. Regulation foresees institution responsibility involved in national system, the management of data flow, QA/QC procedures for experts and independent quality assurance. The main changes include involvement of Latvia University of Agriculture for inventory preparation in Agriculture sector and change of National inventory focal point due to management changes. Hereinafter the address of National inventory focal point is Ministry of the Environmental Protection and Regional Development, 25 Peldu Str., Riga, LV-1494, phone: +371 67026508, fax:+371 67820442, email: agita.gancone@varam.gov.lv

CHAPTER 14: INFORMATION ON CHANGES IN NATIONAL REGISTRY

EU emissions trading system (ETS) (include Latvian's ETR) was temporarily closed by EU in January, because of the series of cyber-attacks on national registries, where carbon permits are stored.

No significant technical, functional or documentary changes were made in Latvia's ETR during 2011.

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) 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 2) 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 3) Innofactor helpdesk Technical Administrator Innofactor Oy Keilaranta 19 FI-02150, Espoo Finland Tel.: +358 505871222 e-mail.: etr.helpdesk@innofactor.com
15/CMP.1 annex II.E paragraph 32.(b)	Parties with which Latvia cooperates by maintaining the registry in a consolidated system	Latvia's ETR technical infrastructure maintenance company and ETR technical administrator is Finnish company "Innofactor Oy". The Latvia's ETR national registry is not a part of any consolidated registry system. However, the VPN connection to the ITL is shared with "CR project" participants.
15/CMP.1 annex II.E paragraph 32.(c)	Database structure and capacity of the national registry	No change to the database or to the capacity of the national registry occurred during the reported period
15/CMP.1 annex II.E paragraph 32.(d)	Conformity with DES	No change in the registry's conformance to technical standards occurred for the reported period
15/CMP.1 annex II.E paragraph 32.(e)	Procedure to minimise discrepancies in issuance, transfer, cancellation and retirement of registry units	No change of discrepancies procedures occurred during the reported period
15/CMP.1	Overview of security	Latvia has chosen one of the higher-level authentication mechanisms - at present

annex II.E paragraph 32.(f)	measures (including maintenance of the measures) for unauthorised manipulations and to prevent operator error	for accessing the Latvian Registry for every company / authorized person / account is is mandatory to specify the registry administrator with the holder fixed Internet Protocol (IP). This transitional measure is taken in view of recurring security breaches in national registries over the last year in January. All operators account have the status "Read only", all account operations (surrendering, transaction utt.) can procesed only National RegAdmins. It will work till June, 2012, when EU ETS operations will be centralised into a single European Union registry, operated by the Commission.
15/CMP.1 annex II.E paragraph 32.(g)	List of information publicly accessible through the user interface of the registry	At present for accessing the website for every company / authorized person / account is is mandatory to specify the registry administrator with the holder fixed Internet Protocol (IP), because of the higher-level authentication mechanism.
15/CMP.1 annex II.E paragraph 32.(h)	Internet address of the interface	https://etrlv.lvgmc.lv (at present for accessing the website for every company / authorized person / account is is mandatory to specify the registry administrator with the holder fixed Internet Protocol (IP) because of the higher-level authentication mechanism.
15/CMP.1 annex II.E paragraph 32.(i)	No change of data integrity measures occurred during the reporting period	No change of data integrity measures occurred during the reporting period
15/CMP.1 annex II.E paragraph 32.(j)	No change of test results occurred during the reporting period	No change of test results occurred during the reporting period
The previous Annual Review recommendations		In Submission 2011 it is clearly stated that SIAR Excel files were not reported because there were no such cases to report in the SIAR tables

CHAPTER 15: INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

Latvia is Annex I country and within limits collaborates with developing countries to minimize adverse, social, environmental and economic impacts on the Parties.

Information about actions specified in Decision 15./CMP.1, paragraph 24 how Latvia gives priority to minimize the adverse impact of response measures in developing countries are presented in following table:

Action	Implementation in Latvia's policy
The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities.	Latvia is working in accordance with terms of EU market and its fiscal initiatives including those aiming energy price reforms. In 2010 government decided to phase out the market distortion related to VAT exemption on natural gas, introducing additional excise-duty. Natural gas is main fossil fuel in GHG-emitting energy sector hence its competition with biomass and other has been balanced.
Removing subsidies associated with the use of environmentally unsound and unsafe technologies.	No subsidies are given for environmentally unsound and unsafe technologies.
Cooperating in the technological development of non-energy uses of fossil fuels and supporting developing country Parties to this end.	Latvia does not have any support activities on this issue.
Cooperating in the development, diffusion, and transfer of less-greenhouse-gas-emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort.	Latvia does not have any support activities on this issue.
Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities.	Our developing policy support capacity building in developing countries, taking into account their needs.
Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.	Latvia does not have any support activities on this issue.

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ANNEXES TO THE NATIONAL INVENTORY REPORT

ANNEX 1: KEY CATEGORIES

Level assessment year 2010 without LULUCF

IPCC GHG Source and Sink Categories (LULUCF not included)	Gas	1990 Estimate, Gg CO2-eq	2010 Estimate, Gg CO2-eq	2010 absolute values	% Level Assessment for 2010	% Cumulative Total of Level Assessment	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2 644,313	2 088,694	2 088,694	17,295%	17,295%	2,00%	5,00%	5,39%	0,93%	3,33%	7,87%	0,17%	0,22%	0,28%
1.A.3.b Road Transportation - Diesel Oil	CO_2	616,136	2 031,344	2 031,344	16,820%	34,115%	2,00%	2,00%	2,83%	0,48%	6,59%	7,65%	0,13%	0,22%	0,25%
4.D.1. Direct Soil Emissions	N_2O	1 618,317	956,339	956,339	7,919%	42,033%	40,00%	25,00%	47,17%	3,74%	0,83%	3,60%	0,21%	2,04%	2,05%
1.A.3.b Road Transportation - Gasoline	CO_2	1 689,330	844,414	844,414	6,992%	49,025%	2,00%	2,00%	2,83%	0,20%	0,29%	3,18%	0,01%	0,09%	0,09%
4.A. Enteric Fermentation	CH_4	2 148,053	672,186	672,186	5,566%	54,591%	2,00%	20,00%	20,10%	1,12%	-1,15%	2,53%	-0,23%	0,07%	0,24%
2.A.1 Cement Production	CO_2	366,123	431,197	431,197	3,570%	58,161%	10,00%	5,00%	11,18%	0,40%	1,00%	1,62%	0,05%	0,23%	0,23%
4.D.3.Indirect Emissions	N_2O	1 033,873	388,414	388,414	3,216%	61,378%	30,00%	40,00%	50,00%	1,61%	-0,31%	1,46%	-0,12%	0,62%	0,63%
5.A.2. Unmanaged Waste Disposal Sites	CH_4	329,978	336,267	336,267	2,784%	64,162%	20,00%	52,00%	55,71%	1,55%	0,70%	1,27%	0,36%	0,36%	0,51%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	694,469	330,152	330,152	2,734%	66,896%	2,00%	10,00%	10,20%	0,28%	0,05%	1,24%	0,01%	0,04%	0,04%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	337,481	310,515	310,515	2,571%	69,467%	2,00%	5,00%	5,39%	0,14%	0,59%	1,17%	0,03%	0,03%	0,04%
1.A.4.b Residential - Gaseous Fuels	CO_2	219,607	288,303	288,303	2,387%	71,854%	50,00%	5,00%	50,25%	1,20%	0,71%	1,09%	0,04%	0,77%	0,77%
1.A.2.f Other - Gaseous Fuels	CO_2	835,236	217,635	217,635	1,802%	73,656%	2,00%	5,00%	5,39%	0,10%	-0,61%	0,82%	-0,03%	0,02%	0,04%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234,464	212,007	212,007	1,755%	75,411%	2,00%	5,00%	5,39%	0,09%	0,40%	0,80%	0,02%	0,02%	0,03%
1.A.3.c Railways - Liquid Fuels	CO_2	531,380	207,496	207,496	1,718%	77,130%	2,00%	5,00%	5,39%	0,09%	-0,13%	0,78%	-0,01%	0,02%	0,02%
1.A.4.b Residential - Biomass	CH_4	126,063	193,687	193,687	1,604%	78,733%	50,00%	50,00%	70,71%	1,13%	0,51%	0,73%	0,26%	0,52%	0,58%
1.A.2.f Other - Solid Fuels	CO_2	38,236	165,519	165,519	1,371%	80,104%	2,00%	15,00%	15,13%	0,21%	0,56%	0,62%	0,08%	0,02%	0,09%
1.A.4.b Residential - Liquid Fuels	CO_2	329,914	153,568	153,568	1,272%	81,375%	50,00%	10,00%	50,99%	0,65%	0,01%	0,58%	0,00%	0,41%	0,41%
1.A.2.f Other - Liquid Fuels	CO_2	944,946	138,399	138,399	1,146%	82,521%	2,00%	10,00%	10,20%	0,12%	-1,10%	0,52%	-0,11%	0,01%	0,11%
4.B.Manure Management	N_2O	569,677	129,613	129,613	1,073%	83,595%	40,00%	30,00%	50,00%	0,54%	-0,49%	0,49%	-0,15%	0,28%	0,31%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1 131,478	109,285	109,285	0,905%	84,500%	2,00%	10,00%	10,20%	0,09%	-1,53%	0,41%	-0,15%	0,01%	0,15%

IPCC GHG Source and Sink Categories (LULUCF not included)	Gas	1990 Estimate, Gg CO2-eq	2010 Estimate, Gg CO2-eq	2010 absolute values	% Level Assessment for 2010	% Cumulative Total of Level Assessment	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174,195	106,028	106,028	0,878%	85,377%	2,00%	5,00%	5,39%	0,05%	0,10%	0,40%	0,01%	0,01%	0,01%
6.B.1 Industrial Waste Water	CH_4	307,123	101,036	101,036	0,837%	86,214%	2,00%	30,00%	30,07%	0,25%	-0,15%	0,38%	-0,04%	0,01%	0,04%
6.A.1 Managed Waste Disposal on Land	CH_4		99,079	99,079	0,820%	87,034%	20,00%	52,00%	55,71%	0,46%	0,37%	0,37%	0,19%	0,11%	0,22%
1.A.4.b Residential - Solid Fuels	CO_2	585,452	98,782	98,782	0,818%	87,852%	50,00%	15,00%	52,20%	0,43%	-0,63%	0,37%	-0,09%	0,26%	0,28%
4.B.Manure Management	CH_4	273,758	96,156	96,156	0,796%	88,649%	2,00%	30,00%	30,07%	0,24%	-0,11%	0,36%	-0,03%	0,01%	0,03%
2.F(a).1 Refrigeration and Air Conditioning Equipment	HFCs		96,133	96,133	0,796%	89,445%	75,00%	75,00%	106,07%	0,84%	0,36%	0,36%	0,27%	0,38%	0,47%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1 331,987	94,467	94,467	0,782%	90,227%	2,00%	15,00%	15,13%	0,12%	-1,92%	0,36%	-0,29%	0,01%	0,29%
1.B.2.b Natural Gas	CH_4	236,250	92,862	92,862	0,769%	90,996%	2,00%	2,00%	2,83%	0,02%	-0,05%	0,35%	0,00%	0,01%	0,01%
4.D.2 Pasture, Range and Paddock Manure	N_2O	358,351	86,866	86,866	0,719%	91,715%	40,00%	25,00%	47,17%	0,34%	-0,29%	0,33%	-0,07%	0,19%	0,20%
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	154,094	77,391	77,391	0,641%	92,356%	2,00%	10,00%	10,20%	0,07%	0,03%	0,29%	0,00%	0,01%	0,01%
6.B.2 Domestic and Commercial Waste Water	CH_4	97,860	72,514	72,514	0,600%	92,956%	10,00%	30,00%	31,62%	0,19%	0,11%	0,27%	0,03%	0,04%	0,05%
1.A.3.b Road Transportation - LPG	CO_2	36,957	61,758	61,758	0,511%	93,468%	2,00%	5,00%	5,39%	0,03%	0,17%	0,23%	0,01%	0,01%	0,01%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3 051,264	55,113	55,113	0,456%	93,924%	2,00%	10,00%	10,20%	0,05%	-5,01%	0,21%	-0,50%	0,01%	0,50%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778,520	53,985	53,985	0,447%	94,371%	2,00%	5,00%	5,39%	0,02%	-1,13%	0,20%	-0,06%	0,01%	0,06%
6.B.2 Domestic and Commercial Waste Water	N_2O	63,528	53,315	53,315	0,441%	94,812%	10,00%	30,00%	31,62%	0,14%	0,09%	0,20%	0,03%	0,03%	0,04%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	44,672	48,358	48,358	0,400%	95,213%	2,00%	5,00%	5,39%	0,02%	0,11%	0,18%	0,01%	0,01%	0,01%

Level assessment year 2010 with LULUCF

IPCC GHG Source and Sink Categories (LULUCF is included)	Gas	1990 Estimate, Gg CO2-eq	2010 Estimate, Gg CO2-eq	2010 absolute values	% Level Assessment for 2010	% Cumulative Total of Level Assessment	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
5.A.1 Forest Land remaining Forest Land	CO_2	-16 925,492	-17 572,266	17 572,266	56,57%	56,57%	10,08%	30,00%	31,65%	109,69%	-247,81%	-166,65%	-74,34%	-23,75%	78,05%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2 644,313	2 088,694	2 088,694	6,72%	63,29%	2,00%	5,00%	5,39%	-2,22%	31,79%	19,81%	1,59%	0,56%	1,69%

IPCC GHG Source and Sink Categories (LULUCF is included)	Gas	1990 Estimate, Gg CO2-eq	2010 Estimate, Gg CO2-eq	2010 absolute values	% Level Assessment for 2010	% Cumulative Total of Level Assessment	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
1.A.3.b Road Transportation - Diesel Oil	CO_2	616,136	2 031,344	2 031,344	6,54%	69,83%	2,00%	2,00%	2,83%	-1,13%	22,06%	19,27%	0,44%	0,54%	0,70%
4.D.1. Direct Soil Emissions	N_2O	1 618,317	956,339	956,339	3,08%	72,91%	40,00%	25,00%	47,17%	-8,90%	16,42%	9,07%	4,11%	5,13%	6,57%
1.A.3.b Road Transportation - Gasoline	CO_2	1 689,330	844,414	844,414	2,72%	75,63%	2,00%	2,00%	2,83%	-0,47%	15,69%	8,01%	0,31%	0,23%	0,39%
4.A. Enteric Fermentation	CH_4	2 148,053	672,186	672,186	2,16%	77,79%	2,00%	20,00%	20,10%	-2,66%	16,14%	6,37%	3,23%	0,18%	3,23%
5.A.2 Land converted to Forest Land	CO_2	0,630	-494,311	494,311	1,59%	79,38%	16,45%	30,00%	34,21%	3,34%	-4,69%	-4,69%	-1,41%	-1,09%	1,78%
2.A.1 Cement Production	CO_2	366,123	431,197	431,197	1,39%	80,77%	10,00%	5,00%	11,18%	-0,95%	5,76%	4,09%	0,29%	0,58%	0,65%
4.D.3.Indirect Emissions	N_2O	1 033,873	388,414	388,414	1,25%	82,02%	30,00%	40,00%	50,00%	-3,83%	8,39%	3,68%	3,36%	1,56%	3,70%
5.A.2. Unmanaged Waste Disposal Sites	CH4	329,978	336,267	336,267	1,08%	83,11%	20,00%	52,00%	55,71%	-3,70%	4,69%	3,19%	2,44%	0,90%	2,60%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	694,469	330,152	330,152	1,06%	84,17%	2,00%	10,00%	10,20%	-0,66%	6,29%	3,13%	0,63%	0,09%	0,64%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	337,481	310,515	310,515	1,00%	85,17%	2,00%	5,00%	5,39%	-0,33%	4,48%	2,94%	0,22%	0,08%	0,24%
1.A.4.b Residential - Gaseous Fuels	CO_2	219,607	288,303	288,303	0,93%	86,10%	50,00%	5,00%	50,25%	-2,86%	3,73%	2,73%	0,19%	1,93%	1,94%
5.B.2 Land converted to Cropland	CO_2	215,490	253,917	253,917	0,82%	86,91%	35,00%	14,60%	37,92%	-1,90%	3,39%	2,41%	0,49%	1,19%	1,29%
5.B.1 Cropland remaining Cropland	CO_2	337,590	219,410	219,410	0,71%	87,62%	30,00%	90,00%	94,87%	-4,11%	3,62%	2,08%	3,26%	0,88%	3,37%
1.A.2.f Other - Gaseous Fuels	CO_2	835,236	217,635	217,635	0,70%	88,32%	2,00%	5,00%	5,39%	-0,23%	5,87%	2,06%	0,29%	0,06%	0,30%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234,464	212,007	212,007	0,68%	89,00%	2,00%	5,00%	5,39%	-0,23%	3,08%	2,01%	0,15%	0,06%	0,16%
1.A.3.c Railways - Liquid Fuels	CO_2	531,380	207,496	207,496	0,67%	89,67%	2,00%	5,00%	5,39%	-0,22%	4,39%	1,97%	0,22%	0,06%	0,23%
1.A.4.b Residential - Biomass	CH_4	126,063	193,687	193,687	0,62%	90,29%	50,00%	50,00%	70,71%	-2,70%	2,41%	1,84%	1,21%	1,30%	1,77%
5.E.2 Land converted to Settlements	CO_2	62,040	173,323	173,323	0,56%	90,85%	19,00%	14,60%	23,96%	-0,82%	1,93%	1,64%	0,28%	0,44%	0,52%
1.A.2.f Other - Solid Fuels	CO_2	38,236	165,519	165,519	0,53%	91,39%	2,00%	15,00%	15,13%	-0,49%	1,74%	1,57%	0,26%	0,04%	0,27%
1.A.4.b Residential - Liquid Fuels	CO_2	329,914	153,568	153,568	0,49%	91,88%	50,00%	10,00%	50,99%	-1,54%	2,96%	1,46%	0,30%	1,03%	1,07%
5.A.1 Forest Land remaining Forest Land	N_2O	146,369	147,146	147,146	0,47%	92,35%	14,14%	70,00%	71,41%	-2,07%	2,06%	1,40%	1,44%	0,28%	1,47%
1.A.2.f Other - Liquid Fuels	CO_2	944,946	138,399	138,399	0,45%	92,80%	2,00%	10,00%	10,20%	-0,28%	5,62%	1,31%	0,56%	0,04%	0,56%
4.B.Manure Management	N_2O	569,677	129,613	129,613	0,42%	93,22%	40,00%	30,00%	50,00%	-1,28%	3,82%	1,23%	1,15%	0,70%	1,34%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1 131,478	109,285	109,285	0,35%	93,57%	2,00%	10,00%	10,20%	-0,22%	6,19%	1,04%	0,62%	0,03%	0,62%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174,195	106,028	106,028	0,34%	93,91%	2,00%	5,00%	5,39%	-0,11%	1,80%	1,01%	0,09%	0,03%	0,09%
1.A.4.b Residential - Solid Fuels	CO_2	585,452	98,782	98,782	0,32%	94,23%	50,00%	15,00%	52,20%	-1,02%	3,60%	0,94%	0,54%	0,66%	0,86%
6.B.1 Industrial Waste Water	CH_4	307,123	101,036	101,036	0,33%	94,55%	2,00%	30,00%	30,07%	-0,60%	2,36%	0,96%	0,71%	0,03%	0,71%
6.A.1 Managed Waste Disposal on Land	CH_4		99,079	99,079	0,32%	94,87%	20,00%	52,00%	55,71%	-1,09%	0,94%	0,94%	0,49%	0,27%	0,56%

IPCC GHG Source and Sink Categories (LULUCF is included)	Gas	1990 Estimate, Gg CO2-eq	2010 Estimate, Gg CO2-eq	2010 absolute values	% Level Assessment for 2010	% Cumulative Total of Level Assessment	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
4.B.Manure Management	CH_4	273,758	96,156	96,156	0,31%	95,18%	2,00%	30,00%	30,07%	-0,57%	2,16%	0,91%	0,65%	0,03%	0,65%

Trend assessment year 2010 without LULUCF

IPCC GHG Source and Sink Categories (LUCF not included)		1990 Estimate, Gg CO2-eq	1990, absolute values	2010 Estimate, Gg CO2-eq	2010 absolute values	% Level Assessment	Trend Assessment	*Trend Assessmen with Uncertainty*	% Contribution to trend	% Cumulative Total of Trend Assessment	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3 051,264	3 051,264	55,113	55,113	0,456%	0,2426	*0,0247*	8,371%	8,3712%	2,00%	10,00%	10,20%
4.D.1. Direct Soil Emissions	N_2O	1 618,317	1 618,317	956,339	956,339	7,919%	0,0401	*0,0189*	6,403%	14,7741%	40,00%	25,00%	47,17%
6.A.2 Unmanaged Waste Disposal on Land	CH_4	329,978	329,978	336,267	336,267	2,784%	0,0339	*0,0189*	6,390%	21,1644%	20,00%	52,00%	55,71%
2.F(a).1 Refrigeration and Air Conditioning Equipment	HFCs			96,133	96,133	0,796%	0,0175	*0,0186*	6,281%	27,4455%	75,00%	75,00%	106,07%
1.A.4.b Residential - Biomass	CH_4	126,063	126,063	193,687	193,687	1,604%	0,0248	*0,0176*	5,939%	33,3850%	50,00%	50,00%	70,71%
1.A.4.b Residential - Gaseous Fuels	CO_2	219,607	219,607	288,303	288,303	2,387%	0,0343	*0,0172*	5,833%	39,2176%	50,00%	5,00%	50,25%
1.A.4.b Residential - Solid Fuels	CO_2	585,452	585,452	98,782	98,782	0,818%	0,0305	*0,0159*	5,385%	44,6030%	50,00%	15,00%	52,20%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1 331,987	1 331,987	94,467	94,467	0,782%	0,0931	*0,0141*	4,766%	49,3693%	2,00%	15,00%	15,13%
4.B.Manure Management	N_2O	569,677	569,677	129,613	129,613	1,073%	0,0236	*0,0118*	3,988%	53,3569%	40,00%	30,00%	50,00%
4.A. Enteric Fermentation	CH_4	2 148,053	2 148,053	672,186	672,186	5,566%	0,0555	*0,0112*	3,773%	57,1298%	2,00%	20,00%	20,10%
6.A.1 Managed Waste Disposal on Land	CH_4			99,079	99,079	0,820%	0,0180	*0,0101*	3,400%	60,5302%	20,00%	52,00%	55,71%
1.A.3.b Road Transportation - Diesel Oil	CO_2	616,136	616,136	2 031,344	2 031,344	16,820%	0,3188	*0,0090*	3,051%	63,5813%	2,00%	2,00%	2,83%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2 644,313	2 644,313	2 088,694	2 088,694	17,295%	0,1613	*0,0087*	2,939%	66,5208%	2,00%	5,00%	5,39%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1 131,478	1 131,478	109,285	109,285	0,905%	0,0738	*0,0075*	2,546%	69,0669%	2,00%	10,00%	10,20%
4.D.3.Indirect Emissions	N_2O	1 033,873	1 033,873	388,414	388,414	3,216%	0,0149	*0,0074*	2,519%	71,5856%	30,00%	40,00%	50,00%
4.D.2 Pasture, Range and Paddock Manure	N_2O	358,351	358,351	86,866	86,866	0,719%	0,0139	*0,0065*	2,211%	73,7970%	40,00%	25,00%	47,17%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798,124	798,124	45,286	45,286	0,375%	0,0578	*0,0059*	1,996%	75,7927%	2,00%	10,00%	10,20%
1.A.2.f Other - Liquid Fuels	CO_2	944,946	944,946	138,399	138,399	1,146%	0,0530	*0,0054*	1,830%	77,6230%	2,00%	10,00%	10,20%
2.A.1 Cement Production	CO_2	366,123	366,123	431,197	431,197	3,570%	0,0482	*0,0054*	1,823%	79,4460%	10,00%	5,00%	11,18%
2.A.6 Road Paving with Asphalt	CO_2	1,463	1,463	41,000	41,000	0,339%	0,0073	*0,0053*	1,809%	81,2548%	20,00%	70,00%	72,80%
1.A.2.f Other - Solid Fuels	CO_2	38,236	38,236	165,519	165,519	1,371%	0,0270	*0,0041*	1,381%	82,6357%	2,00%	15,00%	15,13%
2.A.3 Limestone and Dolomite Use	CO_2	141,005	141,005	20,209	20,209	0,167%	0,0080	*0,0040*	1,354%	83,9895%	2,00%	50,00%	50,04%
1.A.4.b Residential - Biomass	N_2O	24,812	24,812	39,908	39,908	0,330%	0,0052	*0,0037*	1,247%	85,2363%	50,00%	50,00%	70,71%

IPCC GHG Source and Sink Categories (LUCF not included)		1990 Estimate, Gg CO2-eq	1990, absolute values	2010 Estimate, Gg CO2-eq	2010 absolute values	% Level Assessment	Trend Assessment	*Trend Assessmen with Uncertainty*	% Contribution to trend	% Cumulative Total of Trend Assessment	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	338,628	338,628	39,722	39,722	0,329%	0,0208	*0,0031*	1,065%	86,3016%	2,00%	15,00%	15,13%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778,520	778,520	53,985	53,985	0,447%	0,0546	*0,0029*	0,995%	87,2970%	2,00%	5,00%	5,39%
1.A.2.c Chemicals - Liquid Fuels	CO_2	276,669	276,669	6,289	6,289	0,052%	0,0218	*0,0022*	0,751%	88,0480%	2,00%	10,00%	10,20%
3.D Other	CO_2	20,394	20,394	24,962	24,962	0,207%	0,0029	*0,0022*	0,731%	88,7792%	10,00%	75,00%	75,66%
6.B.1 Industrial Waste Water	CH_4	307,123	307,123	101,036	101,036	0,837%	0,0070	*0,0021*	0,716%	89,4948%	2,00%	30,00%	30,07%
1.A.4.b Residential - Solid Fuels	CH_4	43,019	43,019	6,734	6,734	0,056%	0,0023	*0,0017*	0,559%	90,0537%	50,00%	50,00%	70,71%
6.B.2 Domestic and Commercial Waste Water	CH_4	97,860	97,860	72,514	72,514	0,600%	0,0051	*0,0016*	0,546%	90,5993%	10,00%	30,00%	31,62%
1.A.2.f Other - Gaseous Fuels	CO_2	835,236	835,236	217,635	217,635	1,802%	0,0295	*0,0016*	0,538%	91,1374%	2,00%	5,00%	5,39%
4.B.Manure Management	CH_4	273,758	273,758	96,156	96,156	0,796%	0,0052	*0,0016*	0,525%	91,6624%	2,00%	30,00%	30,07%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	337,481	337,481	310,515	310,515	2,571%	0,0286	*0,0015*	0,521%	92,1833%	2,00%	5,00%	5,39%
1.A.4.a Commercial/Institutional - Biomass	CH_4	32,873	32,873	30,083	30,083	0,249%	0,0028	*0,0015*	0,502%	92,6853%	20,00%	50,00%	53,85%
6.B.2 Domestic and Commercial Waste Water	N_2O	63,528	63,528	53,315	53,315	0,441%	0,0044	*0,0014*	0,476%	93,1611%	10,00%	30,00%	31,62%
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	94,804	94,804	2,417	2,417	0,020%	0,0074	*0,0011*	0,379%	93,5405%	2,00%	15,00%	15,13%
2.F(a).9 Other	HFCs			5,680	5,680	0,047%	0,0010	*0,0011*	0,371%	93,9116%	75,00%	75,00%	106,07%
1.A.2.f Other - Biomass Fuels	N_2O	0,482	0,482	11,315	11,315	0,094%	0,0020	*0,0011*	0,357%	94,2684%	15,00%	50,00%	52,20%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234,464	234,464	212,007	212,007	1,755%	0,0192	*0,0010*	0,350%	94,6180%	2,00%	5,00%	5,39%
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	91,116	91,116	5,120	5,120	0,042%	0,0066	*0,0010*	0,339%	94,9565%	2,00%	15,00%	15,13%
1.A.3.b Road Transportation - Diesel Oil	N_2O	5,819	5,819	13,574	13,574	0,112%	0,0020	*0,0010*	0,337%	95,2934%	2,00%	50,00%	50,04%
2.A.2 Lime Production	CO_2	8,205	8,205	12,815	12,815	0,106%	0,0017	*0,0008*	0,280%	95,5734%	2,00%	50,00%	50,04%

Trend assessment 2010 with LULUCF

IPCC GHG Source and Sink Categories (LUCF is included)		1990 Estimate, Gg CO2-eq	1990, absolute values	2010 Estimate, Gg CO2-eq	2010 absolute values	% Level Assessment	Trend Assessment	*Trend Assessmen with Uncertainty*	% Contribution to trend	% Cumulative Total of Trend Assessment	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
5.A.1 Forest Land remaining Forest Land	CO_2	-16 925,492	16 925,492	-17 572,266	17 572,266	56,569%	-10,5471	*-3,3378*	58,275%	58,2755%	10,08%	30,00%	31,65%
4.D.1. Direct Soil Emissions	N_2O	1 618,317	1 618,317	956,339	956,339	3,079%	-0,7115	*-0,3356*	5,860%	64,14%	40,00%	25,00%	47,17%
4.D.3.Indirect Emissions	N_2O	1 033,873	1 033,873	388,414	388,414	1,250%	-0,3633	*-0,1816*	3,171%	67,31%	30,00%	40,00%	50,00%
5.B.1 Cropland remaining Cropland	CO_2	337,590	337,590	219,410	219,410	0,706%	-0,1566	*-0,1486*	2,594%	69,90%	30,00%	90,00%	94,87%
4.A. Enteric Fermentation	CH_4	2 148,053	2 148,053	672,186	672,186	2,164%	-0,6994	*-0,1406*	2,454%	72,35%	2,00%	20,00%	20,10%

IPCC GHG Source and Sink Categories (LUCF is included)		1990 Estimate, Gg CO2-eq	1990, absolute values	2010 Estimate, Gg CO2-eq	2010 absolute values	% Level Assessment	Trend Assessment	*Trend Assessmen with Uncertainty*	% Contribution to trend	% Cumulative Total of Trend Assessment	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
6.A.2 Unmanaged Waste Disposal on Land	CH4	329,978	329,978	336,267	336,267	1,083%	-0,2030	*-0,1131*	1,975%	74,33%	20,00%	52,00%	55,71%
4.B.Manure Management	N_2O	569,677	569,677	129,613	129,613	0,417%	-0,1655	*-0,0828*	1,445%	75,77%	40,00%	30,00%	50,00%
1.A.4.b Residential - Solid Fuels	CO_2	585,452	585,452	98,782	98,782	0,318%	-0,1560	*-0,0814*	1,422%	77,20%	50,00%	15,00%	52,20%
1.A.4.b Residential - Gaseous Fuels	CO_2	219,607	219,607	288,303	288,303	0,928%	-0,1616	*-0,0812*	1,418%	78,61%	50,00%	5,00%	50,25%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2 644,313	2 644,313	2 088,694	2 088,694	6,724%	-1,3784	*-0,0742*	1,296%	79,9098%	2,00%	5,00%	5,39%
1.A.4.b Residential - Biomass	CH_4	126,063	126,063	193,687	193,687	0,624%	-0,1043	*-0,0738*	1,288%	81,20%	50,00%	50,00%	70,71%
5.A.2 Land converted to Forest Land	CO_2	0,630	0,630	-494,311	494,311	1,591%	-0,2027	*-0,0693*	1,210%	82,41%	16,45%	30,00%	34,21%
1.A.4.b Residential - Liquid Fuels	CO_2	329,914	329,914	153,568	153,568	0,494%	-0,1281	*-0,0653*	1,140%	83,55%	50,00%	10,00%	50,99%
5.A.1 Forest Land remaining Forest Land	N_2O	146,369	146,369	147,146	147,146	0,474%	-0,0892	*-0,0637*	1,113%	84,66%	14,14%	70,00%	71,41%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3 051,264	3 051,264	55,113	55,113	0,177%	-0,6245	*-0,0637*	1,112%	85,77%	2,00%	10,00%	10,20%
5.B.2 Land converted to Cropland	CO_2	215,490	215,490	253,917	253,917	0,817%	-0,1467	*-0,0556*	0,971%	86,74%	35,00%	14,60%	37,92%
4.D.2 Pasture, Range and Paddock Manure	N_2O	358,351	358,351	86,866	86,866	0,280%	-0,1063	*-0,0501*	0,876%	87,62%	40,00%	25,00%	47,17%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1 331,987	1 331,987	94,467	94,467	0,304%	-0,3015	*-0,0456*	0,797%	88,42%	2,00%	15,00%	15,13%
2.F(a).1 Refrigeration and Air Conditioning Equipment	HFCs			96,133	96,133	0,309%	-0,0394	*-0,0418*	0,730%	89,15%	75,00%	75,00%	106,07%
5.C.1 Grassland remaining Grassland	CO_2	40,150	40,150	64,269	64,269	0,207%	-0,0343	*-0,0353*	0,616%	89,76%	50,00%	90,00%	102,96%
6.B.1 Industrial Waste Water	CH_4	307,123	307,123	101,036	101,036	0,325%	-0,1020	*-0,0307*	0,536%	90,30%	2,00%	30,00%	30,07%
4.B.Manure Management	CH_4	273,758	273,758	96,156	96,156	0,310%	-0,0934	*-0,0281*	0,491%	90,79%	2,00%	30,00%	30,07%
2.A.1 Cement Production	CO_2	366,123	366,123	431,197	431,197	1,388%	-0,2491	*-0,0279*	0,486%	91,27%	10,00%	5,00%	11,18%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	694,469	694,469	330,152	330,152	1,063%	-0,2724	*-0,0278*	0,485%	91,76%	2,00%	10,00%	10,20%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1 131,478	1 131,478	109,285	109,285	0,352%	-0,2680	*-0,0273*	0,477%	92,24%	2,00%	10,00%	10,20%
1.A.3.b Road Transportation - Diesel Oil	CO_2	616,136	616,136	2 031,344	2 031,344	6,539%	-0,9548	*-0,0270*	0,472%	92,71%	2,00%	2,00%	2,83%
1.A.2.f Other - Liquid Fuels	CO_2	944,946	944,946	138,399	138,399	0,446%	-0,2432	*-0,0248*	0,433%	93,14%	2,00%	10,00%	10,20%
6.A.1 Managed Waste Disposal on Land	CH_4			99,079	99,079	0,319%	-0,0406	*-0,0226*	0,395%	93,54%	20,00%	52,00%	55,71%
5.E.2 Land converted to Settlements	CO_2	62,040	62,040	173,323	173,323	0,558%	-0,0833	*-0,0200*	0,349%	93,89%	19,00%	14,60%	23,96%
1.A.3.b Road Transportation - Gasoline	CO_2	1 689,330	1 689,330	844,414	844,414	2,718%	-0,6796	*-0,0192*	0,336%	94,22%	2,00%	2,00%	2,83%
2.A.3 Limestone and Dolomite Use	CO_2	141,005	141,005	20,209	20,209	0,065%	-0,0361	*-0,0181*	0,315%	94,54%	2,00%	50,00%	50,04%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid	CO_2	798,124	798,124	45,286	45,286	0,146%	-0,1760	*-0,0179*	0,313%	94,85%	2,00%	10,00%	10,20%

IPCC GHG Source and Sink Categories (LUCF is included)		1990 Estimate, Gg CO2-eq	1990, absolute values	2010 Estimate, Gg CO2-eq	2010 absolute values	% Level Assessment	Trend Assessment	*Trend Assessmen with Uncertainty*	% Contribution to trend	% Cumulative Total of Trend Assessment	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
Fuels													
5.D.1 Wetlands remaining Wetlands	CO_2	19,800	19,800	19,800	19,800	0,064%	-0,0120	*-0,0157*	0,275%	95,12%	90,00%	95,00%	130,86%

Level assessment 1990 with LULUCF

IPCC GHG Source and Sink Categories		1990 Estimate, Gg CO2-eq	1990, absolute values	% Level Assessment	% Cumulative Total of Level Assessment
5.A.1 Forest Land remaining Forest Land	CO_2	-16 925.492	16 925.492	38.125%	38.125%
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3 051.264	3 051.264	6.873%	44.998%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2 644.313	2 644.313	5.956%	50.954%
4.A. Enteric Fermentation	CH_4	2 148.053	2 148.053	4.838%	55.792%
1.A.3.b Road Transportation - Gasoline	CO_2	1 689.330	1 689.330	3.805%	59.598%
4.D.1. Direct Soil Emissions	N_2O	1 618.317	1 618.317	3.645%	63.243%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1 331.987	1 331.987	3.000%	66.243%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1 131.478	1 131.478	2.549%	68.792%
4.D.3.Indirect Emissions	N_2O	1 033.873	1 033.873	2.329%	71.121%
1.A.2.f Other - Liquid Fuels	CO_2	944.946	944.946	2.128%	73.249%
1.A.2.f Other - Gaseous Fuels	CO_2	835.236	835.236	1.881%	75.131%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798.124	798.124	1.798%	76.928%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778.520	778.520	1.754%	78.682%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	694.469	694.469	1.564%	80.246%
1.A.3.b Road Transportation - Diesel Oil	CO_2	616.136	616.136	1.388%	81.634%
1.A.4.b Residential - Solid Fuels	CO_2	585.452	585.452	1.319%	82.953%
4.B.Manure Management	N_2O	569.677	569.677	1.283%	84.236%
1.A.3.c Railways - Liquid Fuels	CO_2	531.380	531.380	1.197%	85.433%
2.A.1 Cement Production	CO_2	366.123	366.123	0.825%	86.258%
4.D.2 Pasture, Range and Paddock Manure	N_2O	358.351	358.351	0.807%	87.065%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	338.628	338.628	0.763%	87.828%
5.B.1 Cropland remaining Cropland	CO_2	337.590	337.590	0.760%	88.588%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	337.481	337.481	0.760%	89.348%
6.A.2. Unmanaged Waste Disposal Sites	CH_4	329.978	329.978	0.743%	90.091%
1.A.4.b Residential - Liquid Fuels	CO_2	329.914	329.914	0.743%	90.835%
6.B.1 Industrial Waste Water	CH_4	307.123	307.123	0.692%	91.526%
1.A.2.c Chemicals - Liquid Fuels	CO_2	276.669	276.669	0.623%	92.150%
4.B.Manure Management	CH_4	273.758	273.758	0.617%	92.766%
1.B.2.b Natural Gas	CH_4	236.250	236.250	0.532%	93.298%

IPCC GHG Source and Sink Categories		1990 Estimate, Gg CO2-eq	1990, absolute values	% Level Assessment	% Cumulative Total of Level Assessment
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234.464	234.464	0.528%	93.826%
1.A.4.b Residential - Gaseous Fuels	CO_2	219.607	219.607	0.495%	94.321%
5.B.2 Land converted to Cropland	CO_2	215.490	215.490	0.485%	94.807%

Level assessment 1990 without LULUCF

IPCC GHG Source and Sink Categories		1990 Estimate, Gg CO2-eq	1990 Absolute values	% Level Assessment	% Cumulative Total of Level Assessment
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3 051.264	3 051.264	11.490%	11.490%
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2 644.313	2 644.313	9.958%	21.448%
4.A. Enteric Fermentation	CH_4	2 148.053	2 148.053	8.089%	29.537%
1.A.3.b Road Transportation - Gasoline	CO_2	1 689.330	1 689.330	6.362%	35.898%
4.D.1. Direct Soil Emissions	N_2O	1 618.317	1 618.317	6.094%	41.992%
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1 331.987	1 331.987	5.016%	47.008%
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1 131.478	1 131.478	4.261%	51.269%
4.D.3.Indirect Emissions	N_2O	1 033.873	1 033.873	3.893%	55.162%
1.A.2.f Other - Liquid Fuels	CO_2	944.946	944.946	3.558%	58.721%
1.A.2.f Other - Gaseous Fuels	CO_2	835.236	835.236	3.145%	61.866%
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798.124	798.124	3.005%	64.871%
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778.520	778.520	2.932%	67.803%
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	694.469	694.469	2.615%	70.418%
1.A.3.b Road Transportation - Diesel Oil	CO_2	616.136	616.136	2.320%	72.738%
1.A.4.b Residential - Solid Fuels	CO_2	585.452	585.452	2.205%	74.943%
4.B.Manure Management	N_2O	569.677	569.677	2.145%	77.088%
1.A.3.c Railways - Liquid Fuels	CO_2	531.380	531.380	2.001%	79.089%
2.A.1 Cement Production	CO_2	366.123	366.123	1.379%	80.468%
4.D.2 Pasture, Range and Paddock Manure	N_2O	358.351	358.351	1.349%	81.817%
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	338.628	338.628	1.275%	83.093%
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	337.481	337.481	1.271%	84.363%
6.A.2. Unmanaged Waste Disposal Sites	CH_4	329.978	329.978	1.243%	85.606%
1.A.4.b Residential - Liquid Fuels	CO_2	329.914	329.914	1.242%	86.848%
6.B.1 Industrial Waste Water	CH_4	307.123	307.123	1.157%	88.005%
1.A.2.c Chemicals - Liquid Fuels	CO_2	276.669	276.669	1.042%	89.047%
4.B.Manure Management	CH_4	273.758	273.758	1.031%	90.078%
1.B.2.b Natural Gas	CH_4	236.250	236.250	0.890%	90.967%
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234.464	234.464	0.883%	91.850%
1.A.4.b Residential - Gaseous Fuels	CO_2	219.607	219.607	0.827%	92.677%
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174.195	174.195	0.656%	93.333%

IPCC GHG Source and Sink Categories		1990 Estimate, Gg CO2-eq	1990 Absolute values	% Level Assessment	% Cumulative Total of Level Assessment
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	CO_2	163.886	163.886	0.617%	93.950%
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	154.094	154.094	0.580%	94.531%

ANNEX 2: DETAILED DISCUSSION OF METHODOLOGY AND DATA FOR ESTIMATING CO_2 EMISSIONS FROM FOSSIL FUEL COMBUSTION

GUIDANCE MANUAL FOR CO_2 EMISSION ESTIMATIONS

(Developed in accordance with UNFCCC and IPCC recommendations and physical characteristics of fuels used in Latvia)

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Riga

2004

Annotation

The report is done in accordance with conditions of contract No. 15 of 17 May 2004. Guidance manual of CO_2 emissions from stationary fuel combustion installations estimations is developed in accordance to requirements from IPCC Guidelines. It means that according to developed guidance, CO_2 emissions from every object could be determined using physical characteristics of combusted fuel and amount of consumed fuel. In case such physical characteristics are not available, average estimated data for types of fuels used in Latvia could be used (Table 1).

Following additional information are given:

- capacity of combustion installations,
- particle content of fuel,
- concept of heat of combustion and use of it in estimations
- discretion in composition of thermal balance of combustion installation that provide better understanding of combustion installations operations and processes that generate CO_2 emissions.

The report is developed to help enterprises that operate with combustion installations, Regional Environmental Boards (REB) and environment experts calculate CO_2 emission from stationary fuel combustion.

Introduction

Guidance for practical determination of CO_2 emission factors in the case of:

1. combusted type of fuel and physical qualities of it;
2. combusted amount of fuel,

is developed for enterprises to fulfil the requirements of national legislation (Cabinet of Ministers Regulations "About taxes of natural resources" and Cabinet of Ministers Regulation No. 555).

Stationary combustion installations are divided in:

1. boiler units – generation of electricity and heat for public utilities;
2. technological equipment combustion installations that are divided in:

installations where flue gases directly do not collide with produced products (mainly food industry – bread baking, malt drying;

Installations where flue gases directly collide with produced products (construction materials and metal production).

In point 1 and 2.1 mentioned installations emission thresholds of noxious products are determined and guidance of CO_2 emission estimations could be used. In other cases technological specific of production should be taken into account.

Mathematical expression of CO_2 emission determination given in first chapter is used in specified calculation using data from fuel certificates and combusted amount of fuels. In cases when data from fuel certificates are not available (carbon content and net calorific value of fuel), CO_2 emission factors (Table 1) that are estimated using mathematical expression, IPCC Guidelines and average values of physical qualities of fuels used in Latvia are used.

In CO_2 emission determination it is assumed that all carbon stored in fuel transforms into CO_2 in combustion process. Practically part of carbon (depends on type of fuel, type of furnaces, maintenance conditions of boiler units) doesn't burn fully and forms CO that transforms into CO_2 in length of time (approximately 48 h).

Consequently enterprise operating combustion installation and permit chemically incomplete combustion (q_3) has to consume bigger amount of fuel to obtain necessary amount if heat and therefore bigger amount of CO_2 is generated.

Part of fuel did not participate in combustion processes. This part is composed by non-combusted fuel (carbon) that is discharged from combustion installation with ashes, slag and soot. Non-combusted part of fuel is accounted as mechanically incomplete combustion losses q_4 in thermal balance of combustion installation. These loses are rather big if solid fuels – coal, peat, are combusted (ashes, slag), smaller – if liquid fuels are combusted (soot) and minimal – if gaseous fuels are combusted. For gaseous fuels q_4 is technological losses (maintenance of installations and safe work requirements provision) that are gas-fittings leakage in units processes to avoid possible explosions. In leakage process other greenhouse effect gas – methane, is emitted to atmosphere.

Brief discretion in particle content of organic fuel, relevance between fuel working, dry and combusted volumes, gross and net calorific values and suggestions in what cases previously mentioned relevancies could be used in estimations are given in the report.

1. CO_2 emission estimations for combusted organic fuels (guidance manual)

In combustion of organic fuels process carbon (C) in fuel connects with air oxygen as a result carbon dioxide (CO_2) is made. In case of chemically incomplete combustion also carbon monoxide (CO) is made that in approximately 48 h time connects with air oxygen and transforms in CO_2.

To estimate CO_2 emissions, it is necessary to know:

- combusted type of fuel;
- amount of combusted fuel B_n;
- carbon content (C^d %) in working mass of fuel;
- net calorific values of working mass of fuel (Q_z^d, MJ/kg (m^3)).

Easier way to estimate CO_2 emissions is to calculate emission factor (E) and consumed amount of fuel (B_q) marked in heat amount units (MJ, GJ, TJ…. / time period). For E and B_q estimation necessary data is collected from fuel certificates (Quality note) or analyse data and accounting of combusted fuels.

For emission factor calculation following relevance is used:

$$EF_{CO_2} = \frac{C^d \times M_{CO_2} \times 1000}{Q_z^d \times M_C \times 100} = \frac{C^d}{Q_z^d} \times 36{,}6413$$

where:
EF_{CO2} – emission factor for CO_2 (kg CO_2/MJ)
Q_z^d – net calorific value of fuel (MJ/kg (m^3))
C^d – carbon content in fuel (%)
M_{CO2} – molecule weight for CO_2 – 44, 0098 (g/mcl)
Mc – molecule weight for C – 12,011 (g/mcl)
1000 – switching from MJ to GJ
100 – percentage determination

Heat amount generated into furnaces with fuel is estimated:

$$B_q = B_n \times Q_z^d$$

where:
Bn – consumption of fuel in natural units in time period, tn (10^3 □ m^3)

CO_2 emissions in time period are estimated:

$$CO_2 = E_{CO_2} \times B_q$$

where:
CO_2 – estimated emissions, kg (t)
E_{CO2} – calculated emission factor, kg/GJ (t/TJ);
B_q - heat amount generated into furnaces with fuel, GJ (TJ).

Practically all amount of fuel input in furnaces doesn't take part in combustion process. Part of non-combusted fuels is discharged from furnace with ashes, soot and slag. These are so-called mechanically incomplete combustion losses. That's why oxidation factor p has to be taken into account in CO2 emission estimations.

Oxidation factor:

$$p = \frac{100 - q_4}{100}$$

Practically CO_2 emissions:

$$E'_{CO_2} = E_{CO_2}\, p$$

If data from fuel certificates are not available, average data summarized in Table 1 could be used in CO_2 emission estimations. Data reported in table are estimated by using average data from fuel certificates of fuels used in Latvia and suggestions from IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.

Table 1 Carbon content in organic fuels working masses, net calorific values and CO_2 emission factor

Type of fuel	Carbon content C^d %	NCV (Q_z^d) MJ/kg	Emission factor without oxidation factor (E CO_2) kg/GJ	Oxidation factor (p)	Emission factor with oxidation factor (EF CO_2) kg/GJ
Coal	67,32	26,22	94,08	0,98	**92,20**
Wood, W^d = 55%	20,11	6,70*	109,98	0,98	**107,78**
Peat, W^d = 40%	29,07	10,05	105,99	0,98**	**103,87**
Residual fuel oil	85,72	40,60	77,36	0,99	**76,59**
Diesel oil, liquid oven fuel	86,68	42,49	74,74	0,99	**74,00**
Motor gasoline (for off-roads****)	83,13	43,96	69,29	0,99	**68,60**
Natural gas	51,54	33,66***	56,10	0,995	**55,82**
LPG	77,99	45,54	62,75	0,995	**62,44**
Shale oil	82,82	39,35	76,19	0,99	**75,43**
Coke	63,87	26,37	88,75	0,98	**86,98**
Lubricants	83,77	41,86	73,33	0,99	**72,60**
Other kerosene	85,17	43,20	72,24	0,99	**71,52**
Jet fuel	85,18	43,60	71,58	0,99	**70,86**

* for wood – Q_z^d ir TJ/1000m^3
** for electricity production p = 0,99
*** natural gas – Q_z^d is MJ/m^3
**** off roads – vehicles not involved in traffic, for example, asphalt pavers, and other commercial and household technological equipment, for example, grass rollers

Emission factor values (E^n_{CO2}) that are determined for natural unit of consumed amount of fuel – t, (1000 m^3) could be used equally in CO_2 emission estimations. These values are reported in Table 2.

Table 2 CO_2 emission factors for natural units of organic fuel

Type of fuel	E^n_{CO2}, kg/t (1000 m^3)
Coal	2417
Wood, W^d = 55%	722
Peat, W^d = 40%	1044
Residual fuel oil	3110
Diesel oil, liquid oven fuel	3144
Motor gasoline (for off-roads)	3016
Natural gas	1879
LPG	2844
Shale oil	2968
Coke	2294
Lubricants	3039
Other kerosene	3090
Jet fuel	3089

Following relevance for very approximate (control) CO2 emission estimations could be used:

$$E_k \approx \frac{B_n \times C^d \times M_{CO_2}}{M_C \times 100} \approx B_n \times C^d \times 0{,}0366413$$

where:
B_n – consumed natural units amount of fuels, t (1000 m^3)
C^d – carbon content in working mass of fuel, %

Note: CO_2 emissions of renewable energy resources are not estimated. Emission factors given in Table 1.1 and Table 1.2 could be used as comparative values.

2. Installed capacity

Following concept of combustion installations (boiler units) capacity are used in practice:

1. capacity **N**;
2. installed capacity **N_{nom}**;
3. with fuel input installed capacity **N_{th}**;

N – momentary capacity of combustion installation (existing moment). Temporary it can exceed installed capacity. Mostly it is lower than installed capacity during operating time of combustion installations. As often as not average capacity of specific time period N_{vid} (h, day, and month) is used.

N_{nom} – capacity that could be used permanent without harmful influence on installation safety. For New installations installed capacity is equal to boiler unit installed capacity that is reported in technical documentation of installation – passport. For operating installations installed capacity could be determined by control (testing) institution – boiler unit inspection.

N_{th} – capacity input with fuels marked in MW to provide consummation of installed capacity.

$$N_{th} = \frac{N_{nom}}{\eta_{ka}}$$

where:
η_{ka} – boiler unit (boiler-house) efficiency factor with nominal load.

It means: to reach installed capacity, it is necessary to input in combustion installation more fuel than it is required for furnaces installed capacity (in capacity units) to cover all heat losses.

3. Organic fuels

Particle content off organic fuel:

$$C + H + N + O + S + A + W = 100 \quad \text{(\% mass content)}$$

where:
C – carbon content in solid or liquid fuels (%);
H – hydrogen content in solid or liquid fuels (%);
N – nitrogen content in solid or liquid fuels (%)
O – oxygen content in solid or liquid fuels (%)
S – sulphur content in solid or liquid fuels (%)
A – ash content in solid or liquid fuels (%)
W – moisture content in solid or liquid fuels (%)

For gaseous fuels usually it is declared hydrocarbons CnHm, hydrogen, nitrogen and CO2 (% volume units):

$$CH_4 + C_2H_6 + C_3H_8 + C_4H_{10} + C_5H_{12} + H_2 + N_2 + CO_2 = 100$$

According to mass content fuel is divided:

- working mass of fuels (marked with index **d**)

$$C^d + H^d + N^d + O^d + S^d + A^d + W^d = 100$$

- dry mass of fuels (marked with index **s**)

$$C^s + H^s + N^s + O^s + S^s + A^s = 100$$

- burning mass of fuels (marked with index **deg**)

$$C^{deg} + H^{deg} + N^{deg} + O^{deg} + S^{deg} = 100$$

As it can be seem from these expressions for different masses particle percentage content is different. Mostly particle content of dry mass is given in fuel certificates, except moisture content – for working mass. In this case recalculations have to be done and all indices have to be determined as for working mass.

Coefficients for fuel content recalculations

Given mass content	Needed mass content		
	Working	Dry	Burning
Working	1	$\frac{100}{100 - W^d}$	$\frac{100}{100 - \left(A^d + W^d\right)}$
Dry	$\frac{100 - W^d}{100}$	1	$\frac{100}{100 - A^s}$
Burning	$\frac{100 - \left(A^d + W^d\right)}{100}$	$\frac{100 - A^s}{100}$	1

In practice gross and net calorific values of organic fuels working mass is used.

For solid and liquid fuels net calorific values are estimated with equations:

$$Q_z^d = 339C^d + 1031H^d - 109\left(O^d - S_g^d\right) - 25W^d \text{ (kJ/kg)}$$

(S_g – fugitive sulphur amount)

Relevance between net and gross calorific values:

$$Q_z^d = Q_a^d - 25\left(9H^d + W\right) \text{ (kJ/kg)}$$

As it can be seen from these expressions gross calorific values of fuels is always higher than net calorific values. That's because value of condensation heat from water vapour that contain flue gasses is used, respectively outgoing flue gases temperature is lower than condensation temperature of water vapour (dew-point). That kind of operations is allowable if fuel doesn't contain sulphur. Otherwise final heating surfaces, gas lines and smokestack have to be safeguarded from aggressive environment (acids) influence and condensate neutralization have to be done.

4. Explanation and suggestions

1. In IPCC methodology [L1, Chapter 1.Energy 1.1 and 2.Energy 2.1.1.2] it is determined that in each country all available data have to be used in estimation of CO_2 emission factors for different fuel types and only when these data aren't available data from methodology could be used. It was taken into account when CO_2 emission factors for fuels used in Latvia were estimated.

2. Country's average CO_2 emission factors are estimated using actual data of fuel consumption and types [L1 chapter 1.2.1]. These data are obtained by Central Statistical Bureau of Latvia. Also in L1 it is stated that only part of fuel consumption used for acquisition of Energy has to be taken into account instead of the part that is used in technological processes. In the same chapter it is stated that amount of all combusted fuel types has to be estimated by using the same output measures. In the energy balance prepared by Central Statistical Bureau fuel consumption is estimated by using net calorific value of working volume of each particular type of fuel Q_z^d, but for natural gas – gross calorific value Q_a (it is recommendation of EUROSTAT). It has to be taken into account in estimation of total country's CO_2 emissions.

3. In total amount of CO_2 emissions leakage of gas (ventilation and technological losses) in the extraction fields of coal-gas aren't taken into account. It is referable to the exploitation of natural gas utilization equipment. Oxidation coefficient for the gaseous fuels is used in the estimation of CO_2 emissions. Leakage of gas is accounted as fugitive CH_4 emissions.

4. Oxidation coefficient for coal p = 0.98 is determined as global average. Oxidation factor is depending on type of coal and type of combustion installation. That's why in national account it could descend to p = 0.91, it means q_4 = 9% [L1].

5. In cases if net calorific values of fuels Q_z^d aren't available but only Q_a data it is possible to use average values in the estimation [L1]:

for liquid and solid fuels $Q_z^d \sim 0,95\ Q_a$

for gaseous fuels $Q_z^d \sim 0,9\ Q_a^d$

6. If installed capacity introduced with fuel marked in heat measures N_{th} is used in the estimations, oxidation coefficient isn't used because it is implicitly taken into account as losses of mechanically incomplete combustion and included in coefficient of efficiency of combustion installation $\square_{ka}$.

ANNEX 3: OTHER DETAILED METHODOLOGICAL DESCRIPTIONS FOR INDIVIDUAL SOURCE OR SINK CATEGORIES, INCLUDING FOR KP-LULUCF ACTIVITIES

A.3.1 Energy (excluding Transport sector)

Type of fuel	Sulphur content (%)															
	1990-1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
diesel	0.3	0.3	0.2645	0.333	0.226	0.298	0.284	0.333	0.209	0.188	0.136	0.12	0.184	0.157	0.141	0.213
RFO	2	2	2.1221	2.097	2.005	2.078	1.983	1.922	1.972	1.452	1.292	03.Jan	1.184	0.888	0.613	1.418
gasoline	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.02	0.015	0.015	0.015	0.015
jet fuel	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.050
jet fuel (for off-roads)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.050
other liquids	0.551	0.551	0.551	0.564	0.523	0.428	0.417	0.3	0.253	0.215	0.211	0.23	0.268	0.183	0.146	0.146
LPG	0.2	0.2	0.2	0.2	0.15	0.15	0.15	0.014	0.013	0.014	0.013	0.01	0.02	0.02	0.005	0.005
shale oil	1	1	1	1	0.8	0.735	0.834	0.545	0.616	0.647	0.628	0.8	0.817	0.84	0.85	0.550
coal	08.Jan	08.Jan	1.4674	1.368	1.064	0.896	0.871	0.831	0.666	0.667	0.726	0.64	0.438	0.412	0.338	0.334
coke	08.Jan	02.Jan	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.400
oil shale	1	1				0.05	0.7	1	1	0.86						
peat	0.3	0.3	0.2803	0.219	0.205	0.237	0.215	0.273	0.265	0.254	0.271	0.24	0.217	0.116	0.21	0.170

Type of fuel	EF (Gg/PJ)															
	1990-1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
diesel	0.141	0.141	0.125	0.157	0.106	0.140	0.133	0.157	0.098	0.088	0.064	0.059	0.087	0.074	0.067	0.100
RFO	0.966	0.966	1.024	1.012	0.968	1.003	0.957	0.928	0.952	0.701	0.624	0.497	0.572	0.429	0.296	0.685
gasoline	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
jet fuel	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
jet fuel (for off-roads)	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023

other liquids	0.263	0.263	0.263	0.269	0.250	0.205	0.199	0.143	0.121	0.103	0.101	0.109	0.128	0.087	0.070	0.070
LPG	0.088	0.088	0.088	0.088	0.066	0.066	0.066	0.006	0.006	0.006	0.006	0.005	0.009	0.009	0.002	0.002
shale oil	0.508	0.508	0.508	0.508	0.407	0.374	0.424	0.277	0.313	0.329	0.319	0.407	0.415	0.427	0.432	0.280
coal	1.236	1.236	1.007	0.939	0.730	0.615	0.598	0.570	0.457	0.458	0.498	0.442	0.301	0.283	0.232	0.229
coke	1.209	0.806	0.403	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269
oil shale	1.957	1.957				0.098	1.370	1.957	1.957	1.683						
peat	0.507	0.507	0.474	0.370	0.347	0.400	0.364	0.462	0.448	0.429	0.458	0.414	0.367	0.196	0.354	0.288

Notes:

Gasoline – due to legislation

Shale oil – average amount from database Nr. 2-Air

Peat – average amount from database Nr. 2-Air

Coal - average amount from database Nr. 2-Air and additional calculated average amount by periods

Diesel oil (transport) – due to legislation

A.3.2 Transport

Distribution of road transport fleet by subsectors and layers, year 2010

Subsector	Technology	Population	Mileage
Passenger Cars			
Gasoline <1,4 l	ECE 15/00-01	176	1500
Gasoline <1,4 l	ECE 15/02	264	1700
Gasoline <1,4 l	ECE 15/03	617	1700
Gasoline <1,4 l	ECE 15/04	7052	2000
Gasoline <1,4 l	PC Euro 1 - 91/441/EEC	6390	3000
Gasoline <1,4 l	PC Euro 2 - 94/12/EEC	5553	7000
Gasoline <1,4 l	PC Euro 3 - 98/69/EC Stage2000	10798	18000
Gasoline <1,4 l	PC Euro 4 - 98/69/EC Stage2005	13222	26500
Gasoline 1,4 - 2,0 l	ECE 15/00-01	1092	1500
Gasoline 1,4 - 2,0 l	ECE 15/02	3649	1800
Gasoline 1,4 - 2,0 l	ECE 15/03	6552	1800
Gasoline 1,4 - 2,0 l	ECE 15/04	37130	2500
Gasoline 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	41499	4500
Gasoline 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	55271	10000
Gasoline 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	37424	19000
Gasoline 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	35797	26792
Gasoline >2,0 l	ECE 15/00-01	308	1500
Gasoline >2,0 l	ECE 15/02	616	1900
Gasoline >2,0 l	ECE 15/03	1231	2500
Gasoline >2,0 l	ECE 15/04	9236	4000
Gasoline >2,0 l	PC Euro 1 - 91/441/EEC	3556	6000
Gasoline >2,0 l	PC Euro 2 - 94/12/EEC	17686	10000
Gasoline >2,0 l	PC Euro 3 - 98/69/EC Stage2000	14777	20000
Gasoline >2,0 l	PC Euro 4 - 98/69/EC Stage2005	14161	28000
Diesel <2,0 l	Conventional	17588	10000
Diesel <2,0 l	PC Euro 1 - 91/441/EEC	10761	16000
Diesel <2,0 l	PC Euro 2 - 94/12/EEC	25974	23200
Diesel <2,0 l	PC Euro 3 - 98/69/EC Stage2000	22616	27000
Diesel <2,0 l	PC Euro 4 - 98/69/EC Stage2005	20414	30000
Diesel >2,0 l	Conventional	9594	11000
Diesel >2,0 l	PC Euro 1 - 91/441/EEC	6703	17000
Diesel >2,0 l	PC Euro 2 - 94/12/EEC	20906	24000
Diesel >2,0 l	PC Euro 3 - 98/69/EC Stage2000	19375	27500
Diesel >2,0 l	PC Euro 4 - 98/69/EC Stage2005	13317	30000
LPG	Conventional	3265	12000
LPG	PC Euro 1 - 91/441/EEC	2473	13000
LPG	PC Euro 2 - 94/12/EEC	3773	20000
LPG	PC Euro 3 - 98/69/EC Stage2000	3027	26000
LPG	PC Euro 4 - 98/69/EC Stage2005	3037	28000
Light Duty Vehicles			
LPG	Conventional	63	12500
LPG	LD Euro 1 - 93/59/EEC	108	18000
LPG	LD Euro 2 - 96/69/EEC	159	21000
LPG	LD Euro 3 - 98/69/EC Stage2000	142	22000
LPG	LD Euro 4 - 98/69/EC Stage2005	170	25000
Gasoline <3,5t	Conventional	296	12500
Gasoline <3,5t	LD Euro 1 - 93/59/EEC	506	16000
Gasoline <3,5t	LD Euro 2 - 96/69/EEC	742	19000
Gasoline <3,5t	LD Euro 3 - 98/69/EC Stage2000	661	20000
Gasoline <3,5t	LD Euro 4 - 98/69/EC Stage2005	798	25000
Diesel <3,5 t	Conventional	2563	20000
Diesel <3,5 t	LD Euro 1 - 93/59/EEC	4398	25000
Diesel <3,5 t	LD Euro 2 - 96/69/EEC	6440	30000
Diesel <3,5 t	LD Euro 3 - 98/69/EC Stage2000	5740	35000
Diesel <3,5 t	LD Euro 4 - 98/69/EC Stage2005	6929	40000

Subsector	Technology	Population	Mileage
Heavy Duty Trucks			
LPG	Conventional	305	20000
LPG	HD Euro I - 91/542/EEC Stage I	81	25000
LPG	HD Euro II - 91/542/EEC Stage II	84	35000
LPG	HD Euro III - 2000 Standards	98	40000
Gasoline >3,5 t	Conventional	1046	20000
Gasoline >3,5 t	HD Euro I - 91/542/EEC Stage I	298	20000
Gasoline >3,5 t	HD Euro II - 91/542/EEC Stage II	303	25000
Gasoline >3,5 t	HD Euro III - 2000 Standards	179	35000
Gasoline >3,5 t	HD Euro IV - 2005 Standards	185	40000
Rigid <=7,5 t	Conventional	1404	35000
Rigid <=7,5 t	HD Euro I - 91/542/EEC Stage I	562	50000
Rigid <=7,5 t	HD Euro II - 91/542/EEC Stage II	540	50000
Rigid <=7,5 t	HD Euro III - 2000 Standards	348	55000
Rigid <=7,5 t	HD Euro IV - 2005 Standards	375	55000
Rigid 7,5 - 12 t	Conventional	788	50000
Rigid 7,5 - 12 t	HD Euro I - 91/542/EEC Stage I	171	65000
Rigid 7,5 - 12 t	HD Euro II - 91/542/EEC Stage II	185	70000
Rigid 7,5 - 12 t	HD Euro III - 2000 Standards	102	70000
Rigid 7,5 - 12 t	HD Euro IV - 2005 Standards	98	70000
Rigid 12 - 14 t	Conventional	327	60000
Rigid 12 - 14 t	HD Euro I - 91/542/EEC Stage I	113	70000
Rigid 12 - 14 t	HD Euro II - 91/542/EEC Stage II	94	70000
Rigid 12 - 14 t	HD Euro III - 2000 Standards	20	70000
Rigid 12 - 14 t	HD Euro IV - 2005 Standards	41	70000
Rigid 14 - 20 t	Conventional	902	60000
Rigid 14 - 20 t	HD Euro I - 91/542/EEC Stage I	1026	70000
Rigid 14 - 20 t	HD Euro II - 91/542/EEC Stage II	1336	75000
Rigid 14 - 20 t	HD Euro III - 2000 Standards	1039	75000
Rigid 14 - 20 t	HD Euro IV - 2005 Standards	2175	75000
Rigid 20 - 26 t	Conventional	267	65000
Rigid 20 - 26 t	HD Euro I - 91/542/EEC Stage I	282	70000
Rigid 20 - 26 t	HD Euro II - 91/542/EEC Stage II	380	75000
Rigid 20 - 26 t	HD Euro III - 2000 Standards	277	75000
Rigid 20 - 26 t	HD Euro IV - 2005 Standards	557	77000
Rigid 26 - 28 t	Conventional	247	65000
Rigid 26 - 28 t	HD Euro I - 91/542/EEC Stage I	261	70000
Rigid 26 - 28 t	HD Euro II - 91/542/EEC Stage II	351	75000
Rigid 26 - 28 t	HD Euro III - 2000 Standards	255	75000
Rigid 26 - 28 t	HD Euro IV - 2005 Standards	515	80000
Rigid 28 - 32 t	Conventional	28	65000
Rigid 28 - 32 t	HD Euro I - 91/542/EEC Stage I	26	70000
Rigid 28 - 32 t	HD Euro II - 91/542/EEC Stage II	32	75000
Rigid 28 - 32 t	HD Euro III - 2000 Standards	23	75000
Rigid 28 - 32 t	HD Euro IV - 2005 Standards	26	80000
Rigid >32 t	Conventional	21	65000
Rigid >32 t	HD Euro I - 91/542/EEC Stage I	21	70000
Rigid >32 t	HD Euro II - 91/542/EEC Stage II	22	75000
Rigid >32 t	HD Euro III - 2000 Standards	19	75000
Rigid >32 t	HD Euro IV - 2005 Standards	43	80000
Articulated 14 - 20 t	Conventional	211	65000
Articulated 14 - 20 t	HD Euro I - 91/542/EEC Stage I	240	70000
Articulated 14 - 20 t	HD Euro II - 91/542/EEC Stage II	422	75000
Articulated 14 - 20 t	HD Euro III - 2000 Standards	328	75000
Articulated 14 - 20 t	HD Euro IV - 2005 Standards	725	80000
Articulated 20 - 28 t	Conventional	220	65000
Articulated 20 - 28 t	HD Euro I - 91/542/EEC Stage I	292	70000
Articulated 20 - 28 t	HD Euro II - 91/542/EEC Stage II	430	75000
Articulated 20 - 28 t	HD Euro III - 2000 Standards	370	75000

Subsector	Technology	Population	Mileage
Articulated 20 - 28 t	HD Euro IV - 2005 Standards	842	80000
Articulated 28 - 34 t	Conventional	329	65000
Articulated 28 - 34 t	HD Euro I - 91/542/EEC Stage I	383	70000
Articulated 28 - 34 t	HD Euro II - 91/542/EEC Stage II	544	75000
Articulated 28 - 34 t	HD Euro III - 2000 Standards	423	75000
Articulated 28 - 34 t	HD Euro IV - 2005 Standards	917	80000
Buses			
LPG	Conventional	3	25000
LPG	HD Euro I - 91/542/EEC Stage I	1	35000
LPG	HD Euro II - 91/542/EEC Stage II	2	35000
LPG	HD Euro III - 2000 Standards	7	35000
Urban Buses	Conventional	10	25000
Urban Buses	HD Euro I - 91/542/EEC Stage I	8	35000
Urban Buses	HD Euro II - 91/542/EEC Stage II	14	35000
Urban Buses	HD Euro III - 2000 Standards	44	35000
Urban Buses Midi <=15 t	Conventional	395	65000
Urban Buses Midi <=15 t	HD Euro I - 91/542/EEC Stage I	213	75000
Urban Buses Midi <=15 t	HD Euro II - 91/542/EEC Stage II	210	80000
Urban Buses Midi <=15 t	HD Euro III - 2000 Standards	353	85000
Urban Buses Midi <=15 t	HD Euro IV - 2005 Standards	515	85000
Coaches Standard <=18 t	Conventional	441	65000
Coaches Standard <=18 t	HD Euro I - 91/542/EEC Stage I	319	70000
Coaches Standard <=18 t	HD Euro II - 91/542/EEC Stage II	241	75000
Coaches Standard <=18 t	HD Euro III - 2000 Standards	147	80000
Coaches Standard <=18 t	HD Euro IV - 2005 Standards	123	85000
Coaches Articulated >18 t	Conventional	86	40000
Coaches Articulated >18 t	HD Euro I - 91/542/EEC Stage I	132	55000
Coaches Articulated >18 t	HD Euro II - 91/542/EEC Stage II	124	60000
Coaches Articulated >18 t	HD Euro III - 2000 Standards	155	60000
Coaches Articulated >18 t	HD Euro IV - 2005 Standards	65	60000
Mopeds			
<50 cm³	Conventional	211	1000
<50 cm³	Mop - Euro I	1227	1500
<50 cm³	Mop - Euro II	8181	1500
Motorcycles			
2-stroke >50 cm³	Conventional	1815	1500
2-stroke >50 cm³	Mot - Euro I	820	2000
2-stroke >50 cm³	Mot - Euro II	311	2000
2-stroke >50 cm³	Mot - Euro III	628	2000
4-stroke <250 cm³	Mot - Euro III	278	500
4-stroke 250 - 750 cm³	Conventional	995	2000
4-stroke 250 - 750 cm³	Mot - Euro I	910	2500
4-stroke 250 - 750 cm³	Mot - Euro II	377	2500
4-stroke 250 - 750 cm³	Mot - Euro III	751	3000
4-stroke >750 cm³	Conventional	645	2500
4-stroke >750 cm³	Mot - Euro I	540	2500
4-stroke >750 cm³	Mot - Euro II	221	2500
4-stroke >750 cm³	Mot - Euro III	597	3000

A.3.3 Industrial Processes Sector

Table 1 HFC–134a estimation from domestic refrigeration

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
amount of inhabitants	2469531	2444912	2420789	2399248	2381715	2364254	2345768	2331480	2319203	2306434	2294590	2281305	2270894	2261294	2248374	2229641
Amount of households (units)	1009791,2	999724,52	989860,6221	981052,5072	973883,2635	966743,4606	975785	958402	967065	986557	997821	1018096	1035713	1042168	1035126	1035126
Amount of households (%)	40,89%	40,89%	40,89%	40,89%	40,89%	40,89%	41,60%	41,11%	41,70%	42,77%	43,49%	44,63%	45,61%	46,09%	46,04%	46,43%
Amount of refrigerators in households (units)	874479,2	865761,43	861772,6576	858617,1543	856822,4952	854987,9166	867472,87	866395,41	888732,74	921444,24	946932,13	981444,54	999463,05	1006734,3	1000966,8	1002002
Amount of refrigerators in households (%)	86,60%	86,60%	87,06%	87,52%	87,98%	88,44%	88,90%	90,40%	91,90%	93,40%	94,90%	96,40%	96,50%	96,60%	96,70%	96,80%
Amount of freezers in households (units)	22215,407	21993,939	23954,62705	25899,78619	27853,06134	29775,69859	32200,905	42936,41	54735,879	67480,499	80025,244	93664,832	90624,888	86499,944	81257,391	76599,324
Amount of freezers in households (%)	2,2%	2,2%	2,4%	2,6%	2,9%	3,1%	3,3%	4,5%	5,7%	6,8%	8,0%	9,2%	8,8%	8,3%	7,9%	7,4%
Refrigerators and freezers containing HFC-134a (%)	5,0%	7,0%	8,0%	9,0%	11,0%	13,0%	15,0%	18,0%	22,0%	26,0%	30,0%	34,0%	38,0%	42,0%	45,0%	48,0%
Amount of refrigerators containing HFC-134a (units)	43724	60603	68942	77276	94250	111148	130121	155951	195521	239576	284080	333691	379796	422828	450435	480961
Amount of freezers containing HFC-134a (units)	1111	1540	1916	2331	3064	3871	4830	7729	12042	17545	24008	31846	34437	36330	36566	36768
HFC-134a in refrigerators (140 g) (kg)	6121,35	8484,46	9651,85	10818,58	13195,07	15560,78	18216,93	21833,16	27372,97	33540,57	39771,15	46716,76	53171,43	59195,98	63060,91	67334,53
HFC-134a in freezers (140 g) (kg)	155,51	215,54	268,29	326,34	428,94	541,92	676,22	1082,00	1685,87	2456,29	3361,06	4458,45	4821,24	5086,20	5119,22	5147,47
HFC-134a in stocks (t)	6,28	8,70	9,92	11,14	13,62	16,10	18,89	22,92	29,06	36,00	43,13	51,18	57,99	64,28	68,18	72,48
HFC-134a charging one in a lifetime for refrigerators – (176.25 g) (kg)	3,72	5,16	5,87	6,58	8,02	9,46	7,38	8,85	11,09	13,59	16,12	18,93	21,55	23,99	25,56	27,29
HFC-134a charging one in a lifetime for freezers – (176.25 g) (kg)	0,09	0,13	0,16	0,20	0,26	0,33	0,27	0,44	0,68	1,00	1,36	1,81	1,95	2,06	2,07	2,09
HFC-134a charged	0,0038	0,0053	0,0060	0,0068	0,0083	0,0098	0,0077	0,0093	0,0118	0,0146	0,0175	0,0207	0,0235	0,0261	0,0276	0,0294
HFC-134a leakage during charging of refrigerators (2%) (kg)	0,074	0,103	0,117	0,132	0,160	0,189	0,148	0,177	0,222	0,272	0,322	0,379	0,431	0,480	0,511	0,546

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
HFC-134a leakage during charging of freezers (2%) (kg)	0,00189	0,00262	0,00326	0,00397	0,00522	0,00659	0,00548	0,00877	0,01366	0,01991	0,02724	0,03614	0,03908	0,04123	0,04149	0,04172
HFC-134a from charging (t)	0,00008	0,00011	0,00012	0,00014	0,00017	0,00020	0,00015	0,00019	0,00024	0,00029	0,00035	0,00041	0,00047	0,00052	0,00055	0,00059
HFC-134a leakage from stocks in refrigerators containing HFC-134a (1%) (kg)	61,21	84,84	96,52	108,19	131,95	155,61	182,17	218,33	273,73	335,41	397,71	467,17	531,71	591,96	630,61	673,35
HFC-134a leakage from stocks in freezers containing HFC-134a (1%) (kg)	1,56	2,16	2,68	3,26	4,29	5,42	6,76	10,82	16,86	24,56	33,61	44,58	48,21	50,86	51,19	51,47
HFC-134a from stock (t)	0,0628	0,0870	0,0992	0,1114	0,1362	0,1610	0,1889	0,2292	0,2906	0,3600	0,4313	0,5118	0,5799	0,6428	0,6818	0,7248
HFC-134a leakage after disposal (80%60%) (kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
HFC-134a leakage after disposal (80%60%) (kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 2 HFC–134a emission estimation from commercial and industrial refrigeration

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Amount of HFC-134a used in installation of new equipment (t)	0.08	0.0211	0.1118	0.233	0.3532	0.585	0.6639	0.3765	6.8653	4.8303	6.6466	7.0848	8.7729
Amount of HFC-134a used for charging (t)	0.0108	0.142	0.181	0.2233	0.5878	0.6982	0.3738	0.736	IE	IE	IE	IE	IE
Amount of gas is manufactured equipment (t)		0.03			0.0202	0.0136							
Total amount of HFC-134a charged (t)	0.0908	0.1931	0.2928	0.4563	0.9612	1.2968	1.0377	1.1125	6.8653	4.8303	6.6466	7.0848	8.7729
Leakage from charging (%)	15%	15%	15%	15%	15%	15%	15%	15%	8%	8%	8%	8%	8%
HFC-134a held in stocks (t)	0.0908	0.2231	0.3128	0.7748	1.0352	1.4044	2.1133	2.4695	30.7908	25.9109	43.0996	61.6263	46.6234
Leakage from stocks (%)	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	1.50%	1.50%	1.50%	1.50%	1.50%
HFC-134a emissions from charging (t)	0.0032	0.0068	0.0102	0.016	0.0336	0.0454	0.0363	0.0389	0.103	0.0725	0.0997	0.1063	0.1316
HFC-134a emissions from stocks (t)	0.0136	0.0335	0.0469	0.1162	0.1553	0.2107	0.317	0.3704	2.4633	2.0729	3.448	4.9301	3.7299
HFC-134a from disposal								NO	NO	NO	NO	NO	NO

Table 3 HFC–32 emission estimation from commercial and industrial refrigeration

	2004	2005	2006	2007	2008	2009	2010
Amount of HFC-32 used in installation of new equipment (t)			0.4846	1.5818	1.3011	1.6591	1.6591
Amount of HFC-32 used for charging (t)	0.046		IE	IE	IE	IE	IE
Total amount of HFC-32 charged (t)	0.046		0.4846	1.5818	1.3011	1.6591	2.0065
Leakage from charging (%)	15%	15%	8%	8%	8%	8%	8%
HFC-32 held in stocks (t)	0.4837	0.0184	1.1819	2.9121	5.546	11.6342	6.7596
Leakage from stocks (%)	3.50%	3.50%	1.50%	1.50%	1.50%	1.50%	1.50%
HFC-32 emissions from charging (t)	0.0016		0.0073	0.0237	0.0195	0.0249	0.0301
HFC-32 emissions from stocks (t)	0.0726	0.0028	0.0945	0.233	0.4437	0.9307	0.5408
HFC-32 from disposal		NO	NO	NO	NO	NO	NO

Table 4 HFC–125 emission estimation from commercial and industrial refrigeration

	2004	2005	2006	2007	2008	2009	2010
Amount of HFC-125 used in installation of new equipment (t)		0.066	8.2509	6.4119	12.1509	14.7358	19.1665
Amount of HFC-125 used for charging (t)	0.0931		IE	IE	IE		
Total amount of HFC-125 charged (t)	0.0931	0.066	8.2509	6.4119	12.1509	14.7358	19.1665
Leakage from charging (%)	15%	15%	8%	8%	8%	8%	8%
HFC-125 held in stocks (t)	0.6247	0.0861	7.2225	21.5748	33.4125	44.3485	35.2342
Leakage from stocks (%)	3.50%	3.50%	1.50%	1.50%	1.50%	1.50%	1.50%
HFC-125 emissions from charging (t)	0.0033	0.0023	0.1238	0.0962	0.1823	0.221	0.2875
HFC-125 emissions from stocks (t)	0.0937	0.0129	0.5778	1.726	2.673	3.5479	2.8187
HFC-125 from disposal		NO	NO	NO	NO	NO	NO

Table 5 HFC–143 emission estimation from commercial and industrial refrigeration

	2004	2005	2006	2007	2008	2009	2010
Amount of HFC-143 used in installation of new equipment (t)		0.078	9.0183	5.6805	12.5648	13.5303	18.9081
Amount of HFC-143 used for charging (t)	0.051		IE		IE	IE	IE
Total amount of HFC-143 charged (t)	0.051	0.078	9.0183	5.6805	12.5648	13.5303	18.9081
Leakage from charging (%)	15%	15%	8%	8%	8%	8%	8%
HFC-143 held in stocks (t)	0.0874	0.078	6.8324	23.4256	32.0315	24.2838	32.3061
Leakage from stocks (%)	3.50%	3.50%	1.50%	1.50%	1.50%	1.50%	1.50%

	2004	2005	2006	2007	2008	2009	2010
HFC-143 emissions from charging (t)	0.0018	0.0027	0.1353	0.0852	0.1885	0.203	0.2836
HFC-143 emissions from stocks (t)	0.0131	0.0117	0.5466	1.874	2.5625	1.9427	2.5845
HFC-143 from disposal		NO	NO	NO	NO	NO	NO

Table 6 HFC–152 emission estimation from commercial and industrial refrigeration

	2006	2007	2008	2009	2010
Amount of HFC-152 used in installation of new equipment (t)	0.012267				
Amount of HFC-152 used for charging (t)	IE				
Leakage from charging (%)	8%	8%	8%	8%	8%
HFC-152 held in stocks (t)	0.1110061	0.0744925	0.0379789	0.0024739	0.000546
Leakage from stocks (%)	1.50%	1.50%	1.50%	1.50%	1.50%
HFC-152 emissions from charging (t)	0.0002				
HFC-152 emissions from stocks (t)	0.0089	0.006	0.003	0.0002	0.00004368

Table 7 HFC– 23 emission estimation from commercial and industrial refrigeration

	2008	2009	2010
Amount of HFC-23 used in installation of new equipment (t)	0.0012	0.02336	0.05732
Leakage from charging (%)	8%	8%	8%
HFC-23 held in stocks (t)	0.011		
Leakage from stocks (%)	1.50%	1.50%	1.50%
HFC-23 emissions from charging (t)			
HFC-23 emissions from stocks (t)	0.0009	0.0019	0.0046
HFC-23 from disposal	NO	NO	NO

Table 8 HFC–134a emission estimation from transport refrigeration

	1999	2000	2001	2002	2003	2004	2005	2006
Amount of HFC-134a held in stocks (t)	0.0308	0.0913	0.2898	0.2598	0.3093	0.4580	0.5622	0.5440
Leakage from stocks (%)	15%	15%	15%	15%	15%	15%	15%	8%
Emissions from stocks (t)	0.0046	0.0137	0.0435	0.0390	0.0464	0.0687	0.0843	0.0435

Table 9 HFC–23 emission estimation from transport refrigeration

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Amount of HFC-23 held in stocks (t)	0.1	0.024	0.05	0.18	0.09	0.01	0.01	0.02	0.12
Leakage from stocks (%)	15%	15%	15%	15%	15%	15%	15%	15%	15%
Emissions from stocks (t)	0.015	0.0036	0.0075	0.027	0.0135	0.0015	0.0015	0.003	0.018

Table 10 HFC–125 emission estimation from transport refrigeration

	2004	2005	2006
Amount of HFC-125 held in stocks (t)	0.0133	0.1704	0.3274
Leakage from stocks (%)			
Emissions from stocks (t)	0.0020	0.0256	0.0262

Table 11 HFC – 134a emission estimation from mobile air conditioning equipment

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Passenger cars with manufacturing year >1995	384	5137	9512	16061	23091	30730	41049	55166	73510	103917	151705	230926	324774	371591	376 123	392 265
Trucks with manufacturing year >1995	35	716	6655	8154	8220	12724	15164	17714	20875	25955	36693	46068	57906	63271	60437	49827
Passenger cars equipped with MACs (%)	20%	20%	20%	20%	20%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%
Trucks equipped with MACs (%)	50,0%	50,0%	50,0%	50,0%	50,0%	50,0%	52,5%	55,0%	57,5%	60,0%	62,5%	65,0%	67,5%	70,0%	72,5%	75,0%
Passenger cars equipped with MACs (pieces)	77	1027	1902	3212	4618	6146	10262	16550	25729	41567	68267	115463	178626	222955	244480	274586
Trucks equipped with MACs (pieces)	18	358	3327	4077	4110	6362	7961	9743	12003	15573	22933	29944	39086	44290	43816	37370
Amount of HFC-134a in passenger cars (kg)	61	822	1522	2570	3695	4917	8210	13240	20583	33253	54614	92370	142901	178364	195584	219668
Amount of HFC-134a in trucks (kg)	21	430	3993	4892	4932	7634	9553	11691	14404	18688	27520	35933	46904	53148	52580	44844
Total amount of HFC-134a in cars (t)	0,082	1,252	5,515	7,462	8,627	12,551	17,763	24,931	34,987	51,941	82,133	128,304	189,804	231,512	248,164	264,513
Leakage from stocks (%)	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
HFC-134a emission from stocks (t)	0,012	0,188	0,827	1,119	1,294	1,883	2,664	3,740	5,248	7,791	12,320	19,246	28,471	34,727	37,225	39,677
Disposed MACs from passenger cars in year (piece)	6	82	152	257	369	492	821	1324	2058	3325	5461	9237	14290	17836	19558	21967
Disposed MACs from trucks in year (piece)	1	29	266	326	329	509	637	779	960	1246	1835	2396	3127	3543	3505	2990
F-gases remained in one MAC (5)	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
Remained f-gases in annually disposed MACs (kg)	4,946	75,091	330,883	447,718	517,594	753,072	1065,787	1495,873	2099,210	3116,462	4928,009	7698,216	11388,246	13890,699	14889,823	15870,762
Leakage from disposal (%)	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
HFC-134a disposal emissions (t)	0,004	0,068	0,298	0,403	0,466	0,678	0,959	1,346	1,889	2,805	4,435	6,928	10,249	12,502	13,401	14,284

Table 12 Potential f-gases emissions estimation from Refrigerating and Air Conditioning Equipment

Chemicals / GWP	2004	2005	2006	2007	2008	2009	2010
HFC-32 (kg)	2.153	1.357	3.095	6.221	5.375	3.621	3.414
(Gg CO_2 eqv.) GWP 650	1.39945	0.88205	2.01175	4.04388	3.49375	2.35365	2.2191
HFC-125 (kg)	11.737	11.461	18.364	16.757	22.695	24.1915	37.553
(Gg CO_2 eqv.) GWP 2800	32.8636	32.0908	51.41982	46.92015	63.546	67.7362	105.1473
HFC-134a (kg)	3.964	3.944	6.837	7.774	8.824	6.9485	9.885
(Gg CO_2 eqv.) GWP 1300	5.1532	5.1272	8.88849	10.10619	11.4712	9.03305	12.8505
HFC-143a (kg)	11.046	11.738	17.576	11.64	20.14	22.88	33.12
(Gg CO_2 eqv.) GWP 3800	41.9748	44.6044	66.7888	44.2301	76.532	86.944	125.837
HFC-152 (kg)	0.065	0.221	0.035	0.2055	0.3675		
(Gg CO_2 eqv.) GWP 140	0.0091	0.03094	0.004914	0.02877	0.05145		
TOTAL (Gg CO_2 eqv.)	**81.40015**	**82.73539**	**129.11377**	**105.3290831**	**155.04295**	**166.0669**	**163.61137**

Table 13 Potential f-gases emissions estimation from Foam Blowing

	2003	2004	2005	2006	2007	2008	2009	2010
HFC-134a (t)	24.882	3.9	37.283	178.62	318.48	12.563	0.0702	6.4691
HFC-134a (Gg CO_2 eq)	32.347	5.07	48.468	232.21	414.03	16.331	0.0913	8.4099
actual emissions during use (t)	**2.488**	**0.39**	**3.728**	**17.862**	**31.848**	**1.256**	**0.007**	**0.6469**
HFC-134a				0.058	0.047			
HFC-134a (Gg CO_2 eq)				0.075	0.061			
actual emissions during use (t)				**0.006**	**0.005**			
TOTAL HFC-134a	**24.88**	**3.9**	**37.28**	**178.7**	**318.5**	**12.56**	**0.07**	**6.4691**
HFC-134a (Gg CO_2 eq)	**32.35**	**5.07**	**48.47**	**232.3**	**414.1**	**16.33**	**0.091**	**8.4099**
actual emissions during use (t)	**2.488**	**0.39**	**3.728**	**17.87**	**31.85**	**1.256**	**0.007**	**0.6469**
HFC-152	**2.613**	**0.41**	**3.915**	**18.76**	**33.44**	**1.319**	**0.007**	**0.6793**
HFC-152 (Gg CO_2 eq)	**0.366**	**0.057**	**0.548**	**2.626**	**4.682**	**0.185**	**0.001**	**0.0951**
actual emissions during use (t)	**0.261**	**0.041**	**0.391**	**1.876**	**3.344**	**0.132**	**7.00E-04**	**0.0679**
HFC-227ae (Tecfoam SP-27-B5/365/245)		2.9	2.7	2.5				
HFC-227ae (Gg CO_2 eq)		8.41	7.83	7.25				
actual emissions during use (t)		**0.29**	**0.27**	**0.25**				
100% HFCs in products (Gg CO_2 eq) – potential emissions	**32.35**	**13.48**	**56.3**	**239.5**	**414.03**	**16.33**	**0.091**	**8.4099**

Table 14 HFC–227ea emission estimation from fire extinguishing equipment

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Amount of HFC-227ea in installed equipment (t)	0.2435	0.2435	0.6085	1.232	0.793	0.2775	0.2775	0.2775	0.2775	0.2775
Amount of HFC-227ea held in containers (t)	195.5	195.5	195.5	195.5	195.5	195.5	195.5	195.5	195.5	195.5
Leakage from installed equipment (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Emission from stocks (t)	0.0122	0.0122	0.0304	0.0616	0.0397	0.0139	0.0139	0.0139	0.0139	0.0139

Table 15 Potential HFC–227ea emissions estimation from fire extinguishing equipment

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Amount of HFC-227ea in installed equipment (t)	0.2435	0.2435	0.6085	1.232	0.793	0.2775	0.2775	0.2775	0.2775	0.2775
Amount of HFC-227ea held in	195.5	195.5	195.5	195.5	195.5	195.5	195.5	195.5	195.5	195.5

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
containers (t)										
Leakage from installed equipment (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Emission from stocks (t)	9.787 18	9.787 18	9.805 43	9.836 6	9.814 65	9.788 88	9.788 88	9.788 88	9.788 88	9.788 88
Total emission from stocks (Gg CO_2 eqv.)	28.38 281	28.38 281	28.43 573	28.52 614	28.46 249	28.38 774	28.38 774	28.38 774	28.38 774	28.38 774

Table 16 HFC-134a emission estimation from metered dose inhalers

Type of medicine	Amount of HFC-134a in particular inhaler[1]	Total amount of HFC-134a sold/imported in country (kg)													Amount of sold/imported particular type of metered dose inhalers (pieces)												
		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Bioparox	11.3				410.13	368.24	396.42	423	411.98	362.39	546.74	528.94	354.23	290.8733				36295	32588	35081	37434	36458	32070	48384	46809	31348	25741
Bioparox	15.37	53.49	258.26	360.58											3480	16803	23460										
Berotec	13.66				138.33	148.4	4.29											10127	10864	314							
Berotec	9.11				152.47	140.99	76.99	7.17	0.01									16737	15476	8451	787	1					
Berotec	7.051	82.46	106.49	22.48											11695	15103	3188										
Flixotide 50mkg	10.59					1.14	5.01	3.85	3.01	3.55	2.95	5.53	4.95	9.50982					108	473	364	284	335	279	522	467	898
Flixotide 125mkg – 60 doses	7.99												82.34	89.30423												10306	11177
Flixotide 125mkg – 120 doses	12					1.14	24.14	36.31	64.8	115.67	179.64	157.26							95	2012	3026	5400	9639	14970	13105		
Flixotide 250mkg – 60 doses	7.99												18.61	19.98299												2329	2501
Flixotide 250mkg – 120 doses	12					1.8	1.14	0.42	4.38	22.63	38.24	32.77							150	95	35	365	1886	3187	2731		
Ecobec Easi-Breathe	17.95				0.25													14									
Ecobec Easi-Breathe	15				0.33	0.2				0.06	0.05							22	13				4	3			
Ecobe	14.3								0.01	3.79	3.4	3.56	5.36									1	265	238	249	375	
Ecosal	7.5								0.01	8.51	13.35	18.11	14.59									1	1134	1780	2415	1945	
Flixotide inhaler	14.3	2.6	43.58	42.16											490	8222	7955										
Ventolin Inhaler	7.5				226.88	310.63	303.21	372.38	579.16	622.7	723.42	766.52	732.56	797.3748				22243	30454	29726	36508	56780	61049	70924	75149	71820	78174
Berodual	20.52				219.77	234.79	105.7					29.04	6.26					10710	11442	5151					1415	305	
Berodual	13.687				7.13	4.01	4.65	2.05										521	293	340	150						
Seretide – all doses	9						18.75	32.92	53.28	79.03	98.97	107.06	91.93	150.291						2083	3658	5920	8781	10997	11896	10214	16699
Berotec N	7				4.24	2.04	83.2	150.35	123.74	131.07	122.42	118.29	107.3	101.5				605	292	11886	21479	17677	18724	17489	16898	15328	14500
Berodual N	7.8				4.91	3.09	48.38	139.51	118.72	179.99	183.85	183.5	35.12	365.7966				630	396	6202	17886	15221	23075	23570	23526	45016	46897
Berodual N	10.158	28.83	46.44	25.6											2838	4572	2520										
Serevent inhaler – 60 doses	4.5				20.73	19.77	14.78	12.9	12.24	8.84		0.01						4606	4394	3285	2866	2719	1964		3		
Serevent inhaler – 120 doses	9				22.63	17.9	18.9	12.44	14	14.33	23.39	20.21	15.31	13.032				2514	1989	2100	1382	1556	1592	2599	2245	1701	1448
Becotide inhaler	10.1				93.85	63.78	67.29	79.93	86.25	84.09	80.25							9292	6315	6662	7914	8540	8326	7946			
Becloforte inhaler	9.8				126.28	97.71	108.93	115.34	121.11	109.82	106.86	98.45	89.9444	89.0624				12886	9970	11115	11769	12358	11206	10904	10046	9178	9088
Seretide all doses	11.99		0.96													80											
Ventolin inhaler	17.98	72.69	278.17	544.51											4043	15471	30284										
Total		**240.07**	**733.9**	**995.32**	**1427.94**	**1415.64**	**1281.76**	**1388.58**	**1592.69**	**1746.45**	**2123.55**	**2045.48**	**1874.50**	**1926.73**	**22546**	**60251**	**67407**	**90907**	**92251**	**89895**	**107824**	**126823**	**147980**	**164886**	**160200**	**200332**	207123
Actual HFC-134a emission (t)		**0.12**	**0.487**	**0.8646**	**1.2116**	**1.4218**	**1.3487**	**1.3352**	**1.4906**	**1.6696**	**1.935**	**2.085**	**1.960**	**1.901**													
Potential HFC-134a emission (t)		**0.24**	**0.734**	**0.995**	**1.428**	**1.416**	**1.282**	**1.389**	**1.593**	**1.746**	**2.124**	**2.045**	**1.875**	**1.927**													

Table 17 SF_6 emission estimation from electrical equipment

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Amount of SF_6 in installed equipment in particular year (t)	0.5255	0.0756	0.4619	0.4217	0.5597	0.6231	1.4681	2.9396	1.158	2.0503	2.22	2.125	2.5984	3.6065	3.0399	0.47542
Amount of SF_6 in operational equipment (t)		0.5255	0.6011	1.063	1.4847	2.0444	2.6675	4.1356	7.0751	8.2332	10.2835	12.5035	14.6286	17.2269	21.5331	23.80474
Amount of SF_6 stored in containers (t)	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.3945	0.3895	0.439	0.458	0.44075
Leakage from charging and stocks (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Leakage from containers (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
SF_6 emission from charging (t)	0.0105	0.0015	0.0092	0.0084	0.0112	0.0125	0.0294	0.0588	0.0232	0.041	0.0444	0.0425	0.052	0.0721	0.0608	0.0095084
SF_6 emission from stocks (t)		0.0105	0.012	0.0213	0.0297	0.0409	0.0534	0.0827	0.1415	0.1647	0.2057	0.2501	0.2926	0.3445	0.4307	0.4760948
Emergency leakage (t)									0.02	0.019	0.065	0.0055	0.0151	0.0049	0.0746	0.02711
total actual emissions (t)	0.0105	0.012	0.0213	0.0297	0.0409	0.0534	0.0827	0.1415	0.1847	0.2247	0.3151	0.2981	0.3597	0.4216	0.5661	0.0220375
Leakage from containers (t)	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.0197	0.0195	0.022	0.0229	12.78054173
Total potential emissions (t)	0.0265	0.028	0.0373	0.0457	0.0569	0.0694	0.0987	0.1575	0.2007	0.2407	0.3311	0.3178	0.3792	0.4436	0.589	0.589
Total potential emission (Gg CO2 eqv.)	0.6336	0.6697	0.8905	1.0921	1.3596	1.6575	2.3592	3.7643	4.7959	5.752	7.9126	7.5953	9.0618	10.601	14.0766	14.0766

Table 18 HFC-134a emission estimation from shoes (shoes soles)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
amount of manufactured shoes (pieces)	2266666	2050667	1834667	1586000	1468000	1154000	1240000	751400	596400	548200	175400								
amount of imported shoed (pieces)	708000	1020000	1332000	1660000	1924000	2284000	3756000	3922000	5088000	7008000	8462000	9748000	12246000	14194000	13284000	15266000	13940000	10856000	11392000
amount of exported shoes (pieces)	2338000	2338000	2338000	2338000	3082000	1754000	1512000												
amount of shoes containing HFC-134a (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
average amount of HFC-134a in one shoe (kg)	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
HFC-134a in manufactured shoes (t)	0.9067	0.8203	0.7339	0.6344	0.5872	0.4616	0.496	0.3006	0.2386	0.2193	0.0702								
HFC-134a in imported shoes (t)	0.2832	0.408	0.5328	0.664	0.7696	0.9136	1.5024	1.5688	2.0352	2.8032	3.3848	3.8992	4.8984	5.6776	5.3136	6.1064	5.576	4.3424	4.5568
HFC-134a in exported shoes (t)	0.9352	0.9352	0.9352	0.9352	1.2328	0.7016	0.6048												
HFC-134a in stocks (t)	0.2547	0.2931	0.3315	0.3632	0.124	0.6736	1.3936	1.8694	2.2738	3.0225	3.455	3.8992	4.8984	5.6776	5.3136	6.1064	5.576	4.3424	4.5568
Leakage from manufacturing (%)	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
HFC-134a emission from manufacturing (t)				0.095	0.088	0.069	0.074	0.045	0.036	0.033	0.011								
Leakage from stocks (%)				1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%	1.50%
HFC-134a emission stocks (t)				0.005448	0.00186	0.010104	0.020904	0.02804	0.034106	0.045337	0.051824	0.058488	0.073476	0.085164	0.079704	0.091596	0.083736	0.065136	0.068352
Amount of HFC-134a remained in shoes after the lifetime (%)				98.50%	98.50%	98.50%	98.50%	98.50%	98.50%	98.50%	98.50%	98.50%	98.50%	98.50%	98.50%	98.50%	98.50%	98.50%	98.50%
HFC-134a left in shoes after the lifetime in year t^{-3}				0.2508	0.2887	0.3265	0.3578	0.1221	0.6635	1.3727	1.8413	2.2397	2.9771	3.4031	3.8407	4.8249	5.5924	5.2339	6.014804
Lifetime factor (years)				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Leakage from disposal (%)				71.50%	71.50%	71.50%	71.50%	71.50%	71.50%	71.50%	71.50%	71.50%	71.50%	71.50%	71.50%	71.50%	71.50%	71.50%	71.50%
HFC-134a emission of disposal (t)				0.179355	0.2064	0.233444	0.255793	0.08733	0.4744	0.981478	1.316544	1.601352	2.128657	2.433242	2.746109	3.449821	3.998592	3.742236	4.30058486
HFC-134a emission total (t)				**0.28**	**0.1049**	**0.0943**	**0.1103**	**0.0881**	**0.0849**	**0.0932**	**0.0773**	**0.0735**	**0.0885**	**0.1002**	**0.0947**	**0.1066**	0.0986	0.0801	0.083352

Table 19 Potential HFC-134a emission estimation from shoes (shoes soles)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
amount of manufactured shoes (pieces)	2266666	2050667	1834667	1586000	1468000	1154000	1240000	751400	596400	548200	175400								
amount of imported shoed (pieces)	708000	1020000	1332000	1660000	1924000	2284000	3756000	3922000	5088000	7008000	8462000	9748000	12246000	14194000	13284000	15266000	13940000	10856000	11392000
amount of exported shoes (pieces)	2338000	2338000	2338000	2338000	3082000	1754000	1512000												
amount of shoes containing HFC-134a (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
average amount of HFC-134a in one shoe (kg)	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
HFC-134a in manufactured shoes (t)	0.9067	0.8203	0.7339	0.6344	0.5872	0.4616	0.496	0.3006	0.2386	0.2193	0.0702								
HFC-134a in imported shoes (t)	0.2832	0.408	0.5328	0.664	0.7696	0.9136	1.5024	1.5688	2.0352	2.8032	3.3848	3.8992	4.8984	5.6776	5.3136	6.1064	5.576	4.3424	4.5568
HFC-134a in exported shoes (t)	0.9352	0.9352	0.9352	0.9352	1.2328	0.7016	0.6048												
HFC-134a in stocks (t)	0.2547	0.2931	0.3315	0.3632	0.124	0.6736	1.3936	1.8694	2.2738	3.0225	3.455	3.8992	4.8984	5.6776	5.3136	6.1064	5.576	4.3424	4.5568
Leakage from manufacturing (%)				15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
HFC-134a emission from manufacturing (t)				0.095	0.088	0.069	0.074	0.045	0.036	0.033	0.011								
Leakage from stocks (%)				5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
HFC-134a emission stocks (t)				0.018	0.006	0.033	0.069	0.093	0.113	0.151	0.172	0.194	0.2449	0.2838	0.2656	0.3053	0.2788	0.2171	0.2278

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
				16	2	68	68	468	688	124	748	96	2	8	8	2		2	4
Amount of HFC-134a remained in shoes after the lifetime (%)				95.00%	95.00%	95.00%	95.00%	95.00%	95.00%	95.00%	95.00%	95.00%	95.00%	95.00%	95.00%	95.00%	95.00%	95.00%	95.00%
HFC-134a left in shoes after the lifetime in year t^{-3}				0.2508	0.2887	0.3265	0.345	0.1178	0.6399	1.3239	1.7759	2.1601	2.8714	3.2822	3.7042	4.6535	5.3937	5.0479	5.80108
Lifetime factor (years)				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Leakage from disposal (%)				100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
HFC-134a emission of disposal (t)				0.250846	0.288671	0.326495	0.34504	0.1178	0.63992	1.32392	1.775892	2.160072	2.871356	3.282212	3.70424	4.65348	5.39372	5.04792	5.80108
HFC-134a emission total (t)				0.3642	0.383	0.4294	0.4891	0.2564	0.7894	1.5079	1.9592	2.355	3.1163	3.5661	3.9699	4.9588	5.6725	5.265	6.0289
HFC-134a emission total (Gg CO_2 eqv)				0.4734	0.4978	0.5582	0.6359	0.3333	1.0262	1.9603	2.5469	3.0615	4.0512	4.6359	5.1609	6.4464	7.3743	6.8446	7.8376

A.3.4 Agriculture

Distribution of different manure management systems for 2000-2011 is estimated according to studies of Latvia University of Agriculture researchers. The number and detailed explanation of calculation is available in the report *Lauksaimniecības rādītāju prognoze 2015. un 2020. gadam* (Forecast of Agricultural indicators 2015-2020), published in 2011, Riga.

A.3.5. LULUCF

1 LULUCF – Methods utilized to recalculate historical forest increment data

In accordance with Republic of Latvia Cabinet Regulation No 590 Adopted 28 August 2007 „Regulations regarding Forest Inventory and Information Flow in the State Forest Register of Forests" (Issued pursuant to Section 34, Paragraphs two and three and Section 39, Paragraphs three and six of the Law on Forests) "The methodology for the performance of the forest statistical inventory and calculation of secondary parameters of a forest stand" is approved by Minister for Agriculture (vajadzētu pievienotot literatūras sarakstam).

Inventory is performed by The Latvian State Forestry Research Institute „Silava". The Latvian State Forestry Research Institute „Silava" is responsible for the accuracy of the inventory data. Each year by 1 April, the Latvian State Forestry Research Institute „Silava" submits to the Ministry of Agriculture the information obtained during the inventory of the previous year. The content of the submission of the information is determined by the Ministry of Agriculture. The results of the inventory are presented in tables.

„Silava" is ensuring that the inventory data is permanently kept in electronic form in a chronological sequence according to the forest inventory periods.

1.1. Aim and object of forest statistical inventory

The aim of the inventory is to get quick and precise information about forest resources to satisfy needs of national and international statistics, to control dynamics of forest area, to get precise information about structure and dynamics of wood resources, to evaluate effectiveness of usage of resources and forest ecosystem (dynamics of damages and biological diversity) and to accumulate historical information about way of development of forest stands.

The object of forest statistical inventory is the whole territory of the country, which according to the Law of Forests is qualified as land used for growing forests independently to form of ownership. Simultaneously continuous control of the whole land area of the country is performed to ensuring observation of the dynamics of land property and evaluation of naturally or artificially afforested land.

1. 2. Net of sample plots and sampling design

1. 2.1. Overall characteristics of net of sample plots

Forest statistical inventory is based on the method of continuous, combined, multistage sampling and GIS technology.

Forest statistical inventory is done according to three stage selection principle:

1. By using ortofoto maps (1:10 000) in whole territory of Latvia initial inventory units following each other after 250 m are placed to estimate the land use categories in accordance with State land service.

2. Net of permanent and temporary sample plots (hereinafter - SP) is estimated by selecting tracts of permanent SP with 4 SP in each as well as tracts of temporary SP with 8 SP in each:

2.1. The net of permanent SP tracts is placed evenly in whole territory of country in distance 4*4 km from each other in a way that they are making equilateral triangles (picture 1.a.). Each year 1/5 from all permanent SP is measured.

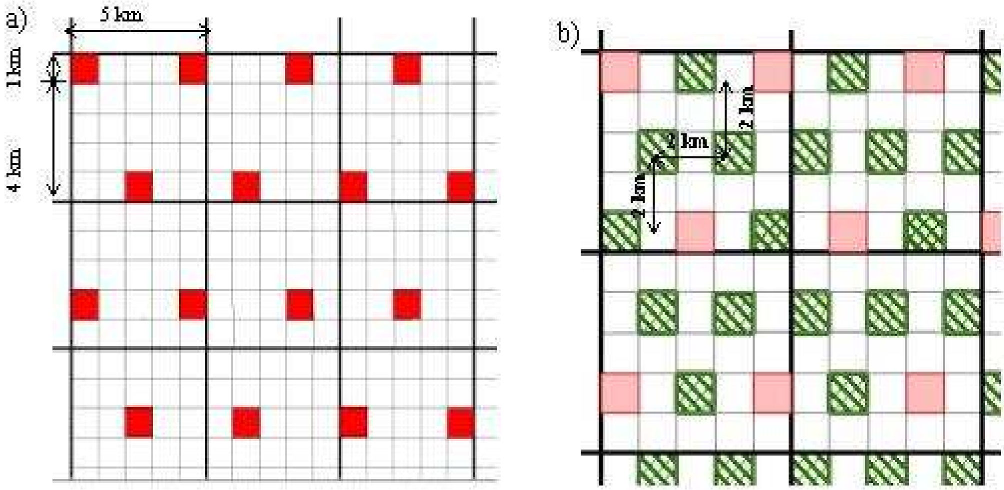

Figure 1 Schema of layout of permanent (a) and temporary SP (b) tracts

Temporary SPs are placed according to 2*2 km net with target to push up confidence level of results (picture 1.b). By quantity temporary SPs are 1/3 from yearly measured permanent SPs. Temporary sample plots are no re-measured.

SP tracts are placed on ortofoto. Permanent SPs are grouped by 4 in one tract. SP in tract are placed in peaks of quadrate 250*250 and centre of SP is moved by 25m from peaks of this quadrate (2.Picture).

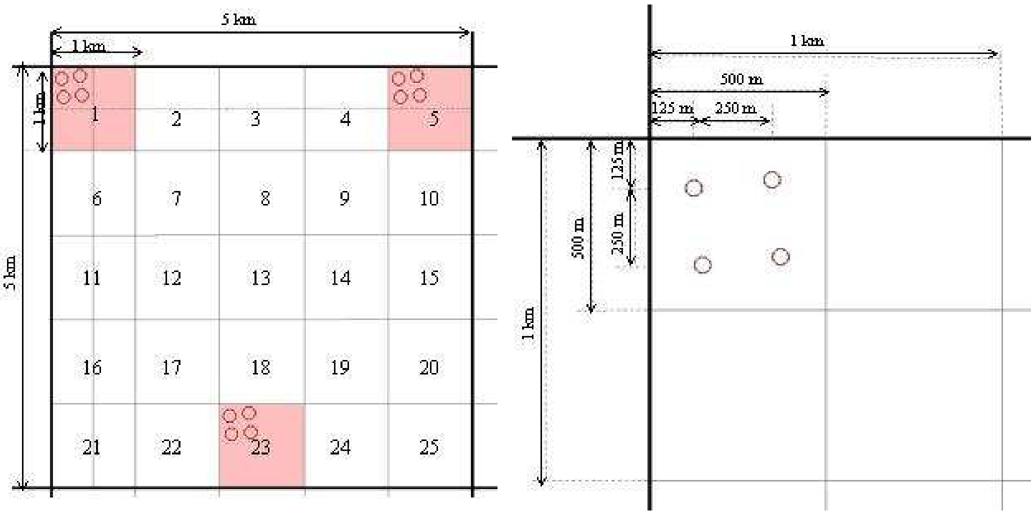

Figure 2 Schema of selecting permanent and temporary sample plots on ortofoto

In all permanent and temporary SPs accounting trees are selected with target to evaluate height, age, increment, quality and damages. These trees are selected in proportion with diameter of existing trees. Intensity of selection is 20-30% form all trees, whose diameters are measured.

Net of permanent SPs is established according to systematic schema of placement with random start. Each SP is measured once in one period of NFI (it means once in 5 years). One permanent plot represents area of 400 ha.

For placement of temporary SPs, random selection in used. By using tables of random numbers, number of 1*1 km quadrant is gradually selected for each tract. From selection of temporary SP tracts 1*1 km quadrants with permanent SPs are excluded as well as temporary SPs from previous years.

Temporary SPs are measured like permanent SPs, but measurement is made only once and without fixing geographical placement of trees. In the same tract, together with SPs for accounting of trees, stump sample plots are placed with aim to deal only with accounting of felled trees. In these SPs (stump) unlike in permanent and temporary SPs other characteristics of forest land is not accounted.

Each temporary plot after one year measurement represents territory of 6000 ha, but during 5 years – 1200 ha. Taking together permanent and temporary SPs, each plot during one year represents 1500ha, but during 5 years 300 ha. By making repeated measurements in permanent SPs changes in 5 years period are evaluated, but taking together permanent and temporary SPs present condition of forest stands is evaluated.

1.2.2. Schema of sample plots.

In net of permanent SPs, plots are placed in tracts whose margins (with length of 250 m) are oriented in direction of north, east, south and west. Centre of SP is moved from peak of tract by 25 m. (3.a. picture)

Temporary SPs are placed in quadrates of 500*500 m and they are divided in two parts - stump SPs, where only stumps are measured and SPs for accounting of trees which are measured like permanent SPs, but without fixation of placement of trees.

In tracts of temporary SPs plots for accounting of trees are placed in corners of 500*500 m quadrate, but stump SPs - in midpoints of quadrate margins. SPs are moved aside by 25 m in opposite to direction of movement. (3.b picture).

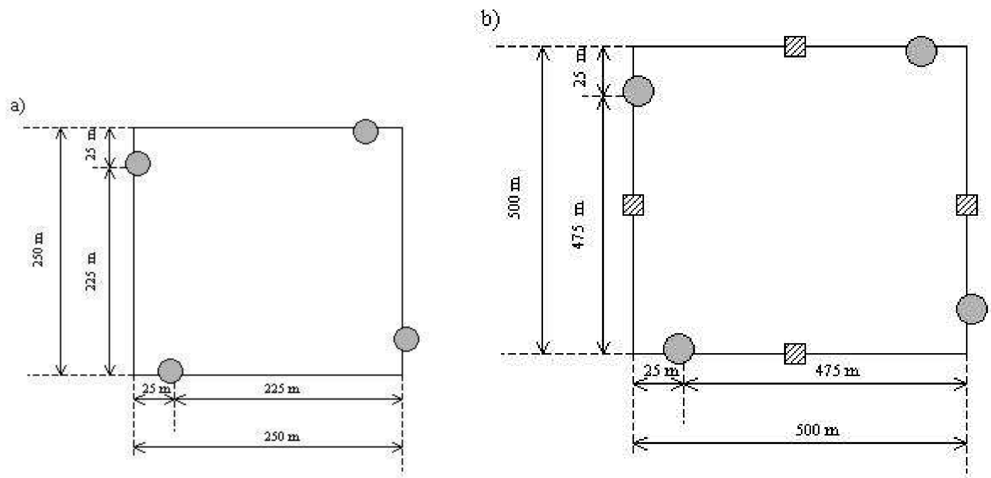

Figure 3 Schema of placement of permanent sample plots (a) and temporary sample plots (b)

Main element of measurements is permanent SP with fixed radius, with square of 500 m2 (R = 12.62 m), where measurements of trees with diameter >= 14.1 cm at 1.3 m height above root collar, stumps with diameter >= 14.1 cm at root collar and dead wood are done (4.Picture).

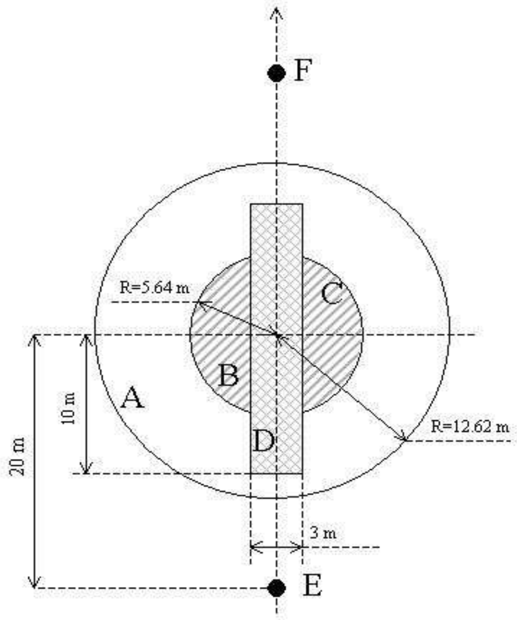

Figure 4 SP schema (A – 500 m^2 SP, B – 100 m^2 SP, C – 25 m^2 SP, D – SP for Understorey and brushwood , E and F – SP for measurements outside the permanent SP (used for radial increment measurement with boring method)

In the centre of SP another circular sample plot is singled out (B) - 100 m^2 (R=5.64 m), where all trees, stumps and deadwood with diameter >= 6.1 cm are measured. In the first ¼ of this SP (accounting from north direction) in 25 m2 (C) all naturally growing saplings and shoots with diameter >=2.1 cm in height of 1.3 m above the root collar and stumps with diameter >=2.1 cm at root collar are measured.

Understorey and brushwood are taken into account in a 3*20 m strip-like plot allocated within the main plot. For 1. and 3. SPs - in E-W direction, for 2. and 4. SPs - in N-S direction.

1.2.3. Dividing sample plots in sectors.

Sample plots occurring on the boundaries of several forest compartments are divided into smaller units – sectors. Each singled out sector is described separately, with trees being measured as in a separate sampling unit. The sample plots are divided in sectors, if there is different property form, land use, forest land category, origin of stand, forest site type, main species; age differences exceed 20 years, stocking level of the main storey differs by 0.3 or more.

During identifying sectors of SP, azimuths and distances till centre of SP for those points, where sectors making line crossing border of SP, is fixed. (5.picture)

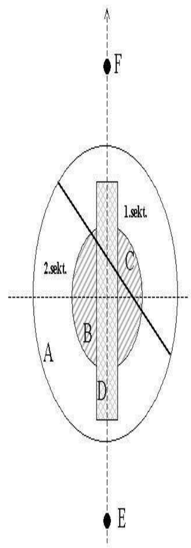

Figure 5 Sample plot dividing in sectors – schematic picture

1.2.4. Numbering of tracts and sample plots

Sample plots within tracts are numbered from „1" to „8" clockwise. (6. b Picture).

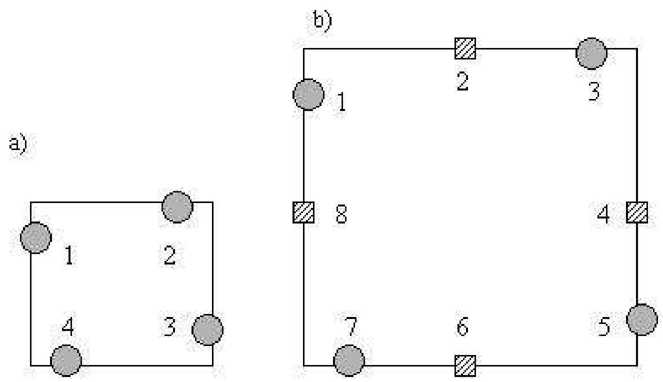

Figure 6 Schema of numbering permanent sample plots (a) and temporary sample plots (b)

1.2.5. Determination of coordinates of tracts and sample plot centres

According to Latvian system of coordinates, ortofoto maps and schema shown in 1.Picture coordinates of permanent SP tract centres are calculated. On the 5*5 km sheet of ortofoto map in the middle of territory of Latvia permanent SPs tracts are placed in centres of three 1*1 km quadrates (7.Picture). Starting from three sample plot tracts in the central ortofoto sheet of Latvia to the north, east, south and west directions coordinates of next centres of tracts are calculated in distance 4 km for all inland territory of Latvia. Coordinates of each next tract centre are calculated using coordinates of neighbour tract centre.

Coordinates of sample plot centres are calculated following coordinates of tract centres taking into account principle that centre of tract is centre of 250*250 m quadrate in whose corners sample plots are placed. Additionally displacement of sample plot centre from corners of quadrate by 25 m is calculated (3.Picture).

Coordinates of centres of temporary sample plot tracts are calculated analogically taking into account distance of 2*2 km between sample plot tracts and placement of sample plots in corners of quadrate 500*500 m and midpoints of margins (3.Picture).

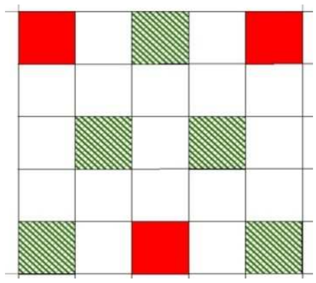

Figure 7 Schema of placement of permanent and temporary sample plots in central 5*5km ortofoto sheet of Latvia

1.3. Organisation of forest statistical inventory

1.3.1. Periodicity of forest inventory

Forest statistical inventory is performed each year in whole territory of Latvia. During first 5 years number of permanent SPs is gradually growing - each year 1/5 form overall count of SPs is measured.

After each 5 years according to cartographic materials - ortofoto and satellite pictures – changes in forest area distribution by land use categories are fixed. Re-measurements of permanent SPs are done during each next 5 years. Time period between re-measurements of permanent sample plots is 5 years +/- 20 days.

Temporary SPs each year are established in new places and measurements are done once – temporary SPs are not measured repeatedly.

1.3.2. Preparatory work of forest inventory

Preparatory work ensures timely and successful start and progress of field work. Preparatory work is done in period December - April, until beginning of field work.

By using ortofoto maps (not older than 5 years) according to calculated coordinates of tracts and SPs is fixed following information – either SPs of tracts is in forest or not as well as if they touches to separate trees or groups of trees. As a result there is prepared list about those SPs, which has to be measured or inspected – to get precise information if SP is in forest land or touches separate trees. SPs in other land use categories (except forest) are inspected as well.

Following documentation is prepared - printouts of ortofoto maps (S 1:10000), copies of forest land maps (S 1:10000) and maps of land cadastre, printouts of satellite images (S 1:50000).

Preparatory work includes also preparing measuring instruments for field work.

1.3.3. Organisation of field work

Measurements in SPs are done by at least 5 field work field work groups. Field work group consists from group leader and 2 technical workers. Group leader organises work of field group, trips, chooses the routs of visiting tracts, organises detection of tracts and measurements in SPs, takes responsibility about all documentation, training of group workers and compliance with methodology as well as taking care about transport and storage and verification of measuring instruments.

1.3.4. Quality assurance of field work

Field work is controlled with aim to prevent mistakes of measurements and the causes of these mistakes. Not less than 5 % from SPs measured by each field group are checked. Quality control is done by separate control group which consists from 3 specialists.

During field work control is done regarding all those parameters which are re-measured repeatedly in next cycles (azimuth of trees, distance, diameter, and height). Random control is placed also on parameters which are not going to be re-measured (width of growth rings, present deadwood and stumps). Control is performed each year in permanent sample plots.

1.4. Measurements and data registration

1.4.1. Identification of sample plots

For allocation of SP centre GPS receivers are used accordingly to calculated coordinates in navigation regime. In case it is not possible to found centre of SP with GPS receiver (low ability of data receiving in forest environment), coordinates of centre are found in nearest open area as well as distance and azimuth where to go to identify the point. The centre of SP in this case is found by using measuring-tape and compass. SP centre detection is fixed in documents.

After inspection all sample plots and their parts are divided in accessible and inaccessible. Sample plot is considered as inaccessible if it is not possible to reach its centre because of different reasons – centre is in water reservoirs, bogs etc. Situation is fixed in SP description.

Measurements for inaccessible SPs are done outside SP in plots whose centre are placed as close as possible to theoretical centre of SP. In this case a location of centre of plot, used for measurements, is described in SP description and nearest trees is marked.

If SP is accessible, but its centre matches with some natural barrier (stone, asphalt etc.), the centre of SP is marked at closest possible distance from theoretical centre (nearest trees are marked), but measurements are done from theoretical centre. The same methodology is used if centre of SP falls in places where destruction of centre is very possible (cropland or object of forest infrastructure). Changes are fixed in documents and design of marked centre is depictured.

Established permanent SPs in time period until next measurements should be as less visible as possible. The centre of SP is marked invisible with iron pole under surface of soil and nails (with diameter of head of a nail at least 0,7mm) in roots of nearest trees after measurements are done. If it is not possible to mark SP centre using trees or stumps in SP (for example in coppice), then trees outside SP are found but not further than 20 m from centre of SP. If proper trees are located further than 20 m, they are not marked. Identification of SP centre is documented by indicating species, distance to centre of SP and azimuth of marked trees.

During re-measurements of permanent SPs, centres are found with metal detector – seeking for iron pole and marked trees. If iron marks are destroyed, then GPS ore distance measurer is used.

For detection of sample plots in nature the same methodology is used for permanent and temporary sample plots.

1.4.2. Sample trees outside the sample plot

Sample trees for detection of age and increment in permanent sample plots are selected outside the permanent sample plot, but for temporary sample plots these measurements are done within the sample plot. Sample trees outside the sample plots are chosen following principle that these trees according to dimensions should fit to average tree in sample plot and are located in the same forest stand where sample plot is.

Outside of SP the age of growing trees is estimated (+/- 1 year) by boring method in 1.3 m height from roots collar. Diameter in 1.3 m from roots collar and tree species are estimated for sample trees as well. If trees of corresponding species in SP is more than 40%, age is measured for 3 trees, if less than 40% - for 1 tree. Age is fixed also in breakdown by stand stories.

For increment estimation measurements of growth rings of sample trees are done in forest, but data are fixed in inventory card. Increment is estimated for not more than10 borings and growth rings are measured for last 2 five-years.

All data gathered in field work are registered in tables for data accumulation, but initially inventory card of tract is completed.

*1.4.3. Estimation of forest site typ*e

Forest site types are defined by ascertaining mean height of tree species, woody vegetation and the presence of characteristic grassy vegetation as well as the intensity of draining is considered. For each forest sample plot or its sector forest site type is assessed by using Latvian typology of forest by K. Bušs (Bušs K. 1981. Meža tipoloģija un ekoloģija. Riga).

1.4.4. Estimation of understorey and brushwood

Understorey and brushwood is assessed in all forest lands (except lands under objects of forest infrastructure) as well as in lands outside forest land if this area is in sector and starts to cover with forest or brushes.

As understorey are fixed trees of forest element which in height of 1.3 m have not reached 2.1 cm diameter. If forest element with diameter less than 2.1 cm is making dominant stand then trees are not accounted as understorey. Artificially planted trees are not accounted as understorey.

Understorey and brushwood is accessed in strip with 20 m length and 3m width (4. Picture, strip-like plot D). In case of sectors this area may be smaller or to stay away at all – it is fixed in description of sector.

For trees of understorey and brushwood - species, number of individuals, height and diameter in the mid of middle shoot is accessed.

According to quality individuals of understorey and brushwood are sorted in healthy and perspective or damaged and prospect less. Trees are accounted as healthy if they are well grown, but with small damages (animal damages less than 30%, bark is not damaged).

For each tree species of understorey and brushwood average age is assessed – by counting whorls or growth rings for tree felled down outside of sample plot. During assessment of brushwood all shoots are accounted.

1.4.5. Measurements of trees

1.4.5.1. Choosing of sample trees

Sample trees are chosen from living trees (whom measurements of diameter in 1,3 m height are done) in sample plot. If certain forest element is formed only by dead trees, sample trees are measured from them. In general not less than 1 tree from seven should be selected. For selecting of sample trees third, 10^{th} and 17^{th} and so on tree is selected. Sample trees are selected accordingly to species composition in stand - incase of stand with several tree species and stories – more sample trees are selected. If it is not possible to gather appropriate number of sample trees systematically – missing trees are selected from trees with larger dimensions.

Sample trees are selected in temporary as well as in permanent sample plots. For chosen sample trees additional measurements are done - measurements of diameter at root collar, height of tree, height of first green branch, height of first dry branch, evaluation of defoliation.

Trees are not bored in permanent sample plots. Number of growth rings and increment is assessed outside of sample plot. During re-measuring of permanent sample plots the same sample trees are measured. If sample trees are felled down or shriveled up systematically next sample tree is selected.

1.4.5.2. Estimation of tree distance to centre of sample plot

Distance from centre of sample plot to centre of tree in height of 1.3 m is measured with ultrasound device. In permanent sample plots distance is measured for each tree, in temporary sample plots only for border trees to identify is it in the sample plot or outside. For distance measurements in the centre of sample plot is set up rack to which ultrasound device reflector is fastened. Ultrasound source with indicator of measurements is placed in horizontal position against reflector at central axis of tree.

In card of inventory of trees only distance of living trees to centre of sample plot is fixed. Distances for fallen trees and stumps are measured only to detect their belonging to sample plot.

1.4.5.3. Estimation of azimuth

From centre of sample plot with compass, which is fixed on rack, azimuths of trees are measured with precision of 1^o. Azimuth is fixed as indication from instrument without taking into account magnetic declination. Azimuth is measured only for living and standing dead trees, but not for stumps and lying trees. Measuring of trees starts from magnetic north and movement is clockwise. Azimuth is determined against magnetic north.

Distance to tree is measured in height of 1,3 m against axis of tree (1/2 form diameter). If tree is situated in slope, distance is measured parallel surface of land at height of 1.3 m and distance is recalculated taking into account angle of land surface. If, because of inconvenient visibility of tree (measurements are interfered by projection of stem of other tree), measurement of azimuth or diameter is not possible precisely in height of 1.3 m, cause of possible mistake is fixed in trees inventory card.

1.4.5.4. Estimation of parameters of tree stems

In each sample plot measurements of trees and stumps are done.

For each tree following measurements are done and fixed in inventory card - distance of tree to the centre of sample plot (+/- 1 cm), azimuth of tree (+/-1^o), tree species, stand storey, Kraft class, diameter in height of 1,3 m (+/- 1 mm), for sample trees root collar diameter (+/- 1 mm), for sample trees height of tree (+/- 0.5 m), height of first living and first dry branch (+/- 0.5 m), damages (type, intensity, height (placement on tree stem) of damage).

For stumps following measurements are done and fixed in inventory card – diameter (specifying with or without bark) (+/-1 mm), root collar diameter (+/-1 mm), height above root collar (+/-1 cm), species.

For evaluating deadwood following measurements are done and fixed in inventory card – species, length (+/- 0.5 m), diameter at thin end (+/- 1 mm), diameter at butt end (+/- 1 mm), quality group, position (standing or lying deadwood)

1.4.5.5. Estimation of tree storey

In permanent sample plots as well as in temporary sample plots for each tree, whose diameter is measured, belonging to first or second storey of stand is assessed.

In first storey goes trees with a height difference which, when compared to the average height of trees, does not exceed 20 %. The second storey is identified separately if the average height of trees thereof is not less than one quarter of the average height of trees of the first storey of the forest stand.

1.4.5.6. Estimation of Kraft class

According to Kraft biological classes (grouping of trees that characterize tree accordingly to its position in forest stand) for each tree of first storey in permanent and temporary sample plots (whose diameter is measured) Kraft class is assessed. Kraft classes are accessed following such principles –

I. Class – trees with largest height and diameters and well developed crown. Tops of these trees are above average crown coverage of stand.

II. Class – trees that forms main crown coverage of stand. Stems have a bit smaller dimensions as trees in I. class. II. Class trees are bout 20-40% form total number of trees in stand, but growing stock is 40-70% total growing stock of stand.

III. Class – trees with relatively smaller crowns - squashed into crowns of trees of I. and II. Class. Crowns are in the lower layer of main crown coverage.

IV. Class – trees with shorter and narrower crowns to compare with trees in III. Class. Crown tops touches lower layer of main crown coverage of stand. Trees have considerably smaller dimensions than trees in I. – III. Class.

V. Class – trees with mortifying or already dead crowns that are under main crown layer of stand.

1.4.5.7. Estimation of diameters of trees

For all trees in sample plot, that has reached 2.1 cm diameter in height of 1.3 m, diameter measurements are done in 1.3 m height with accuracy of 0.1 cm. For sample trees root collar diameter is also measured. The place of diameter measurements on stems is not marked.

During re-measurements diameter of trees has to be measured in the same place. Following prescriptions are considered:

- Place of tree diameter measurement at 1.3 m height is identified using a 1.3 m long ruler. If trees branching out lower than in 1.3 m height, diameters of two trees are measured. If there is scar or outgrowth in 1.3 m, diameter is measured above and below this point and recalculations of middle value made;
- If tree has not reached 2.1 cm diameter at 1.3 m height, diameter is not measured;
- If tree is situated at the border of sample plot, then diameter is measured at 1.3 m height above root collar;
- If vertical axis of tree is in sample plot, then tree is measured, if outside border of sample plot – diameter is not measured;
- For sample trees root collar diameter is measured in direction, where diameter is least;
- Living trees diameters at the 1.3 m height and at root collar are measured with bark. If trees are without bark, the diameters are measured without bark and respective remarks are made;
- Diameters of stumps are measured only in temporary sample plots, but in permanent sample plots during first time of survey.

1.4.5.8. Estimation of height of trees

Height is measured only for sample trees. Total height of tree, height of first living branch and height of first dry branch (diameter at least 2 cm) is measured. Accuracy of height measurements is 0.5 m.

Height is measured from place from which top of tree is well observable. In case tree is growing slantwise, distance for height measurements is determined from place, which is situated on the surface perpendicularly to top of tree. Height is measured from place against which slope of tree is directed. In general if it is possible to choose appropriate sample tree, height of slantwise tree is not measured.

Height of beginning of crown is measured analogically. Crown beginning is detected taking into account first living branches.

1.4.5.9. Estimation of increment and age

Radial increment with boring method is assessed for those forest elements whose middle diameter exceeds 10 cm.

If middle diameter is less than 10 cm, annual increment is assessed by dividing growing stock of forest element with age. For this reason outside of sample plot in 1.3 m height is felled tree (with average dimensions) whose growth rings are counted.

If middle diameter of forest element exceeds 10 cm, age is determined as follows:

- selects trees for age detection;
- if growing stock of forest element in stand exceeds 40%, 2 trees are bored for age detection. If age difference exceeds 15 years, third tree is bored;
- if growing stock of forest element in stand is less than 40%, 1 by eye chosen middle tree is bored;
- age is detected for all forest elements.

For increment detection additional trees (to those whose age is detected) are bored. Increment is accessed about last 5 and 10 years. Last growth ring is not measured. For increment detection at least 3 trees are bored. Bored trees should represent different groups of diameter. In general increment is accessed for 1-2 thinnest, 1-2 largest and 2-3 middle trees of stand (including trees that are bored for age detection).

Borings for increment detection are always made in thickest place of bark. If it is possible borings for increment detection are not made for eccentric trees. If boring should be made in trees that are damaged by animals, boring is made in opposite side of stem.

During detection of increment in forest, widths of last 5 and 10 years growth rings is fixed (for coniferous, oak and ash with 0,1 mm, for other tree species with 0,5 mm accuracy), as well as bark thickness to growth ring of current year. During age detection additionally thickness of wood part from bark to beginning of rot is accessed.

1.4.5.10. Estimation of damages

Remark about damages is made for each tree in sample plot.

Defoliation and dehromation is accessed only for sample trees and only for coniferous. Defoliation is fixed if it reaches 20%. Loss of needles is evaluated by comparing with normal. Needle losses are estimated for whole crown (from beginning to top). Distance for evaluation of defoliation is chosen close to height of tree. During evaluation of defoliation form of crown, development, embranchment etc. is taken into account.

For damaged tree type of damage, intensity and placement is fixed. Following damages are reported – pest damages, disease damages, wild animal damages, fire damages, windfall (snow-thrown wood) and damages by other abiotic factors, damages with other causes.

Intensity of damage is estimated as follows:

- stem damages – width of damage (%) form perimeter of tree;
- damaged shoots, buds, needles, leaves – damaged percentage from total;
- defoliation – amount of needles (%);
- dehromation - amount of needles and leaves (%).

Placement of damage is registered as part of tree where damage is fixed. Following placements of damages are fixed:

- roots and stumps along 30 cm above root collar;
- lower part of stem from stump height to first living branch;
- whole stem from stump height to top;
- upper part of stem from first living branch to top;
- top;
- branches in living crown;
- branches growing from the stem with diameter more then 2 cm;
- buds and shoots;
- needles and leaves.

If tree has more than one type of damage, damage more closely to root collar is fixed.

1.4.5.11. Measurements of deadwood

During measurements of deadwood species, position (standing or lying) and diameter (in thin end and butt-end) is detected.

If lying deadwood has stem with stump, diameter of butt-end is measured at 1.3 m distance from root collar, but thin end is assumed - 1 cm.

If lying deadwood is tree top, diameter of butt-end is measured at break place, but thin end is assumed - 1 cm.

If lying deadwood is broken part of stem, diameters are measured at both ends.

For standing deadwood diameter is measured at 1.3 m height and at the end of standing deadwood. If near is found lying deadwood, what had been part of standing deadwood, diameter of thin end of standing deadwood is assumed as butt-end of this lying deadwood.

If standing deadwood is shorter than 1.3 m, butt-end of standing deadwood is measured at the root collar.

If it is not possible to measure diameter of thin end directly, it is detected accordingly to height of standing deadwood.

Newly felled timber, hauling roads, felled as well as shorter than 0.5 m broken stumps are not recorded as deadwood.

Lying deadwood is measured if diameter of butt-end exceeds 6.1 cm. Belonging of lying deadwood to sample plot A or B is detected accordingly to butt-end location inside or outside of sample plot. If butt-end is located in sample plot, all length of lying deadwood is measured (also if part of lying deadwood is located outside of sample plot). If butt-end of lying deadwood is situated outside of sample plot, deadwood is not measured.

Lying deadwood is measured by degree of decomposition:

- fresh deadwood – until the beginning of bark peeling;
- old deadwood – from the beginning of bark peeling until the beginning of dissemination of epiphyte mosses (less than 10% from visible part of stem surface);

- rotten wood - dissemination of epiphyte mosses more than 10% from visible part of stem surface.

1.4.5.12. Measurements of stumps

Stumps are measured in permanent and temporary sample plots if they are younger than 5 years. Diameters of stumps are measured only in temporary sample plots and in permanent sample plots if they are measured for first time.

Remark is made if stump is measured with or without bark. Diameter is measured for stump and at root collar of felled tree. Height of stump above root collar is also detected. Information about stump measurements is fixed separately for each sector.

1.4.6. Data registration and storage

Data gathered during sample plot measurements initially are registered in working tables or in field computers.

Data from field computers are transferred to data basis not rare than once in two weeks. After logical control found mistakes are sent back to the measurement groups for correction. Finally checked data comprise primary database. Primary data are stored according to the measurement year and full cycle of five years. A permanent database gives possibility to supplement it with new parameters any time.

Information summarized during preparatory work and cartographic materials are stored in printouts until next measurements, when they as possible are renewed with new data.

1.5. Calculation of secondary parameters of a forest stands

Calculations of secondary parameters of a forest stand are done during cameral work of forest statistical inventory in accordance with standard algorithms for estimation of all stand characteristics in a sample plot.

2. The determination of 1990 land use category in areas at 2006 described as forests

In cartographical material for Latvian NFI, the data of sample plots are prepared in digital shape file format accordingly to Latvian coordinate system LKS-92.

It is possible to make spatial comparison of NFI sample plots with all other digital map layers in appropriate coordinate system. In such way as background materials digital raster data - ortophoto maps – are used now.

To assess the historical land cover information of NFI sample plots, they will be compared to LANDSAT satellite images of Latvia's territory, screened at 1990, preparing them at coordinate system LKS 92.

The assessment of NFI sample plots land use on satellite images is possible visually, or using remote sensing programs, in such way producing the layer of 1990 and 2006 forest in digital shape format.

3. The methods of forest resources assessment in NFI's sample plots at 1990

3.1. The methods of growing stock and annual increment assessment for stands more than 17 years old (at present)

3.1.1 General principles

The growing stock and annual increment are assessed for separate forest element (stands part of one species and storey trees). The total growing stock and annual increment of forest stand is assessed as the sum of all forest element values.

In accordance with Latvian NFI methods for the assessment of growing stock it is necessary to get information about:

- average diameter of forest element;
- number of trees of forest element;
- average height of forest element.

Basal area of forest element is calculated, using values of average diameter and number of trees

Growing stock is calculating, using values of basal area and average height.

Additionally, annual increment can be calculated, using value of average width of growth ring.

3.1.2. The estimation of forest element average diameter at 1990

At this moment we have information about:

a. the average diameter of forest element at 2006
b. The average width of growth rings at the period of 2002-2006 and 1997-2001.
c. the average thickness of bark.

For the estimation of average diameter at 1990 it is necessary to take of from average diameter at 2006:

a. the width of growth rings from 1997 (measured in field works of NFI)
b. the width of growth rings Z_5 from 1991 to 1996 what means one period of five years and one single year
c. the thickness of bark produced during last 16 years.

To estimate width of growth rings produced from 1991 it is possible to use the assumption that the width of growth rings at previous period of five years differs from the width of current period of five years in the same proportion as the current width of rings differs from the next period of five years, or if the width of growth rings at 1997_2001 is less than at 2002_2006, the proportion is estimated and the width of rings at 1992_1996 is calculated:

Example: $Z_5$2002-2006=7mm, $Z_5$1997_2001=6mm, $Z_5$1992-1996=$Z_5$1997_2001/ (Z_5 2002_2006 / V 1997_2001) or 6/(7/6)= 5,143

- if the width of growth rings at 1997_2001 is more than at 2002_2006, the calculation is done inversely;
- if the width of growth rings at 1997_2001 is equal than at 2002_2006, the width of growth rings at $Z_5$1992-1996 is assumed the same.
- Having value of width of 5 growth rings Z_5 at 1992_1996, it is easy to calculate width of one ring and is possible to accept that it is the same also at 1991.
- It is assumed that the annual increment of bark thickness is equal to result acquired by dividing the thickness of bark by the age of tree.

Example of total calculation:

<u>*measurements of NFI:*</u>

year 2006: age – 50 years; averageD =27 cm; Z_5 2002-2006 = 9mm, $Z_5$1997_2001=12 mm;

bark - 6 mm

<u>*parameters to be calculated:*</u>

$Z_5$1992-1996= 12*12/9=16mm

One annual ring $Z_1$1992-199616/5=3,2 mm annual increment of bark 6/50=0,12 mm

calculation:

D_{1990} = D_{2006}-2* $Z_5$2002_2006-2*$Z_5$1997_2001-2*$Z_5$1992_1996-2*Z11991-2* bark incr. =

=2700-2*9-2*12-2*16-2*3,2-16*0,12= 18,77 cm.

3.1.3. The estimation of forest element average height at 1991

Having value of tree diameter, it is possible to use equation for calculation average height depending from the diameter of tree and forest site index. The equation is produced by using tables of tree growing progress accepted in Latvia's forest inventory. Site index for each sample plot is calculated accordingly to methodology of Latvian NFI, depending from the tree height at the definite age and don't change in the result of forest growing.

Table1. Algorithms for tree height calculation depending from site index and diameter at the breast height

Site index	Species	Height
Ia	pine	
I	pine	
II	pine	
III	pine	
Lower than III	pine	
all	spruce	
all	deciduous	

3.1.4. The estimation of number of trees at 1990 in the sample plot

If the thinnings are not done in forest, the number of trees at 2006 may differ from the number of trees at 1900 as a result of natural mortality. It is identified theoretically that annual natural mortality in Latvia's forest is approximately 4 mill m^3 per year or 0.6 % of the total growing stock of living trees. It is possible to consider, that the number of trees at NFI sample plots at 1990 was more than 9.6% than at 2006.

As the thinnings are done, it is the expert's opinion, that 50% of dead trees are felled at thinnings. In such way the impact of natural mortality to decrease number of trees since 1990 can be assumed as a half of theoretically calculated – 4.8%.

In the field jobs of NFI the stumps are registered and measured if their age don't exceed 5 years. In this case it is possible to calculate the average number of cutted trees during the last period of five years.

By using official data of the forest statistics, it is possible to have data about felled volume in thinings in tree periods of five years: 1992-1996, 1997-2001; 2002-2006 in three groups of forests: pine, spruce and deciduous stands.

Using previous information, it is possible to estimate the proportion of felled volumes.

Accepting as basis of evaluation, that the proportion of felled volumes is similar to proportion of number of felled trees, the number of felled trees in previous two periods of five years and average annual volume will be calculated.

As a result of calculations the number of felled trees per period 1990 – 2006 will be clarified.

Counting the measured living trees and calculated dead and felled trees in sample plot, the number of trees in NFI sample plots at 1900 will be clarified.

3.1.5. The estimation of basal area at 1991 in the sample plot

Using data calculated previously (average diameter $D_{vid.}$, number of trees N), is possible to calculate basal area of forest element:

$$G=PI()*D_{vid}.\hat{}2/4*N.$$

3.1.6. The estimation of growing stock at 1991 in the sample plot

Using data calculated previously (average diameter $D_{vid.}$, average height of forest element H_{vid}., basal area of forest element G), it is possible to calculate growing stock of forest element at 1990 in accordance with NFI methods.

The sum of forest element's growing stock forms the total growing stock of forest land at 1990.

3.1.7. The estimation of annual increment at 1991 in the sample plot

Using data calculated previously (average diameter $D_{vid.}$, average height of forest element H_{vid}., basal area of forest element G, average growth ring Z_{1990}, is possible to calculate annual increment of forest element at 1990 in accordance with NFI methods.

The sum of forest element's annual increment forms the total annual increment of forest land at 1990

3.2. The methods of growing stock and annual increment assessment for stands less than 17 years old (at 2006)

There were not strictly defined regulations for forest regeneration depending from the previous stand structure use in practical forestry after 1990. Therefore general assumptions must be used to identify stand structure at 1990 for the areas with less than 17 year old forests at 2006.

In Latvia national forest typology (ecosystem classification) is used to characterise forest ecosystems. Typology identifies 23 forest ecosystem types. The main variables used in forest type identification (vegetation, growing conditions, process of forest regeneration and growing) are not changing in process of new stand establishing after forest cutting, and are the same for the new forest.

In the field jobs every NFI sample plot is characterised by forest type, and it is possible to produce the list of forest types for all areas felled since 1990 and regenerated till 2006.

It is possible to assume that the division of felled areas (since 1990) by forest types is similar that division of matured stands at 1990. For this reason it is possible to characterise felled areas using the average values of growing stock and increment from the group of all matured stands at 1990 calculated by us previously.

The identical approach will be used to characterise cutovers described at 2006.

3.2.1. The software of calculations

After the methods of calculation will be approved by customers, the additional software module of Latvian NFI will be produced, preparing reports about forest growing stock and annual increment separately by main species and age groups of ten years, applying to forest situation at 1990.

ANNEX 4: CO_2 REFERENCE APPROACH AND COMPARISON WITH SECTORAL APPROACH, LATVIA'S ENERGY BALANCE

Table 1 Reference Approach estimations (Table 1B)

FUEL TYPES			Unit	Production	Imports	Exports	International bunkers	Stock change	Apparent consumption	Conversion factor (TJ/Unit)	NCV/ GCV (1)	Apparent consumption (TJ)	Carbon emission factor (t C/TJ)	Carbon content (Gg C)	Carbon stored (Gg C)	Net carbon emissions (Gg C)	Fraction of carbon oxidized	Actual CO_2 emissions (Gg CO_2)
Liquid	Primary	Crude Oil	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
Fossil	Fuels	Orimulsion	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Natural Gas Liquids	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
	Secondary	Gasoline	TJ		10 996.00	616.00	NO	-1 452.00	11 832.00	1.00	NCV	11 832.00	18.91	223.70	NO	223.70	0.99	812.02
	Fuels	Jet Kerosene	TJ		5 142.00	NO	5 141.99	NO	0.01	1.00	NCV	0.01	19.71	0.00	NO	0.00	0.99	0.00
		Other Kerosene	TJ		NO	NO	NO	NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Shale Oil	TJ		78.70	NO		NO	78.70	1.00	NCV	78.70	21.05	1.66	NO	1.66	0.99	6.01
		Gas / Diesel Oil	TJ		35 267.00	5 141.00	2 932.00	-2 166.99	29 360.99	1.00	NCV	29 360.99	20.40	598.97	NO	598.97	0.99	2 174.25
		Residual Fuel Oil	TJ		8 769.60	NO	7 592.20	108.00	1 069.40	1.00	NCV	1 069.40	21.11	22.58	NO	22.58	0.99	81.96
		Liquefied Petroleum Gas (LPG)	TJ		5 646.96	3 597.66		-54.00	2 103.30	1.00	NCV	2 103.30	17.13	36.02	NO	36.02	1.00	132.07
		Ethane	TJ		NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Naphtha	TJ		NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Bitumen	TJ		2 009.28	NO		41.86	1 967.42	1.00	NCV	1 967.42	22.00	43.28	43.28	0.00	0.99	0.00
		Lubricants	TJ		2 176.72	1 632.54	NO	-41.86	586.04	1.00	NCV	586.04	20.01	11.73	11.58	0.15	0.99	0.55
		Petroleum Coke	TJ		164.90	NO		-461.72	626.62	1.00	NCV	626.62	27.50	17.23	NO	17.23	0.99	62.55
		Refinery Feedstocks	TJ		NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Other Oil	TJ		929.59	NO		80.83	848.76	1.00	NCV	848.76	22.10	18.76	NO	18.76	0.99	68.10
Other Liquid Fossil														556.00		11.96	10.06	1.90
Gasoline type jet fuel			TJ	NO	TJ	NO	NO	NO	NO	NO	NO	NO	NCV	NO	NO	NO	NO	NO
Paraffin Waxes			TJ	TJ	NO	419.00	NO	NO	NO	419.00	1.00	NCV	419.00	22.00	9.22	9.22	0.00	0.99
Used Oils			TJ	TJ	66.00	29.00	NO	NO	NO	95.00	1.00	NCV	95.00	20.01	1.90	NO	1.90	0.99
White Spirit			TJ	TJ	NO	42.00	NO	NO	NO	42.00	1.00	NCV	42.00	20.00	0.84	0.84	0.00	0.99
Liquid Fossil Totals														49 029.24		985.88	64.91	920.97
Solid	Primary	Anthracite (2)	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
Fossil	Fuels	Coking Coal	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Other Bituminous Coal	TJ	NO	4 719.00	52.00	NO	289.00	4 378.00	1.00	NCV	4 378.00	25.68	112.41	NO	112.41	0.98	403.91
		Sub-bituminous Coal	TJ	NO	NO	NO	NO	NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Lignite	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO

FUEL TYPES			Unit	Production	Imports	Exports	International bunkers	Stock change	Apparent consumption	Conversion factor (TJ/Unit)	NCV/ GCV (1)	Apparent consumption (TJ)	Carbon emission factor (t C/TJ)	Carbon content (Gg C)	Carbon stored (Gg C)	Net carbon emissions (Gg C)	Fraction of carbon oxidized	Actual CO_2 emissions (Gg CO_2)
		Oil Shale	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Peat	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
	Secondary	BKB(3) and Patent Fuel	TJ		NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
	Fuels	Coke Oven/Gas Coke	TJ		80.00	NO		NO	80.00	1.00	NCV	80.00	23.84	1.91	NO	1.91	0.98	6.85
Other Solid Fossil													NA		NA	NA	NA	
Solid Fossil Totals														4 458.00		114.31	NA,NO	114.31
Gaseous Fossil		Natural Gas (Dry)	TJ	TJ	NO	37 879.00	NO		-23 434.00	61 313.00	1.00	NCV	61 313.00	15.14	928.32	NO	928.32	1.00
Other Gaseous Fossil												NA		NA	NA	NA		NA
Gaseous Fossil Totals												61 313.00		928.32	NA,NO	928.32		3 403.83
Total												114 800.24		2 028.51	64.91	1 963.60		7 159.02
Biomass total													50 192.00		1 495.44	NO	1 495.44	
		Solid Biomass	TJ	72 471.00	139.00	22 274.00		1 018.00	49 318.00	1.00	NCV	49 318.00	30.02	1 480.30	NO	1 480.30	0.98	5 319.20
		Liquid Biomass	TJ	1 616.00	NO	1 024.00		87.00	505.00	1.00	NCV	505.00	19.30	9.75	NO	9.75	1.00	35.74
		Gas Biomass	TJ	369.00	NO	NO		NO	369.00	1.00	NCV	369.00	14.62	5.40	NO	5.40	1.00	19.79

Table 2 Comparison of CO_2 emissions from fuel combustion (Table 1.C)

FUEL TYPES	REFERENCE APPROACH			SECTORAL APPROACH		DIFFERENCE	
	Apparent energy consumption (PJ)	Apparent energy consumption (excluding non-energy use and feedstocks) (4) (PJ)	CO_2 emissions (Gg)	Energy consumption (PJ)	CO_2 emissions (Gg)	Energy consumption (%)	CO_2 emissions (%)
Liquid Fuels (excluding international bunkers)	49,03	49,03	3 344,44	56,55	4 100.18	-13.30	-18.43
Solid Fuels (excluding international bunkers) (5)	4,46	4,46	410,76	4,55	420.91	-2.07	-2.41
Gaseous Fuels	61,31	61,31	3 403,83	61,00	3 371.99	0.50	0.94
Other	0,96	0,96	34,3	0,94	33.81	1.53	1.46
Total	***115,76***	***115,76***	***7193,32***	***123,05***	***7 926.89***	***-5.93***	***-9.25***

Table 3 Energobalance of Latvia in year 2010 (TJ)

	Oil products - total	Shale oil	LPG	Gasoline and aviation gasoline	Kerosene type jet fuel	Diesel oil	RFO	White spirit	Lubricants	Bitumen	Paraffin wax	Petroleum coke	Other liquid	Used oils	Coal	Peat	Peat briquettes	Coke	Natural gas	Fuelwood	Used tires	Municipal wastes	Charcoal	Bioethanol	Biodiesel	Landfill gas	Sludge gas	Straws
NCV	...	39,35	45,54	43,97	43,21	42,49	40,6	41,86	41,86	41,86	41,86	32,98	41,86	29,23	26,22	10,05	15,49	26,79	33,67	...	6,7	18,56	30	0,0268	0,0372	19,82	22,8	14,4
production of energy resources																100	0			72471	39320			398	1616	421	137	60
primary product receipts	66													66								334						
import	71660,7	78	5647	10996	5142	35266,7	8769	42	2177	2009	419	165	921	29	4719			80	37879	139	13	761	60	176	129			
export	11163,3		3598	616	173	5141,3		2	1633		0				52	60	1			22274	5394		300	320	1024			
bunkering	10524					2932	7592																					
interproduct transfer																												
stock changes	4071	-39	54	1452	-43	2167	-108		42	-42	42	462	84		-289	60	7	0	23434	1018	54	-19	30	96	87			
statistical differences	10469			835		9634																						
gross energy - total	64579,4	39	2103	12667	4926	38994,4	1069	40	586	1967	461	627	1005	95	4378	100	6	80	61313	51354	33993	1076	-210	350	808	421	137	60
Transformation sector	-771		-8			-31	-703							-29	-550	-10	-1		-39294	-7428	-1481		270		-8	-302	-137	-30
public heat plants	-531					-15	-487							-29	-26	-10			-6970	-4357	-335							
autoproducer heat plants	-37		-8			-16	-13								-131				-1044	-1805	-643							-29
public CHP	-203						-203								-393				-30842	-727					-8	-60	-137	
autoproducer CHP																			-438							-193		
autoproducer electricity plants																	-1			-36						-49		-1
charcoal production plants																				-503	-503		270					
Energy sector*	213					213										0			875									
Losses																60			269									
Final consumption:	63595	39	2095	12667	4926	38750	366	40	586	1967	461	627	1005	66	3828	30	5	80	20875	43926	32512	1076	60	350	800	119		30
transport:	49349		989	12315	4909	30550			586										1					350	787			
international air	4907				4907																							
domestic air	6			4	2																							
road	41248		989	12308		27449			502															350	752			
railways	2888					2804			84																35			
domestic navigation	300			3		297																						
pipelines																												
Industry (including construction)	6017	39	91	44		1359	326	40		1967	461	627	1005	58	1861	10	4	80	10167	9459	1020	1076	0		8			0
Other sectors:	8229		1015	308	17	6841	40		0					8	1967	20	1		10707	34467	31492		60		5	119		30
other consumers	1514		91	44	17	1317	37							8	892		1		4848	3230	2439				4	119		28
residential	2237		911	264		1062									1049	20			5219	30682	28964		60					2
agriculture / forestry / hunting	4053		13	0		4037	3		0						26				640	553	87				1			
fishery	425					425														2	2							

ANNEX 5: ASSESSMENT OF COMPLETENESS AND (POTENTIAL) SOURCES AND SINK OF GHG EMISSIONS AND REMOVALS EXCLUDED FOR THE ANNUAL INVENTORY SUBMISSION

Completeness of the Latvia's inventory 2010 is evaluated by sectors in the tables below. The completeness is estimated by the gases (CO2, CH4, N2O, F-gases, NMVOC) and emission categories according to the detailed CRF-classification.

Abbreviations used in tables:

X - included in the inventory
C - confidential business information
IE - included elsewhere
NA - not applicable
NE - not estimated
NO - not occurring in Latvia

Energy

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	Explanation, -if not estimated -if included elsewhere
Energy				
A. Fuel Combustion Activities				
1. Energy Industries				
a. Public Electricity and Heat Production	X	X	X	
b. Petroleum Refining	NO	NO	NO	
c. Manufacture of Solid Fuels and Other Energy Industries	X	X	X	
2. Manufacturing Industries and Construction				
a. Iron and Steel	X	X	X	
b. Non-Ferrous Metals	X	X	X	
c. Chemicals	X	X	X	
d. Pulp, Paper and Print	X	X	X	
e. Food Processing, Beverages and Tobacco	X	X	X	
f. Other *(as specified in table 1.A(a) sheet 2)*	X	X	X	
Other non-specified	X	X	X	
3. Transport				
a. Civil Aviation	X	X	X	
b. Road Transportation	X	X	X	
c. Railways	X	X	X	
d. Navigation	X	X	X	
e. Other Transportation *(as specified in table 1.A(a) sheet 3)*	NO	NO	NO	
Other non-specified	NO	NO	NO	
4. Other Sectors				
a. Commercial/Institutional	X	X	X	
b. Residential	X	X	X	
c. Agriculture/Forestry/Fisheries	X	X	X	
5. Other				
a. Stationary	NO	NO	NO	
Other non-specified	NO	NO	NO	
b. Mobile	X	X	X	
Other non-specified	X	X	X	

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	Explanation, -if not estimated -if included elsewhere
B. Fugitive Emissions from Fuels				
1. Solid Fuels				
a. Coal Mining and Handling	NO	NO	NO	
b. Solid Fuel Transformation	NO	NO	NO	
c. Other *(as specified in table 1.B.1)*	NO	NO	NO	
Other non-specified	NO	NO	NO	
2. Oil and Natural Gas				
a. Oil	NO	NO	NO	
b. Natural Gas	NO	X		
c. Venting and Flaring	NO	NO	NO	
Venting	NO	NO		
Flaring	NO	NO	NO	
d. Other *(as specified in table 1.B.2)*	NO	X	NO	
NOx and CO emissions from Natural Gas supply sytem	NO	IE	NO	Allocation per IPCC Guidelines: 1.B.2.B.4 Distribution. Allocation used by Parties: 1.B.2.B.4 Distribution. Comment: due to structure of CRF Reporter Software it is not possible to allocate NOx and CO emissions from Natural Gas distribution in sector its should be so these emissions are icluded here, but other emissions are included in right sector.
Underground storage	NO	X	NO	

Industrial Processes

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	Explanation, -if not estimated -if included elsewhere
Total Industrial Processes				
A. Mineral Products				
1. Cement Production	X			
2. Lime Production	X			
3. Limestone and Dolomite Use	X			
4. Soda Ash Production and Use	NO			
5. Asphalt Roofing	X			
6. Road Paving with Asphalt	X			
7. Other *(as specified in table 2(I).A-G)*	X			
Glass Production	NA	NA	NA	
cement production (NOx and NMVOC)	IE	IE	IE	Tis subsector is separate because software did not provide possibility to input NOx and NMVOC emissions from cement production processes to original 2.A.1 sub-sector
Production of Bricks	IE	IE	IE	The data for 1990-1992 is reported in the aggregated level in this sector, data for other years are reported for each bricks production plant separately.
Production of Bricks (plant 1)	X	NE	NE	Emissions are not estimated whereby lack of information about methodology and emission factors.
Production of Bricks (plant 2)	NO	NO	NO	
Production of Bricks (plant 3)	X	NE	NE	Emissions are not estimated whereby lack of information about methodology and emission factors.
Production of Bricks (plant 4)	X	NE	NE	Emissions are not estimated whereby lack of information about methodology and emission factors.
Production of Bricks (plant 5)	X	NE	NE	Emissions are not estimated whereby lack of information about methodology and emission factors.
Production of Glass (Use of fluorspar)	X	NE	NE	Emissions are not estimated whereby lack of information about methodology and emission factors.
Production of Glass (Use of potash)	NO	NE	NE	
Production of Glass Fibre	X	NE	NE	
Production of Tiles	X	NE	NE	Emissions are not estimated whereby lack of information about methodology and emission factors.
B. Chemical Industry				

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	Explanation, -if not estimated -if included elsewhere
1. Ammonia Production	NO	NO	NO	
2. Nitric Acid Production			NO	
3. Adipic Acid Production	NO		NO	
4. Carbide Production	NO	NO		
5. Other	NO	NO	NO	
Carbon Black		NO		
Ethylene	NO	NO	NO	
Dichloroethylene		NO		
Styrene		NO		
Methanol		NO		
C. Metal Production				
1. Iron and Steel Production	X	X		
2. Ferroalloys Production	NO	NO		
3. Aluminium Production	NO	NO		
4. SF_6 Used in Aluminium and Magnesium Foundries				
5. Other	NO	NO	NO	
Other non-specified	NO	NO	NO	
D. Other Production				
1. Pulp and Paper				
2. Food and Drink(2)	NA			
E. Production of Halocarbons and SF_6				
1. By-product Emissions				
Production of HCFC-22				
Other				
2. Fugitive Emissions				
3. Other *(as specified in table 2(II))*				
Other non-specified				
F. Consumption of Halocarbons and SF_6				
1. Refrigeration and Air Conditioning Equipment				
2. Foam Blowing				
3. Fire Extinguishers				
4. Aerosols/ Metered Dose Inhalers				
5. Solvents				
6. Other applications using ODS(3) substitutes				
7. Semiconductor Manufacture				
8. Electrical Equipment				
9. Other *(as specified in table 2(II)*				
Production of shoes				
G. Other				
Other non-specified	NA	NA	NA	

F-gases

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	HFC-23	HFC-32	HFC-41	HFC-43-10mee	HFC-125	HFC-134	HFC-134a	HFC-152a	HFC-143	HFC-143a	HFC-227ea	HFC-236fa	HFC-245ca	Total PFCs	SF_6	Explanation, -if not estimated -if included elsewhere
C. Metal Production																
Aluminium Production																
SF_6 Used in Aluminium Foundries															NO	
SF_6 Used in Magnesium Foundries															NO	
E. Production of Halocarbons and SF_6																
1. By-product Emissions	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Production of HCFC-22	NO															
Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
2. Fugitive Emissions	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
3. Other *(as specified in table 2(II).C,E)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Other non-specified	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
F(a). Consumption of Halocarbons and SF_6 (actual emissions - Tier 2)																
1. Refrigeration and Air Conditioning Equipment	X	X	NO	NO	X	NO	X	X	NO	X	NO	NO	NO	NO	NO	
2. Foam Blowing	NO	NO	NO	NO	NO	NO	X	X	NO	NO	NO	NO	NO	NO	NO	
3. Fire Extinguishers	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.01	NO	NO	NO	NO	
4. Aerosols/Metered Dose Inhalers	NO	NO	NO	NO	NO	NO	X	NO	NO	NO	NO	NO	NO	NO	NO	
5. Solvents	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
6. Other applications using ODS[(3)] substitutes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
7. Semiconductor Manufacture	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
8. Electrical Equipment															X	
9. Other *(as specified in table 2(II)F)*																
Production of shoes	NO	NO	NO	NO	NO	NO	X	NO	NO	NO	NO	NO	NO	NO	NO	
G. Other *(please specify)*																
Other non-specified	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
F(p). Total Potential Emissions of Halocarbons (by chemical) and SF_6 [(4)]																
Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Import:																
In bulk	NO	NO	NO	NO	NO	NO	X	NO	NO	NO	NO	NO	NO	NO	NE	Emissions are not possible to estimate because of lack of this kind statistical information
In products	NO	X	NO	NO	X	NO	X	X	NO	X	NO	NO	NO	NO	NE	Emissions are not possible to estimate because of lack of this kind statistical information
Export:																
In bulk	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
In products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
Destroyed amount	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	

Solvent and other product use

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	N_2O	NMVOC	Explanation, -if not estimated -if included elsewhere
Total Solvent and Other Product Use				
A. Paint Application	X		X	
B. Degreasing and Dry Cleaning	X	NO	X	
C. Chemical Products, Manufacture and Processing	X		X	
D. Other				
1. Use of N_2O for Anaesthesia		X		
2. N_2O from Fire Extinguishers		NE		No statistical data available
3. N_2O from Aerosol Cans		NE		No statistical data available
4. Other Use of N_2O		NE		No statistical data available
5. Other *(as specified in table 3.A-D)*				
Domestic solvent use	X	NO	X	
Glue manufacturing	X	NO	X	
Printing Industry	X	NO	X	

Agriculture

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CH_4	N_2O	Explanation, -if not estimated -if included elsewhere
Agriculture			
A. Enteric Fermentation			
1. Cattle [(1)]	X		
Option A:			
Dairy Cattle	X		
Non-Dairy Cattle	X		
2. Buffalo	NO		
3. Sheep	X		
4. Goats	X		
5. Camels and Llamas	NO		
6. Horses	X		
7. Mules and Asses	NO		
8. Swine	X		
9. Poultry	NO		
10. Other *(as specified in table 4.A)*	NO		
Other non-specified	NO		
B. Manure Management			
1. Cattle [(1)]	X		
Option A:			
Dairy Cattle	X		
Non-Dairy Cattle	X		
2. Buffalo	NO		
3. Sheep	X		
4. Goats	X		
5. Camels and Llamas	NO		
6. Horses	X		
7. Mules and Asses	NO		
8. Swine	X		

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CH_4	N_2O	Explanation, -if not estimated -if included elsewhere
9. Poultry	X		
10. Other livestock	NO		
Other non-specified	NO		
B. Manure Management (continued)			
11. Anaerobic Lagoons		NO	
12. Liquid Systems		X	
13. Solid Storage and Dry Lot		X	
14. Other AWMS		NO	
C. Rice Cultivation			
1. Irrigated	NO		
2. Rainfed	NO		
3. Deep Water	NO		
4. Other *(as specified in table 4.C)*	NO		
Other non-specified	NO		
D. Agricultural Soils			
1. Direct Soil Emissions	NA	X	
2. Pasture, Range and Paddock Manure (3)		X	
3. Indirect Emissions	NA	X	
4. Other *(as specified in table 4.D)*	NA	NA	
Other non-specified	NA	NA	
E. Prescribed Burning of Savannas	NA	NA	
F. Field Burning of Agricultural Residues			
1. Cereals	NO	NO	
2. Pulses	NO	NO	
3. Tubers and Roots	NO	NO	
4. Sugar Cane	NO	NO	
5. Other *(as specified in table 4.F)*	NO	NO	
Other non-specified	NO	NO	
G. Other			
Other non-specified	NO	NO	

LULUCF

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	Explanation, -if not estimated -if included elsewhere
Total Land-Use Categories				
A. Forest Land				
1. Forest Land remaining Forest Land	X	X	X	
2. Land converted to Forest Land	X	IE,NO	IE,NO	
B. Cropland				
1. Cropland remaining Cropland	X	NO	NO	
2. Land converted to Cropland	X	NO	NE/NO	
C. Grassland				
1. Grassland remaining Grassland	X	X	X	
2. Land converted to Grassland	IE/NO	NO	NO	
D. Wetlands				
1. Wetlands remaining Wetlands	X	IE/NO	IE/NO	
2. Land converted to Wetlands	NO	NE/NO	X	
E. Settlements				

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**Net CO_2 emissions/removals**	**CH_4**	**N_2O**	Explanation, -if not estimated -if included elsewhere
1. Settlements remaining Settlements [3]	NA	NE	NE	No data
2. Land converted to Settlements	X	NE	NE	No data
F. Other Land				
2. Land converted to Other Land	NO	NE	NE	No data
G. Other				
Harvested Wood Products	IE	IE	IE	HWP accounted under living biomass on forest land remaining forest as losses considering instant oxidation of all harvested biomass (above- and below-ground)
Other (please specify)	NA	NA	NA	
Information items				
Forest Land converted to other Land-Use Categories	NE	NE	NE	No data
Grassland converted to other Land-Use Categories	NE	NE	NE	No data

Waste

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**CO_2**	**CH_4**	**N_2O**	Explanation, -if not estimated -if included elsewhere
Waste				
A. Solid Waste Disposal on Land				
1. Managed Waste Disposal on Land	NO	X		
2. Unmanaged Waste Disposal Sites	NO	NO		
3. Other	NO	NO		
Other non-specified	NO	NO		
B. Waste Water Handling				
1. Industrial Wastewater		X	X	
2. Domestic and Commercial Waste Water		X	X	
3. Other *(as specified in table 6.B)*		NO	NO	
Other non-specified		NO	NO	
C. Waste Incineration	X	NO	NO	
D. Other *(please specify)*				
Compost production	NE	X	X	No methodology

ANNEX 6: THE ANNUAL INVENTORY SUBMISSION AND THE SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1, OF THE KYOTO PROTOCOL OR OTHER USEFUL REFERENCE INFORMATION

A.6.1: Annual inventory submission

Information on the QA/QC activities:

Example of check – list for waste sector

Waste:

Year of the inventory examined	2011
Category of sources	Solid Waste disposal 6.A
Evaluation prepared by	J.Fridmanis
Materials used	1. UNFCCC CRF Reporter 3.3.4 Latvia-2011-v.1.1. LEGMC, 2011; 2. Latvia's NIR (Draft version) under UNFCCC and the Kyoto Protocol Submission to the European Union. Common Reporting Formats (CRF) 1990 – 2009. LEGMC, 2011; 3. Revised 1996 IPCC Guidelines for National Greenhouse gas Inventories. 2007; 4. IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. 2000; 5. Emission calculations file: Atkr_SEG_emisijas_1990-2009_aktuals.xls. LEGMC, 2011. 6. 2006 IPCC Guidelines for National Greenhouse Gas inventories Excel calculation sheets, IPCC_waste_Model.xls, 2006, EEA; 7. F. 18 instrukcijasF_Atkritumusektors_01.2011.doc; 8. http://oas.vdc.lv:7779/la/atkr/red/mar$www_atkr.atkr_la .

Activity of QC	Procedures	Institution/person responsible for QC	Short description of the activity of QA (date/person/reference to document)	Conclusion regarding the examination	Necessary activities in order to improve the quality of inventory	Actions taken
1. Check that assumptions and criteria for the selection of activity data and emission factors are documented	Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/ [1,2,3,4,5,6]	The descriptions of activity data, emission factors and methodology used with information on source categories is recorded and archived in the internal documentation	DOC value is taken from different guidelines than other factors. It correct that is used latest available information. Use of 0.18 DOC value should be better explained in NIR. Instruction, calculation file and research (pdf file) are archived in LEGMC S:\ disk. Supplement chapter 8.2.2of NIR 2011.	It is done.
2. Check for transcription errors in data input and reference	Confirm that bibliographical data references are properly cited in the internal documentation	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/[1]	Activity data and emission factors are cited to references and documented in the Draft NIR 2011.	DOC value 0.18 needs better explanation in the NIR 2011. Supplement chapter 8.2.2of NIR 2011.	It is done.
	Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/[1,5]	No transaction errors from calculation file to CRF reporter	No needed activities.	
3. Check that emissions are calculated correctly	Reproduce a representative sample of emissions calculations	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/[1,5]	Calculations correct.	No needed activities.	
	Selectively mimic complex model calculations with	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/[1,5]	Accuracy ok.	No needed activities.	

Activity of QC	Procedures	Institution/person responsible for QC	Short description of the activity of QA (date/person/reference to document)	Conclusion regarding the examination	Necessary activities in order to improve the quality of inventory	Actions taken
	abbreviated calculations to judge relative accuracy					
4. Check that parameter and emission units are correctly recorded and that appropriate conversion factors are used	Check that units are properly labelled in calculation sheets	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/[5]	Units ok	No needed activities.	
	Check that units are correctly carried through from beginning to end of calculations	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/[5]	Units ok	No needed activities.	
	Check that conversion factors are correct	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/[1,5]	Factors ok	No needed activities.	
	Check that temporal and spatial adjustment factors are used correctly	-	-	-	-	
5. Check the integrity of database files	Confirm that the appropriate data processing steps are correctly represented in the database	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/[1,2,5,7]	Disposed amount used for calculation is different from data base [8]. Better explanation in NIR about disposed amount estimation is necessary.	Include additional explanation in the NIR Chapter 8.2.1	It is done.
	Confirm that data relationships are correctly represented in the database	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/[1,2]	Relationships are correctly represented	No needed activities.	
	Ensure that data fields are properly labelled and have the correct design specifications	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/	Data fields are properly labelled and have the correct design specifications	No needed activities.	
	Ensure that adequate documentation of database and model structure and operation are archived	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/[2]	No archived files for "3-waste" data base.	Explain in NIR 2011 about data base achieving. Supplement chapter about achieving.	It is done.
6. Check for consistency in data between source categories	Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/[1,5]	Parameters ok	No needed activities.	
7. Check that the movement of inventory data among processing steps is correct	Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/[1,5]	Aggregated ok. In CRF are correct summaries.	No needed activities.	
	Check that emissions data are correctly transcribed between different intermediate products	LEGMC / I.Cakars	21.01.2011./J.Fridmanis/[1,2]	Ok	No needed activities.	
8. Check that uncertainties in emissions and removals are estimated or calculated correctly	Check that qualifications of individuals providing expert judgement for uncertainty estimates are appropriate	LEGMC / I.Cakars	22.01.2011./J.Fridmanis/[1,2]	No documented uncertainty judgment 20%	For Data base "3-Waste" need to develop their quality system	Advice taken into account.
	Check that qualifications, assumptions and expert judgements are recorded. Check that calculated uncertainties are complete and calculated correctly	LEGMC / I.Cakars	22.01.2011./J.Fridmanis/[2]	Uncertainties choose from guidelines [3]. Expert judgment is all uncertainties assessment.	Commonly for GHG inventory must be prepared uncertainty estimation process.	Advice taken into account.

Activity of QC	Procedures	Institution/person responsible for QC	Short description of the activity of QA (date/person/reference to document)	Conclusion regarding the examination	Necessary activities in order to improve the quality of inventory	Actions taken
	If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses	LEGMC / I.Cakars	22.01.2011./J.Fridmanis/	Calculation O.K.	No need for duplicate calculations	-
9. Undertake review of internal documentation	Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates	LEGMC / I.Cakars	22.01.2011./J.Fridmanis/[1,2]	Calculation file includes the detailed internal documentation.	No needed activities.	
	Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review	LEGMC / I.Cakars	22.01.2011./J.Fridmanis [2, 7]	Inventory data, supporting data, and inventory records are archived and stored	No needed activities.	
	Check integrity of any data archiving arrangements of outside organisations involved in inventory preparation	LEGMC / I.Cakars	22.01.2011./J.Fridmanis/	Data from outside organisations archived	-	-
10. Check methodological and data changes resulting in recalculations	Check for temporal consistency in time series input data for each source category	LEGMC / I.Cakars	22.01.2011./J.Fridmanis/[1,2]	Emissions are consistent in time series	No needed activities.	
	Check for consistency in the algorithm/method used for calculations throughout the time series	LEGMC / I.Cakars	22.01.2011./J.Fridmanis/	Consistency is ensured-	Additional activities no needed	-
11. Undertake completeness checks	Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory	LEGMC / I.Cakars	22.01.2011./J.Fridmanis/[1]	The completeness test passed for all years.	No needed activities.	
	Check that known data gaps that result in incomplete source category emissions estimates are documented	LEGMC / I.Cakars	22.01.2011./J.Fridmanis/[1,5]	No data gaps for period 1990 – 2009.	No needed activities.	
12. Compare estimates to previous estimates	For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference	LEGMC / I.Cakars	22.01.2011./J.Fridmanis/	Comparison of current estimates with previous estimates is presented in NIR chapter 8.2.5	No needed activities.	

- **Detailed information about Improvement plan for LULUCF sector**

IMPROVEMENT PLAN TO DEVELOP AND VERIFY METHODOLOGIES OF CALCULATIONS OF GHG EMISSIONS AND CO_2 REMOVALS IN LULUCF SECTOR

By Latvian State Forestry Research Institute "Silava" (LSFRI Silava)

BACKGROUND INFORMATION

The improvement plan to develop and to scientifically verify methodologies and implied emission factors for the National GHG inventory in the LULUCF sector was elaborated in 2009-2010 by the LSFRI Silava in cooperation with invited experts from Latvia University of Agriculture, Ministry of Agriculture of Republic of Latvia and Tartu University of Life Sciences as a project application "National greenhouse gas inventory supporting studies" for the European Regional Development Fund supported research and development program[194] managed by the Ministry of Education and Science of Republic of Latvia.

The application was submitted to the Ministry of Education and Science of Republic of Latvia in 9th of March, 2010. Evaluation of the project applications will be completed latest in September, 2010. In case in the application will receive funding from the European Regional Development fund, practical work will be started in October, 2010 and continued until the end of November, 2013 when all methodologies should be verified, published in scientific articles, presented in the greenhouse gas (GHG) inventory in Land Use, Land Use Change and Forestry (LULUCF) sector dedicated international conference and incorporated into the National GHG inventory.

PROJECT SUMMARY

The overall target of the project is to fulfil Latvia's international obligations within the frame of the United Nations Framework Convention on Climate Change and to create preconditions for the inclusion of CO_2 removals through forestry practices and wood processing in the emission trading scheme.

The specific target of the project is to develop a methodological basis for the preparation of national greenhouse gas emission and removals inventory report. This methodological basis should fit to requirements of the Good Practice Guidelines in the sector of Land Use, Land Use Change and Forestry by the Intergovernmental Panel on Climate Change.

The project corresponds to the priority field of science – sustainable use of local resources (earth entrails, forest, food and transport) – new products and technologies.

According to the paragraph 3.1 of the regulation Nr. 752 (07.07.2009) of the Cabinet of Ministers, the project complies with the following criteria:

1. project is implemented by a scientific institution which, accordingly to its statute, performs scientific activities and dissemination of the results of scientific activities transferring knowledge and technologies; the payments obtained while implementing basic activities are repeatedly invested in the basic activities;

[194] http://translate.google.com/translate?js=y&prev=_t&hl=en&ie=UTF-8&layout=1&eotf=1&u=http%3A%2F%2Fesfondi.izm.gov.lv%2F1060.html&sl=lv&tl=en (original in Latvian - http://esfondi.izm.gov.lv/1060.html)

2. businessmen who can influence the scientific institution , have no privilege on the capacity of the research or results of the research;
3. public accessibility of the results of research will be ensured in the frames of the project.

To achieve the goals following activities are planned in the project:

1. Research & development;
   - 1.1. Definitions and other normative regulations,
   - 1.2. Land use balance,
   - 1.3. Biomass and carbon removals of trees;
   - 1.4. Emissions related to deadwood,
   - 1.5. Emissions related to soil and litter,
   - 1.6. Emissions related to forest damage,
   - 1.7. The integration of the methodology for greenhouse gas inventory in the National forest inventory.
2. Ensuring of the public accessibility of research results.

Place of implementation of the project – LSFRI Silava.

Planned total length of project implementation – 36 months.

JUSTIFICATION OF THE PROBLEMS ADDRESSED IN PROJECT

Latvia has undertaken the fulfilment of international obligations in the prevention of climate change by signing the United Nations Framework Convention on Climate Change in 1992 and ratifying it in 1995. The aim of the Convention is to decrease the concentration of greenhouse gases (GHG) in the atmosphere down to the level that would prevent dangerous anthropogenic interference to the climatic system. According to the Kyoto protocol of the Convention, in the period from 2008 to 2012 Latvia together with other countries must decrease anthropogenic GHG emissions by 8% compared to 1990. According to the Convention, the member states every year submit annual GHG inventory report, as well as prepare national reports that reflect the relevance of accomplished and planned tasks. According to the regulation No. 157 (17.02.2009) of the Cabinet of Ministers, the preparation of GHG inventory report in the LULUCF sector is carried out by LSFRI Silava.

One of the mechanisms mentioned in the Kyoto protocol to reduce GHG emissions is international emission trade. Starting from 2008, also sector of land use, land use change and forestry is included in this scheme, and at the end of the reference period (2012) Latvia will be able to apply for additional 6,23 mill. tons of CO_2 quotas. However, to be able to use these quotas, the national system of GHG inventory must correspond with the quality requirements stated in the Good Practice Guidelines in the sector of Land Use, Land Use Change and Forestry by the Intergovernmental Panel on Climate Change (IPCC GPG LULUCF) and must be scientifically verified. In case the requirements of IPCC are not met, Latvia can be excluded from the emission trading scheme and lose potential income connected with the reduction of GHG emissions in the industry and other sectors.

The main problems connected with GHG emission and removals inventory in the LULUCF sector are incomplete methodological basis for the inventory of alive and dead biomass, soil and litter CO_2 removals and GHG emissions, as well as incomplete land use balance inventory system that lacks accurate geographical information on the historical dynamics of different land use types.

These problems have to be solved by the end of 2012 when Latvia must submit a final report in the frames of Kyoto protocol. If Latvia fails to put into practice appropriate inventory and calculations of GHG emissions and CO_2 removals in the LULUCF sector, the state can lose emission quotas in this sector (6,23 mill. tons of CO_2 equivalent in the time period from 2008 to 2012) but in the worst case the country can be excluded from the emission trading scheme until methodological issues are solved.

The cause for shortcomings in the LULUCF sector inventory system are the changes in the policy of climate change and forestry, creating new mechanisms for the development of these sectors but also setting new tasks to verify the effectiveness of the use of these mechanisms. Similar problems of the LULUCF sector are presently solved in all developed countries of the world.

There are no viable alternatives for the implementation of the goals stated in the project because, according to the guidelines (IPCC GPG LULUCF), every developed country is obliged to produce an individual methodology for the inventory of most important sources of emissions and removals in the LULUCF sector. Alternative solution is the secession from the Kyoto protocol, however, in this case the gain, giving up science development, cannot be compared to the losses that would be created by exclusion from the emission trading scheme. Only in the LULUCF sector the losses during the next 5 years would be around 124 mill. EUR, recalculating to the present prices of emission quotas.

References:

- Edited by Penman J., Gytarsky M., Hiraishi T., Krug T., Kruger D., Pipatti R., Buendia L., Miwa K., Ngara T., Tanabe K., Wagner F., *Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC GPG LULUCF)*, 2003;
- Latvian Environment, Geology & Meteorology Agency, *Latvia's national inventory report Submitted under United Nations Convention on Climate Change*, 2009;
- United Nations, *15/CMP.1 Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol*, 2006;
- United Nations, Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1998.

Description of solutions proposed in the project

Within the scope of the project in collaboration with the leading experts of the LULUCF sector in the Nordic countries and the Baltic states the methodology of GHG emissions and removals inventory will be developed and integrated in the existing inventory systems, including:

1. The matrix of land use balance analysis, as well as the model for the calculation of CO_2 removals in alive and dead biomass (*dieback of living trees and logging residues*) will be integrated in the National forest inventory (NFI) program;
2. The calculations of GHG emissions and CO_2 removals in soils with the organic horizon not thicker than 80 cm and in forest litter will be linked with Level I forest monitoring program;
3. The inventory of GHG emissions created by forest felling and CO_2 removals in wood products will be linked with Forest fund data base maintained by State Forest service;
4. The assessment of damages, as well as analysis of GHG emissions and CO_2 removals in organic soils with the organic horizon above 80 cm will be carried out based on the data from long-term research.

According to the regulation No 590 (28.08.2007) and No 313 (07.04.2009) of the Cabinet of Ministers, NFI and Level I forest monitoring in the frames of international project FutMon are carried out by LSFRI "Silava".

Taking into account the structure of GHG inventory and specific character of problems to be solved, following research activities are outlined in the project:

1. Development of definitions and other normative regulations to ensure the integrity of land use balance and emission data.
2. Updating of the land use balance starting from year 1990 and defining territories corresponding with points 3.3 and 3.4 of the Kyoto protocol, as well as lands where no economic activities are carried out.
3. Analysis of the biomass and carbon removals of trees, including development of species- and land use type-specific equations for above- and below-ground biomass, as well as coefficients for the recalculation of carbon content.
4. Emissions related to deadwood, including deadwood in the growing forest, wood products, logging residues and their use (including burning), and analysis of the decomposition of tree root system.
5. Emissions and removals related to soil and litter, including the development of method for the inventory of soil and litter emissions and removals and integration of this method in the existing modelling instruments (*Yasso*) for the prognosis of the impact of different activities (melioration, logging, land use change).
6. Emissions related to forest damage, including forest fires, animal damage and wind damage.
7. The integration of GHG inventory methodology in the NFI and forest management planning models for the preparation of short and long term prognoses and forest policy planning.

The main result of all project activities will be articles in the international peer reviewed journals, serving as the instrument for scientific verification of the GHG inventory methodology. Altogether it is planned to prepare 9 scientific articles.

In addition, during the project implementation, public accessibility of scientific results will be ensured via project home page and regular (twice a year) press releases. In the final stage of the project an international scientific conference will be organized, where the developed methodology will be presented and discussed. The conference materials will be summarized in proceedings with international editorial board. The language of the proceedings will be English.

DESCRIPTION OF PLANNED ACTIVITIES

Within the scope of the project it is planned to carry out an industrial research in forest science that includes evaluation and broadening of available knowledge related to the GHG inventory in the LULUCF sector, in order to develop a methodology necessary for the preparation of national GHG inventory report and sustainability analysis of land use and timber industry. The implementation of the project will ensure the return of financial resources gained by emission trade to the forest sector through activities promoting sustainable forestry and use of wood products. The project is directed towards significant improvement of existing technologies (inventory methodology). There will be following research activities in the project:

1. Development of definitions and other normative regulations to ensure integrity of land use balance and removals data. The main task of the activity is to use unified nomenclature of land use types in the territory of Latvia, that would include classification principles used in several, also international data bases. It is planned to finish this activity within 3 months from the start of the project.
2. Update of land use balance starting from 1990 and defining territories that correspond to the points 3.3 and 3.4 of the Kyoto protocol, as well as lands where no economic activity is carried out. The main task of the activity is, based on the definitions developed in the 1st scientific activity, to identify the change of land use type in all NFI sample plots including those outside forest land starting from 1990. The change of land use type will be identified analysing series of LANDSAT satellite images and identifying the year of transformation for every sample plot.
3. Analysis of tree biomass and carbon removals is the most extensive scientific activity including development of species- and land use type-specific tree above- and below-ground biomass equations and carbon concentration recalculation coefficients. Original biomass and carbon recalculation equations will be developed for the main tree species (pine (*Pinus sylvestris* L.), spruce (*Picea abies* (L.) H.Karst.), birch (*Betula pendula* Roth and *Betula pubescens* Ehrh.), aspen (*Populus tremula* L.), black alder (*Alnus glutinosa* L.), grey alder (*Alnus incana* (L.) MEPRDnch), ash (*Fraxinus excelsior* L.) and oak (*Quercus robur* L.)) using tree height and breast height diameter as factorial features. To simplify the task the development of equations for conifers and birch will be based on equations used in the GHG inventory in Finland. For less common tree and shrub species contributing only to a small part of GHG balance in the forest lands unified recalculation equations will be developed, based on experimental and literature data. For each tree species several sets of equations will be developed, according to the definitions of 1st scientific activity.
4. Emissions related to deadwood include the dieback of living trees in growing forest and wood products originating from forest felling (timber, biofuel, logging residues and tree below-ground biomass). A significant part of GHG emissions is formed burning the logging residues immediately after logging, therefore a method to estimate an actual amount of this part of emissions will be developed, expanding NFI observations in the forest stands felled in the current year. Within the frames of this activity also a monitoring method for the amount of biofuel production will be developed, based on the NFI grid and additional observations in stands to be felled. In the analysis of removals and emissions from wood products SCAD (*Stock Change Approach on Domestically produced and consumed wood*) method will be used. The amount of dieback of volume increment will be determined using research results obtained in Tartu, Estonian University of Life Sciences. In this task expert from Estonian University of Life Sciences, Ph.D. Kajar Köster will take part.
5. The activity related to emissions and removals in the soil and litter includes the development of method for inventory of CO_2 removals and GHG emissions from soil and litter, as well as integration of this method in the existing modelling instruments (*Yasso*) for the prognosis of the impact of economic activities (melioration, forest felling, land use type change). The activity is divided into two parts according to the thickness of peat layer – (1) mineral soils and shallow organic soils (thickness of organic layer less than 80 cm) and (2) organic soils with thick organic layer. In the first group the methodology of GHG emissions and CO_2 inventory will be based on the grid of long-term monitoring sample plots including forest lands, arable lands and grasslands. For the second group of soils recalculation equations will be developed based on long-term observations in forest and non-forest land.
6. Emissions related to forest damage, including forest fires, animal and wind damage. In this activity data from NFI, State forest service, scientific research, and other sources of information and GIS technologies will be integrated in order to develop a calculation model for the biomass burned in the forest fires. The calculation model of other damage (wind and animals) will be based on NFI data. To prevent double record of emissions researchers of this activity will closely collaborate with researchers from 5th activity.
7. Integration of GHG inventory methodology in the NFI and forest management planning models will be carried out gradually during all project progress. The activity can be finished only after work with biomass and carbon recalculation equations will be over. This activity includes also development of

instructions for field work and calculations and methodology of data validation. The integration of new models in the NFI data base will be carried out so, that also processing of previously obtained data will be possible.

QUANTITATIVE INDICATORS OF THE PROJECT'S RESULTS

The main outputs of the project will be set of scientific publications targeted to be a basis for the GHG inventory in LULUCF sector. The proposed methodologies will be verified and applied practically in the future inventories during the implementation of the project. The methodologies will be introduced into the inventory as soon as they will be elaborated and verified, therefore future inventories will be considerably updated. All methodologies should be ready for use before completion of the National inventory report in 2014.

Quantitative indicators of the project are provided in Table 1, comparison with currently utilized methodologies – in Table 2, the project time schedule – in Table 3.

Table 1 Quantitative indicators

No. of activity	Title of activity	Result	Results in measurable units	
			Count	Measurement unit
1.	Research			
1.1	Definitions and other normative regulations	Instruction for the identification of land use and management types	1	instruction
1.2	Land use balance	Methodology for the calculation of land use balance	1	methodology
		Land use change matrix since 1990 with geographically identifiable territorial units	1	report, integrated in the GHG inventory report
1.3	Biomass and carbon removals of trees	Methodology for the calculation of tree biomass and carbon removals	1	methodology
		Recalculation of CO_2 removals in live biomass since 1990	1	report, integrated in the GHG inventory report
1.4	Emissions related to deadwood	Methodology for the calculation of the increase of dead biomass	1	methodology
		Methodology for the emission calculations related to forest felling and wood products	1	methodology
		Methodology for monitoring of burning logging residues and calculation of emissions	1	methodology
		Recalculation of GHG emissions related to deadwood since 1990	1	report, integrated in the GHG inventory report
1.5	Emissions and removals related to soil and litter	Methodology for CO_2 removals and GHG emission calculations in forest litter, mineral soils and shallow organic soils	1	methodology
		Methodology for GHG emission calculations in drained organic soils with thick organic layer	1	methodology
		Recalculation of GHG emissions and CO_2 removals related to soil and litter since 1990	1	report, integrated in the GHG inventory report
1.6	Emissions related to forest damages	Methodology for the evaluation of GHG emissions due to the forest fires	1	methodology
		Methodology for the evaluation of GHG emissions due to last year's grass fires	1	methodology
		Recalculation of GHG emissions related to forest fires and last year's grass fires since 1990	1	report, integrated in the GHG inventory report

No. of activity	Title of activity	Result	Results in measurable units	
			Count	Measurement unit
1.7	The integration of the methodology for GHG inventory in the NFI	Methodologies developed during the research activities and necessary additional information integrated and verified in the NFI system	1	calculation model
		Instruction for the fieldwork and calculations in NFI	1	instruction
2	Ensuring of the public accessibility of research results	The results of the research activities published in international peer-reviewed journals	9	Internationally acknowledged publications
		An international conference related to questions of GHG inventory in the LULUCF sector is organized	1	scientific conference
		Chapters in the doctoral degree works	3	doctoral degree studies

Table 2 Comparison of currently applied and proposed approaches in GHG inventory of the LULUCF sector

Project activity	Solutions used currently	Solutions proposed by the project
Definitions and other normative regulations	Land use definitions are only partly compatible with definitions given in the IPCC GPG LULUCF 2003. Economic activities in the forest lands are not stated, as well as prerequisites for the land use change.	Land use definitions given by IPCC GPG LULUCF 2003 will be improved according to the local conditions and integrated in the NFI methodology. Economic activities on forest land and non-forest land corresponding to the points 3.3 and 3.4 of the Kyoto protocol will be identified.
Land use balance	Data provided by State Land service about the area of agricultural lands, forest lands, wetlands, infrastructure and other lands corrected by the NFI data about forest lands. The system does not ensure that land use change is geographically identifiable outside forest lands.	Land use balance will be included in the NFI, recalculating the land use every year, according to the data of exact measurements. Land use change will be geographically identifiable. Land use balance calculation will also allow identifying the area of organic agriculture lands in Latvia.
Biomass and carbon removals in living trees	To recalculate removals in the tree biomass coefficients corresponding to the lowest quality level (*Tier1*) are used (coefficient to recalculate stem volume into above-ground biomass – 1.3, coefficient to recalculate above-ground biomass into below-ground biomass – 1.32, wood density – 0.5, carbon concentration in biomass – 50%.)	Species- and land use type-specific equations for the recalculation of carbon removals will be developed, using measured tree height and diameter data. These equations will be scientifically verified and suitable for local conditions.
Stock change of dead biomass	Is not considered at all due to the lack of appropriate method.	Will be evaluated, using data from NFI and former research, recalculation starting from 1990 will be performed, based on changes in stand age structure and species composition.

Project activity	Solutions used currently	Solutions proposed by the project
Emissions related to forest felling	To calculate CO_2 emissions from the felled volume, coefficients corresponding to *Tier1* are used. Emissions are calculated using the method of "direct oxidation", assuming that all biomass (stem, logging residues, and roots) turns to emissions immediately after felling.	GHG emissions will be calculated using equations for the increment of live tree biomass. The decomposition rate of logging residues and tree root systems, as well as life length of wood materials will be taken into account, giving up the method of "direct oxidation".
Burning of logging residues	It is assumed that 30% of the logging residues are left for burning, thus significantly overestimating actual GHG emissions that are related to the forest felling.	For the inventory of further use (including burning) of logging residues a new monitoring system based on the NFI data and remote sensing, will be used. The results will be statistically credible and geographically identifiable.
Emissions and removals related to the soil and litter	CO_2 emission calculations are carried out only for drained organic soils using *Tier1* coefficients corresponding to the temperate zone. Thus emissions related to soil are significantly overestimated.	CO_2 removals and GHG emissions from the mineral soils and shallow organic soils will be evaluated using Level I forest monitoring sample plots. GHG emissions from organic soils with organic layer thicker than 80 cm will be calculated using data from long-term scientific research.
Emissions related to forest damage	Only emissions related to forest fires are evaluated, using equations that are not verified in the local conditions.	GHG emissions from forest and last year's grass fires will be calculated using data about types and areas of fires provided by State Fire and Rescue service and State Forest service, as well as scientifically verified equations. GHG emissions related to wind and other damage will be calculated using NFI data.
Integration of inventory of GHG emissions and CO_2 removal methodology into the NFI	Calculations are not connected to NFI observations.	In the frames of the project the methodology will be integrated in the NFI field work and calculation system, securing transparency of data gathering and calculations, as well as continuity of the process.

Table 3 Time schedule of the project

No. and title of research activity	**Schedule of implementation of the project's activities**																			
	2009				**2010**				**2011**				**2012**				**2013**			
	1.	**2.**	**3.**	**4.**	**1.**	**2.**	**3.**	**4.**	**1.**	**2.**	**3.**	**4.**	**1.**	**2.**	**3.**	**4.**	**1.**	**2.**	**3.**	**4.**
1.1. Definitions and other normative regulations								X												
1.2 Land use balance									X	X	X	X								
1.3 Biomass and carbon removals in living trees									X	X	X	X	X	X	X	X				
1.4 Carbon stock change of dead biomass									X	X	X	X	X	X	X	X				
1.5 Emissions and removals related to soil and litter								X	X	X	X	X	X	X	X	X	X	X	X	
1.6 Emissions related to forest damage												X	X	X						
1.7 The integration of the methodology for GHG inventory in the NFI													X	X	X	X	X	X	X	
2. Dissemination								X	X	X	X	X	X	X	X	X	X	X	X	

A.6.2: Emission trends

CO_2

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	Change from base to latest reported year
	(Gg)																					%
1. Energy	**18 408.26**	**16 897.00**	**13 701.25**	**11 611.28**	**10 041.92**	**8 840.90**	**8 914.15**	**8 380.88**	**7 996.34**	**7 374.24**	**6 852.76**	**7 193.79**	**7 173.97**	**7 360.99**	**7 378.68**	**7 494.90**	**7 931.02**	**8 263.26**	**7 852.57**	**7 113.99**	**7 921.30**	**-56.97**
A. Fuel Combustion (Sectoral Approach)	18 408.26	16 897.00	13 701.25	11 611.28	10 041.92	8 840.90	8 914.15	8 380.88	7 996.34	7 374.24	6 852.76	7 193.79	7 173.97	7 360.99	7 378.68	7 494.90	7 931.02	8 263.26	7 852.57	7 113.99	7 921.30	-56.97
1. Energy Industries	6 267.55	5 747.49	4 923.30	3 969.77	3 731.92	3 417.93	3 549.52	3 305.68	3 349.94	2 924.94	2 475.88	2 419.40	2 314.59	2 245.97	2 057.19	2 047.52	2 073.32	1 943.80	1 916.58	1 865.05	2 247.61	-64.14
2. Manufacturing Industries and Construction	3 742.44	2 804.05	2 368.39	2 097.89	1 899.68	1 866.44	1 826.92	1 780.98	1 559.86	1 421.61	1 224.75	1 089.18	1 121.43	1 128.33	1 140.18	1 163.75	1 204.86	1 223.07	1 124.20	881.77	1 063.25	-71.59
3. Transport	2 894.56	2 710.99	2 416.66	2 226.88	2 112.19	2 011.12	1 977.80	1 969.59	1 945.33	1 899.29	2 108.98	2 498.71	2 577.24	2 721.19	2 859.96	2 986.16	3 293.46	3 729.83	3 523.52	3 091.46	3 167.77	9.44
4. Other Sectors	5 503.71	5 634.46	3 992.90	3 316.74	2 298.12	1 539.28	1 556.67	1 312.29	1 137.95	1 119.07	1 043.00	1 186.34	1 153.95	1 259.18	1 309.88	1 289.87	1 350.50	1 363.72	1 284.88	1 273.45	1 441.48	-73.81
5. Other	NO	NO	NO	NO	NO	6.12	3.25	12.34	3.25	9.33	0.14	0.17	6.76	6.33	11.47	7.60	8.87	2.83	3.39	2.27	1.20	100.00
B. Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Industrial Processes	**598.81**	**536.03**	**256.62**	**83.64**	**146.69**	**159.29**	**175.11**	**180.64**	**181.24**	**218.45**	**172.95**	**197.68**	**210.40**	**227.09**	**366.32**	**250.23**	**278.23**	**296.79**	**288.75**	**251.57**	**521.27**	**-12.95**
A. Mineral Products	585.98	527.32	250.88	76.63	140.14	154.86	171.63	172.64	172.74	210.74	164.52	189.63	202.80	214.92	353.40	237.87	265.66	282.22	280.01	242.00	509.99	-12.97
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Metal Production	12.83	8.71	5.73	7.01	6.55	4.43	3.49	8.00	8.50	7.71	8.43	8.04	7.60	12.16	12.92	12.36	12.57	14.57	8.73	9.56	11.28	-12.09
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Solvent and Other Product Use	50.70	46.49	44.20	41.35	40.51	36.96	38.53	39.12	40.00	40.76	41.62	42.46	30.77	23.72	30.03	33.00	44.13	60.69	39.63	23.03	37.30	-26.44
5. Land Use, Land-Use Change and Forestry(2)	**-16 249.79**	**-17 885.19**	**-18 999.06**	**-18 589.77**	**-17 896.52**	**-17 179.05**	**-18 169.82**	**-15 573.35**	**-14 521.89**	**-14 002.46**	**-14 728.89**	**-15 008.83**	**-14 015.54**	**-15 491.58**	**-16 629.97**	**-17 576.23**	**-20 678.53**	**-22 086.60**	**-23 129.45**	**-20 785.70**	**-17 335.86**	**6.68**
A. Forest Land	-16 924.86	-18 583.82	-19 721.36	-19 335.58	-18 666.00	-17 972.85	-18 848.08	-16 256.24	-15 214.82	-14 705.95	-15 441.95	-15 762.97	-14 805.01	-16 304.26	-17 415.17	-18 362.45	-21 516.14	-22 897.38	-23 941.80	-21 557.46	-18 066.58	6.75
B. Cropland	553.08	572.15	591.25	610.28	629.38	648.49	540.02	542.19	547.26	551.68	558.34	547.16	564.37	576.57	556.87	560.36	563.24	569.67	570.61	517.23	473.33	-14.42
C. Grassland	40.15	41.34	42.64	43.86	45.17	47.08	49.35	49.22	51.57	55.12	55.44	60.91	74.12	80.17	67.43	60.06	103.62	65.40	61.12	67.90	64.27	60.07
D. Wetlands	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	0.00
E. Settlements	62.04	65.34	68.60	71.87	75.13	78.43	69.08	71.68	74.29	76.89	79.49	126.28	131.19	136.14	141.09	146.01	150.96	155.91	160.82	166.83	173.32	179.37
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
G. Other	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0.00
6. Waste	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**0.74**	**1.18**	**2.34**	**0.30**	**0.37**	**0.44**	**0.44**	**1.51**	**1.18**	**0.50**	**0.34**	**0.34**	**100.00**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
C. Waste Incineration	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.74	1.18	2.34	0.30	0.37	0.44	0.44	1.51	1.18	0.50	0.34	0.34	100.00

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	Change from base to latest reported year
	(Gg)																					%
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
7. Other (as specified in Summary 1.A)	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.00**
Total CO2 emissions including net CO2 from LULUCF	**2 807.98**	**-405.68**	**-4 997.00**	**-6 853.51**	**-7 667.40**	**-8 141.90**	**-9 042.02**	**-6 972.70**	**-6 304.32**	**-6 368.27**	**-7 660.38**	**-7 572.56**	**-6 600.09**	**-7 879.41**	**-8 854.51**	**-9 797.67**	**-12 423.65**	**-13 464.68**	**-14 948.00**	**-13 396.77**	**-8 855.64**	**-415.37**
Total CO2 emissions excluding net CO2 from LULUCF	**19 057.77**	**17 479.52**	**14 002.07**	**11 736.26**	**10 229.12**	**9 037.15**	**9 127.80**	**8 600.64**	**8 217.57**	**7 634.19**	**7 068.51**	**7 436.27**	**7 415.44**	**7 612.16**	**7 775.47**	**7 778.56**	**8 254.89**	**8 621.92**	**8 181.45**	**7 388.93**	**8 480.21**	**-55.50**
Memo Items:																						
International Bunkers	**1 721.08**	**747.50**	**653.73**	**756.98**	**963.50**	**554.58**	**408.31**	**324.27**	**137.42**	**121.77**	**106.14**	**697.07**	**733.88**	**714.90**	**788.19**	**1 003.69**	**825.81**	**810.74**	**950.79**	**1 181.67**	**1 156.28**	**-32.82**
Aviation	221.15	299.01	84.10	84.10	77.87	77.87	99.67	99.67	90.33	90.33	80.98	80.98	84.10	121.50	148.08	179.57	201.59	245.82	296.15	311.90	357.76	61.78
Marine	1 499.94	448.49	569.64	672.88	885.63	476.72	308.64	224.60	47.10	31.44	25.15	616.09	649.79	593.40	640.11	824.12	624.22	564.93	654.64	869.77	798.52	-46.76
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO2 Emissions from Biomass	2 964.03	3 476.19	3 466.38	3 862.35	4 002.69	4 538.71	4 744.63	4 755.57	4 693.52	4 608.23	4 280.62	4 800.70	4 772.91	5 073.47	5 349.02	5 353.07	5 388.71	5 273.80	4 992.61	5 713.59	5 657.65	90.88

CH_4

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	Change from base to latest reported year
	(Gg)																					%
1. Energy	25.57	26.46	24.07	24.19	23.79	23.96	23.95	22.57	21.31	20.61	19.28	20.21	20.25	19.04	19.32	20.03	17.78	17.86	17.04	17.85	16.99	-33.55
A. Fuel Combustion (Sectoral Approach)	12.52	13.89	12.61	13.23	13.08	13.53	13.90	13.19	12.31	12.02	11.34	12.51	12.22	12.76	13.11	13.09	12.75	12.70	11.74	12.84	12.16	-2.85
1. Energy Industries	0.27	0.26	0.25	0.24	0.24	0.23	0.25	0.29	0.28	0.23	0.22	0.21	0.22	0.23	0.21	0.18	0.20	0.19	0.19	0.19	0.21	-23.39
2. Manufacturing Industries and Construction	0.26	0.19	0.17	0.18	0.17	0.17	0.18	0.17	0.18	0.17	0.16	0.20	0.19	0.19	0.23	0.26	0.29	0.27	0.28	0.33	0.40	53.82
3. Transport	0.78	0.72	0.69	0.67	0.63	0.58	0.55	0.52	0.49	0.47	0.49	0.54	0.50	0.48	0.45	0.39	0.37	0.34	0.28	0.22	0.21	-73.23
4. Other Sectors	11.20	12.71	11.50	12.15	12.04	12.56	12.92	12.22	11.36	11.15	10.47	11.55	11.31	11.87	12.22	12.25	11.89	11.90	10.99	12.09	11.34	1.24
5. Other	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
B. Fugitive Emissions from Fuels	13.05	12.57	11.46	10.96	10.71	10.43	10.05	9.38	9.00	8.58	7.94	7.70	8.03	6.28	6.21	6.94	5.04	5.16	5.30	5.02	4.83	-62.99
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and Natural Gas	13.05	12.57	11.46	10.96	10.71	10.43	10.05	9.38	9.00	8.58	7.94	7.70	8.03	6.28	6.21	6.94	5.04	5.16	5.30	5.02	4.83	-62.99
2. Industrial Processes	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-2.67**
A. Mineral Products	NA,NE,NO	NA,NE,NO	NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	0.00
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00

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	Change from base to latest reported year
	(Gg)																					%
C. Metal Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.67
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Solvent and Other Product Use																						
4. Agriculture	**115.32**	**109.93**	**89.57**	**55.58**	**47.49**	**46.62**	**44.15**	**43.34**	**40.09**	**34.90**	**34.55**	**36.51**	**36.34**	**35.49**	**35.09**	**36.25**	**36.09**	**37.72**	**36.44**	**36.23**	**36.59**	**-68.27**
A. Enteric Fermentation	102.29	97.81	80.50	50.18	42.57	41.51	39.55	38.94	35.94	31.10	30.89	32.51	32.27	31.46	31.07	32.10	31.75	33.21	32.04	31.79	32.01	-68.71
B. Manure Management	13.04	12.12	9.07	5.40	4.92	5.11	4.59	4.41	4.15	3.79	3.66	4.01	4.07	4.03	4.03	4.15	4.34	4.52	4.40	4.44	4.58	-64.88
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Land Use, Land-Use Change and Forestry	**0.92**	**1.07**	**1.80**	**1.21**	**1.39**	**1.72**	**1.73**	**2.21**	**2.46**	**2.77**	**2.80**	**1.57**	**1.90**	**1.80**	**1.63**	**1.66**	**1.82**	**1.49**	**1.34**	**1.63**	**1.93**	**108.72**
A. Forest Land	0.92	1.07	1.80	1.21	1.39	1.72	1.73	2.21	2.45	2.76	2.80	1.56	1.88	1.76	1.61	1.65	1.76	1.48	1.34	1.62	1.92	108.07
B. Cropland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Grassland	IE,NO	IE,NO	IE,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.03	0.03	0.02	0.01	0.06	0.01	0.00	0.01	0.01	100.00
D. Wetlands	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	0.00
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
G. Other	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0.00
6. Waste	**35.00**	**34.70**	**30.94**	**27.71**	**26.23**	**26.02**	**26.03**	**26.52**	**27.08**	**27.36**	**29.83**	**31.18**	**31.11**	**29.52**	**30.51**	**30.32**	**27.96**	**28.56**	**31.78**	**30.54**	**29.07**	**-16.94**
A. Solid Waste Disposal on Land	15.71	16.29	16.76	17.13	17.40	17.57	17.78	18.05	18.37	18.74	19.15	19.62	19.51	17.88	17.09	17.63	18.38	19.36	20.16	20.35	20.73	31.93
B. Waste-water Handling	19.28	18.41	14.18	10.58	8.84	8.45	8.25	8.47	8.72	8.62	10.68	11.57	11.60	11.63	13.39	12.66	9.53	9.17	11.58	10.14	8.26	-57.15
C. Waste Incineration	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
D. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.01	0.03	0.03	0.05	0.04	0.04	0.06	0.07	100.00
7. Other (as specified in Summary 1.A)	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.00**
Total CH4 emissions including CH4 from LULUCF	**176.82**	**172.16**	**146.39**	**108.69**	**98.91**	**98.33**	**95.86**	**94.65**	**90.94**	**85.63**	**86.47**	**89.47**	**89.60**	**85.85**	**86.55**	**88.26**	**83.66**	**85.64**	**86.61**	**86.27**	**84.58**	**-52.17**
Total CH4 emissions excluding CH4 from LULUCF	**175.89**	**171.09**	**144.59**	**107.48**	**97.51**	**96.61**	**94.13**	**92.44**	**88.49**	**82.86**	**83.67**	**87.91**	**87.70**	**84.05**	**84.92**	**86.60**	**81.84**	**84.15**	**85.27**	**84.63**	**82.65**	**-53.01**
Memo Items:																						
International Bunkers	0.10	0.03	0.04	0.04	0.06	0.03	0.02	0.01	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.05	0.04	0.04	0.04	0.06	0.05	-44.29
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	121.05
Marine	0.09	0.03	0.04	0.04	0.06	0.03	0.02	0.01	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.05	0.04	0.03	0.04	0.05	0.05	-47.00

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	Change from base to latest reported year
	(Gg)																					%
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00

N_2O

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	Change from base to latest reported year
	(Gg)																					%
1. Energy	**0.51**	**0.50**	**0.45**	**0.39**	**0.37**	**0.38**	**0.39**	**0.39**	**0.37**	**0.35**	**0.34**	**0.37**	**0.37**	**0.40**	**0.42**	**0.42**	**0.41**	**0.42**	**0.40**	**0.40**	**0.40**	**-22.34**
A. Fuel Combustion (Sectoral Approach)	0.51	0.50	0.45	0.39	0.37	0.38	0.39	0.39	0.37	0.35	0.34	0.37	0.37	0.40	0.42	0.42	0.41	0.42	0.40	0.40	0.40	-22.34
1. Energy Industries	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.02	0.03	0.03	-40.31
2. Manufacturing Industries and Construction	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.05	89.39
3. Transport	0.27	0.26	0.22	0.16	0.15	0.15	0.15	0.16	0.15	0.14	0.15	0.16	0.17	0.19	0.20	0.20	0.19	0.20	0.19	0.16	0.16	-41.72
4. Other Sectors	0.16	0.18	0.17	0.17	0.16	0.17	0.18	0.17	0.16	0.15	0.14	0.16	0.15	0.16	0.17	0.17	0.16	0.17	0.15	0.17	0.16	-2.68
5. Other	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
B. Fugitive Emissions from Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Industrial Processes	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**0.00**
A. Mineral Products	NA,NE,NO	NA,NE,NO	NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	0.00
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Solvent and Other Product Use	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.01	0.02	0.02	0.01	0.01	0.01	0.03	0.02	0.02	0.02	0.01	0.04	0.01	0.01	0.01	0.02	100.00
4. Agriculture	**11.55**	**10.71**	**8.20**	**5.71**	**4.95**	**4.36**	**4.31**	**4.32**	**4.16**	**3.91**	**4.00**	**4.32**	**4.22**	**4.44**	**4.35**	**4.57**	**4.56**	**4.75**	**4.72**	**4.83**	**5.04**	**-56.39**
B. Manure Management	1.84	1.76	1.42	0.88	0.75	0.75	0.69	0.65	0.60	0.53	0.50	0.54	0.54	0.51	0.49	0.50	0.47	0.48	0.45	0.45	0.42	-77.25
D. Agricultural Soils	9.71	8.95	6.79	4.83	4.19	3.62	3.61	3.67	3.56	3.38	3.50	3.78	3.68	3.93	3.86	4.08	4.09	4.27	4.26	4.39	4.62	-52.45
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Land Use, Land-Use Change and Forestry	**0.71**	**0.71**	**0.72**	**0.71**	**0.71**	**0.71**	**0.58**	**0.58**	**0.58**	**0.58**	**0.58**	**0.56**	**0.57**	**0.56**	**0.56**	**0.56**	**0.57**	**0.56**	**0.56**	**0.52**	**0.48**	**-32.18**
A. Forest Land	0.47	0.47	0.48	0.47	0.47	0.48	0.48	0.48	0.48	0.48	0.48	0.47	0.48	0.47	0.47	0.47	0.48	0.47	0.47	0.47	0.47	0.53
B. Cropland	0.23	0.23	0.23	0.23	0.23	0.23	0.10	0.10	0.10	0.10	0.10	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.05	NE,NO	-100.00
C. Grassland	IE,NO	IE,NO	IE,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
D. Wetlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00

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	Change from base to latest reported year
	(Gg)																					%
G. Other	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0.00
6. Waste	**0.21**	**0.21**	**0.21**	**0.20**	**0.20**	**0.20**	**0.19**	**0.19**	**0.19**	**0.19**	**0.18**	**0.19**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**0.18**	**-16.18**
B. Waste-water Handling	0.21	0.21	0.21	0.20	0.20	0.20	0.19	0.19	0.19	0.19	0.18	0.19	0.18	0.18	0.18	0.18	0.18	0.18	0.17	0.17	0.17	-18.80
C. Waste Incineration	NO	NO	NO	NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
D. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	100.00
7. Other (as specified in Summary 1.A)	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.00**
Total N2O emissions including N2O from LULUCF	**12.98**	**12.13**	**9.58**	**7.01**	**6.23**	**5.66**	**5.48**	**5.49**	**5.31**	**5.04**	**5.12**	**5.46**	**5.36**	**5.61**	**5.53**	**5.75**	**5.76**	**5.92**	**5.87**	**5.95**	**6.10**	**-52.96**
Total N2O emissions excluding N2O from LULUCF	**12.27**	**11.42**	**8.86**	**6.30**	**5.52**	**4.95**	**4.90**	**4.92**	**4.73**	**4.46**	**4.53**	**4.90**	**4.79**	**5.04**	**4.97**	**5.19**	**5.19**	**5.36**	**5.31**	**5.43**	**5.62**	**-54.16**
Memo Items:																						
International Bunkers	**0.19**	**0.04**	**0.04**	**0.06**	**0.11**	**0.05**	**0.04**	**0.03**	**0.02**	**0.02**	**0.01**	**0.14**	**0.12**	**0.11**	**0.11**	**0.13**	**0.10**	**0.09**	**0.08**	**0.11**	**0.12**	**-38.13**
Aviation	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	94.80
Marine	0.18	0.03	0.03	0.06	0.11	0.04	0.03	0.03	0.02	0.01	0.01	0.14	0.12	0.10	0.11	0.13	0.09	0.09	0.07	0.10	0.10	-42.66
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00

HFCs and SF_6

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs(3) - (Gg CO2 equivalent)	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**IE,NA,NE,NO**	**0.64**	**0.87**	**2.09**	**3.07**	**3.52**	**5.48**	**8.19**	**10.92**	**17.53**	**21.30**	**34.17**	**73.02**	**115.63**	**95.33**	**100.16**	**105.17**	**100.00**
HFC-23	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NE,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	IE,NE,NO	IE,NO	IE,NO	IE,NO	0.00	0.00	0.00	100.00
HFC-32	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-125	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-134a	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NE,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.05	0.08	0.06	0.06	0.07	100.00
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-143a	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-227ea	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Unspecified mix of listed HFCs(4) - (Gg CO2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Emissions of PFCs(3) - (Gg CO2 equivalent)	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA,NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**0.00**
CF4	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C2F6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C 3F8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C4F10	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
c-C4F8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C5F12	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C6F14	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of listed PFCs(4) - (Gg CO2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Emissions of SF6(3) - (Gg CO2 equivalent)	**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**	**3.38**	**4.41**	**5.37**	**7.53**	**7.12**	**8.60**	**10.08**	**13.53**	**12.25**	**100.00**
SF6	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00

A.6.3: Supplementary information under Article 6., 12., 17

There no registered Joint Implementation (Article 6) and Clean Development Mechanisms (Article 12) projects in Latvia.

There is no limitation rule to hold in the operators and/or person accounts any Kyoto protocol units with exception of AAUs that could be held only in national holding account.

The list given below includes the legal entities that have active accounts in Latvia's ETR at the end of 2011 and doesn't include accounts that were closed after the compliance period 30/04/2010 (the GHG permits of the installations were permitted at the end of 2009)

Legal entities authorised to participate in the mechanisms under Articles 6, 12 and 17 of the Kyoto Protocol

Legal entity authorised to participate in the mechanisms under Articles 6, 12 and 17 of the Kyoto Protocol	Account ID	Role
A/S "Olaines udens un siltums"	LV6	Latvia's ETS operator (obligatory participation)
Pasvaldibas SIA "Ventspils siltums"	LV7	Latvia's ETS operator (obligatory participation)
Pasvaldibas SIA "Ventspils siltums"	LV8	Latvia's ETS operator (obligatory participation)
AS "Latvenergo" TEC-1	LV11	Latvia's ETS operator (obligatory participation)
AS "Latvenergo" TEC-2	LV12	Latvia's ETS operator (obligatory participation)
SIA "Fortum Jelgava"	LV13	Latvia's ETS operator (obligatory participation)
SIA "Fortum Jelgava"	LV14	Latvia's ETS operator (obligatory participation)
SIA "Livanu siltums"	LV17	Latvia's ETS operator (obligatory participation)
SIA "Aizkraukles siltums"	LV18	Latvia's ETS operator (obligatory participation)
A/S "Rigas siltums" katlu maja Gobas iela 33a	LV19	Latvia's ETS operator (obligatory participation)
A/S "Rigas siltums" siltumcentrale "Daugavgriva"	LV20	Latvia's ETS operator (obligatory participation)
A/S "Rigas siltums" siltumcentrale "Vecmilgravis"	LV21	Latvia's ETS operator (obligatory participation)
A/S "Rigas siltums" siltumcentrale "Ziepniekkalns"	LV22	Latvia's ETS operator (obligatory participation)
A/S "Rigas siltums" iecirknis "Zasulauks"	LV23	Latvia's ETS operator (obligatory participation)
A/S "Rigas siltums" siltumcentrale "Imanta"	LV24	Latvia's ETS operator (obligatory participation)
SIA "Dobeles energija"	LV25	Latvia's ETS operator (obligatory participation)
Ogres novada PA "Malkalne"	LV26	Latvia's ETS operator (obligatory participation)
SIA "Wesemann "Sigulda"	LV27	Latvia's ETS operator (obligatory participation)
SIA "Jurmalas siltums" Dubulti	LV29	Latvia's ETS operator (obligatory participation)
SIA "Jurmalas siltums" Kauguri	LV30	Latvia's ETS operator (obligatory participation)
A/S "Cesvaines piens"	LV33	Latvia's ETS operator (obligatory participation)
SIA "Rigas laku un krasu rupnica"	LV34	Latvia's ETS operator (obligatory participation)
A/s "Putnu fabrika Kekava""	LV35	Latvia's ETS operator (obligatory participation)
A/S "Rigas kugu buvetava"	LV36	Latvia's ETS operator (obligatory participation)
A/S "BLB Baltijas Terminals"	LV37	Latvia's ETS operator (obligatory participation)
SIA "Kraslavas nami"	LV39	Latvia's ETS operator (obligatory participation)
SIA "Cesu siltumtikli"	LV41	Latvia's ETS operator (obligatory participation)
SIA "Tukuma siltums"	LV42	Latvia's ETS operator (obligatory participation)
PAS "Daugavpils siltumtikli" SC3	LV43	Latvia's ETS operator (obligatory participation)
PAS "Daugavpils siltumtikli" SC1	LV44	Latvia's ETS operator (obligatory participation)
PAS "Daugavpils siltumtikli" SC2	LV45	Latvia's ETS operator (obligatory participation)
A/S "Ligija teks"	LV46	Latvia's ETS operator (obligatory participation)
SIA "Jekabpils siltums"	LV47	Latvia's ETS operator (obligatory participation)

Legal entity authorised to participate in the mechanisms under Articles 6, 12 and 17 of the Kyoto Protocol	Account ID	Role
A/S "Valmieras piens"	LV50	Latvia's ETS operator (obligatory participation)
SIA "Lauma Fabrics"	LV52	Latvia's ETS operator (obligatory participation)
SIA "Liepajas energija"	LV53	Latvia's ETS operator (obligatory participation)
SIA "Liepajas energija"	LV54	Latvia's ETS operator (obligatory participation)
A/S "Preilu siers"	LV55	Latvia's ETS operator (obligatory participation)
SIA "KP Tehnologijas"	LV56	Latvia's ETS operator (obligatory participation)
SIA "Salaspils siltums"	LV57	Latvia's ETS operator (obligatory participation)
A/S "Latvijas finieris" rupnica "Furniers"	LV58	Latvia's ETS operator (obligatory participation)
A/S "Latvijas Finieris" rupnica "Lignums"	LV59	Latvia's ETS operator (obligatory participation)
SIA "Sabiedriba Marupe"	LV60	Latvia's ETS operator (obligatory participation)
A/S "Balticovo"	LV61	Latvia's ETS operator (obligatory participation)
A/S "Ventbunkers"	LV62	Latvia's ETS operator (obligatory participation)
SIA "Papirfabrika Ligatne"	LV63	Latvia's ETS operator (obligatory participation)
SIA "Saulkalne S"	LV64	Latvia's ETS operator (obligatory participation)
SIA "Brocenu keramika"	LV65	Latvia's ETS operator (obligatory participation)
A/S "Valmieras stikla šķiedra"	LV66	Latvia's ETS operator (obligatory participation)
A/S "LODE"	LV68	Latvia's ETS operator (obligatory participation)
A/S "Liepajas metalurgs"	LV70	Latvia's ETS operator (obligatory participation)
A/S "LODE" Livanu kiegelis	LV71	Latvia's ETS operator (obligatory participation)
SIA "Ceplis"	LV73	Latvia's ETS operator (obligatory participation)
A/S "LODE" Anes ražotne	LV74	Latvia's ETS operator (obligatory participation)
SIA "Jurmalas siltums" Pliekšana 80	LV75	Latvia's ETS operator (obligatory participation)
SIA "Jurmalas siltums" Aizputes 1d	LV76	Latvia's ETS operator (obligatory participation)
SIA "Olaines kimiska rupnica "BIOLARS""	LV87	Latvia's ETS operator (obligatory participation)
A/S "Grizinkalns"	LV100	Latvia's ETS operator (obligatory participation)
SIA "Bolderaja Ltd"	LV105	Latvia's ETS operator (obligatory participation)
SIA "Talsu BIO-energija"	LV106	Latvia's ETS operator (obligatory participation)
SIA "Port Milgravis"	LV107	Latvia's ETS operator (obligatory participation)
SIA "Juglas jauda"	LV109	Latvia's ETS operator (obligatory participation)
SIA "JELD-WEN Latvija"	LV110	Latvia's ETS operator (obligatory participation)
A/S "Valmieras Energija" Rigas iela 25	LV111	Latvia's ETS operator (obligatory participation)
A/S "Valmieras Energija" Dzelzcela iela 7	LV112	Latvia's ETS operator (obligatory participation)
A/S "Latvijas Gaze"	LV113	Latvia's ETS operator (obligatory participation)
SIA "Buvmateriali AN"	LV115	Latvia's ETS operator (obligatory participation)
SIA "Fortum Jelgava"	LV117	Latvia's ETS operator (obligatory participation)
SIA "Rigens"	LV119	Latvia's ETS operator (obligatory participation)
SIA "Tennere"	LV120	Latvia's ETS operator (obligatory participation)
SIA "Jaunpagasts Plus" Jaunpagasta spirta rupnica	LV121	Latvia's ETS operator (obligatory participation)
A/S "Rezeknes Siltumtikli" Atbrivošanas aleja 155a	LV124	Latvia's ETS operator (obligatory participation)
A/S "Rezeknes Siltumtikli" N.Rancana iela 5	LV125	Latvia's ETS operator (obligatory participation)
A/S "Rezeknes Siltumtikli" Meža iela 1	LV126	Latvia's ETS operator (obligatory participation)
SIA "Gamma - A"	LV129	Latvia's ETS operator (obligatory participation)
SIA "CEMEX"	LV131	Latvia's ETS operator (obligatory participation)

ANNEX 7: TABLES 6.1 AND 6.2 OF THE IPCC GOOD PRACTICE GUIDANCE

Uncertainties without LULUCF

IPCC GHG Source and Sink Categories (LULUCF not included)		1990 Estimate, Gg CO2-eq	2010 Estimate, Gg CO2-eq	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions	Emission factor quality indicator	Activity data quality indicator
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3 051,264	55,113	2,00%	10,00%	10,20%	0,05%	-4,98%	0,21%	-0,50%	0,01%	0,50%	D	R
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	338,628	39,722	2,00%	15,00%	15,13%	0,05%	-0,43%	0,15%	-0,06%	0,00%	0,06%	D	R
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2 644,313	2 088,694	2,00%	5,00%	5,39%	0,96%	3,46%	7,96%	0,17%	0,23%	0,28%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	24,784	15,722	2,00%	10,00%	10,20%	0,01%	0,02%	0,06%	0,00%	0,00%	0,00%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	CO_2	163,886		2,00%	15,00%	15,13%		-0,28%		-0,04%		0,04%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	44,672	48,358	2,00%	5,00%	5,39%	0,02%	0,11%	0,18%	0,01%	0,01%	0,01%	D	R
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	154,094	77,391	2,00%	10,00%	10,20%	0,07%	0,03%	0,30%	0,00%	0,01%	0,01%	D	R
1.A.2.a Iron and Steel - Solid Fuels	CO_2	4,587	9,298	2,00%	15,00%	15,13%	0,01%	0,03%	0,04%	0,00%	0,00%	0,00%	D	R
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234,464	212,007	2,00%	5,00%	5,39%	0,10%	0,41%	0,81%	0,02%	0,02%	0,03%	D	R
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CO_2		7,420	2,00%	5,00%	5,39%	0,00%	0,03%	0,03%	0,00%	0,00%	0,00%	D	R
1.A.2.c Chemicals - Liquid Fuels	CO_2	276,669	6,289	2,00%	10,00%	10,20%	0,01%	-0,45%	0,02%	-0,04%	0,00%	0,04%	D	R
1.A.2.c Chemicals - Solid Fuels	CO_2			2,00%	15,00%	15,13%							D	R
1.A.2.c Chemicals - Gaseous Fuels	CO_2	23,397	33,467	2,00%	5,00%	5,39%	0,02%	0,09%	0,13%	0,00%	0,00%	0,01%	D	R
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	15,547		2,00%	10,00%	10,20%		-0,03%		0,00%		0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO_2	2,417		2,00%	15,00%	15,13%		0,00%		0,00%		0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	149,415	5,578	2,00%	5,00%	5,39%	0,00%	-0,23%	0,02%	-0,01%	0,00%	0,01%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798,124	45,286	2,00%	10,00%	10,20%	0,04%	-1,19%	0,17%	-0,12%	0,00%	0,12%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	91,116	5,120	2,00%	15,00%	15,13%	0,01%	-0,14%	0,02%	-0,02%	0,00%	0,02%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174,195	106,028	2,00%	5,00%	5,39%	0,05%	0,11%	0,40%	0,01%	0,01%	0,01%	D	R
1.A.2.f Other - Liquid Fuels	CO_2	944,946	138,399	2,00%	10,00%	10,20%	0,12%	-1,08%	0,53%	-0,11%	0,01%	0,11%	D	R
1.A.2.f Other - Solid Fuels	CO_2	38,236	165,519	2,00%	15,00%	15,13%	0,21%	0,57%	0,63%	0,08%	0,02%	0,09%	D	R
1.A.2.f Other - Gaseous Fuels	CO_2	835,236	217,635	2,00%	5,00%	5,39%	0,10%	-0,59%	0,83%	-0,03%	0,02%	0,04%	D	R
1.A.2.f Other - Other Fuels	CO_2		33,809	2,00%	5,00%	5,39%	0,02%	0,13%	0,13%	0,01%	0,00%	0,01%	D	R
1.A.3.c Civil Aviation - Aviation Gasoline	CO_2	0,011	0,281	2,00%	5,00%	5,39%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.c Civil Aviation - Jet Kerosene	CO_2	0,055	0,157	2,00%	5,00%	5,39%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Gasoline	CO_2	1 689,330	844,414	2,00%	2,00%	2,83%	0,20%	0,34%	3,22%	0,01%	0,09%	0,09%	D	D
1.A.3.b Road Transportation - Diesel Oil	CO_2	616,136	2 031,344	2,00%	2,00%	2,83%	0,49%	6,69%	7,75%	0,13%	0,22%	0,26%	D	D
1.A.3.b Road Transportation - LPG	CO_2	36,957	61,758	2,00%	5,00%	5,39%	0,03%	0,17%	0,24%	0,01%	0,01%	0,01%	D	D
1.A.3.b Road Transportation - Lubricants	CO_2	0,091	0,125	10,00%	5,00%	11,18%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D

IPCC GHG Source and Sink Categories (LULUCF not included)		**1990 Estimate, Gg CO2-eq**	**2010 Estimate, Gg CO2-eq**	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions	Emission factor quality indicator	Activity data quality indicator
1.A.3.b Road Transportation - Gaseous Fuels	CO_2	19,580		2,00%	5,00%	5,39%		-0,03%		0,00%		0,00%	D	D
1.A.3.c Railways - Liquid Fuels	CO_2	531,380	207,496	2,00%	5,00%	5,39%	0,10%	-0,11%	0,79%	-0,01%	0,02%	0,02%	D	D
1.A.3.d Naviagtion - Gasoline	CO_2	0,181	0,218	20,00%	5,00%	20,62%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1 131,478	109,285	2,00%	10,00%	10,20%	0,10%	-1,51%	0,42%	-0,15%	0,01%	0,15%	D	R
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1 331,987	94,467	2,00%	15,00%	15,13%	0,12%	-1,91%	0,36%	-0,29%	0,01%	0,29%	D	R
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	337,481	310,515	2,00%	5,00%	5,39%	0,14%	0,61%	1,18%	0,03%	0,03%	0,05%	D	R
1.A.4.b Residential - Liquid Fuels	CO_2	329,914	153,568	50,00%	10,00%	50,99%	0,67%	0,02%	0,59%	0,00%	0,41%	0,41%	D	R
1.A.4.b Residential - Solid Fuels	CO_2	585,452	98,782	50,00%	15,00%	52,20%	0,44%	-0,62%	0,38%	-0,09%	0,27%	0,28%	D	R
1.A.4.b Residential - Gaseous Fuels	CO_2	219,607	288,303	50,00%	5,00%	50,25%	1,24%	0,73%	1,10%	0,04%	0,78%	0,78%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	694,469	330,152	2,00%	10,00%	10,20%	0,29%	0,08%	1,26%	0,01%	0,04%	0,04%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	94,804	2,417	2,00%	15,00%	15,13%	0,00%	-0,15%	0,01%	-0,02%	0,00%	0,02%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778,520	53,985	2,00%	5,00%	5,39%	0,02%	-1,12%	0,21%	-0,06%	0,01%	0,06%	D	R
1.A.5.b Mobile - Liquid Fuels	CO_2		1,205	2,00%	50,00%	50,04%	0,01%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
2.A.1 Cement Production	CO_2	366,123	431,197	10,00%	5,00%	11,18%	0,41%	1,02%	1,64%	0,05%	0,23%	0,24%	D	R
2.A.2 Lime Production	CO_2	8,205	12,815	2,00%	50,00%	50,04%	0,05%	0,03%	0,05%	0,02%	0,00%	0,02%	D	R
2.A.3 Limestone and Dolomite Use	CO_2	141,005	20,209	2,00%	50,00%	50,04%	0,09%	-0,16%	0,08%	-0,08%	0,00%	0,08%	D	R
2.A.4 Soda Ash Production and Use	CO_2			2,00%	50,00%	50,04%							D	
2.A.5 Asphalt Roofing	CO_2	0,000	0,001	20,00%	70,00%	72,80%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
2.A.6 Road Paving with Asphalt	CO_2	1,463	41,000	20,00%	70,00%	72,80%	0,25%	0,15%	0,16%	0,11%	0,04%	0,12%	D	R
2.A.7 Other	CO_2	69,189	4,772	15,00%	60,00%	61,85%	0,03%	-0,10%	0,02%	-0,06%	0,00%	0,06%	D	R
2.C.1 Iron and Steel Production	CO_2	12,829	11,278	25,00%	5,00%	25,50%	0,02%	0,02%	0,04%	0,00%	0,02%	0,02%	R	R
3.A Paint Aplication	CO_2	23,235	11,464	10,00%	75,00%	75,66%	0,07%	0,00%	0,04%	0,00%	0,01%	0,01%	D	R
3.B Degreasing and Dry Cleaning	CO_2	7,075	0,022	10,00%	75,00%	75,66%	0,00%	-0,01%	0,00%	-0,01%	0,00%	0,01%	D	R
3.C Chemical Products, Manufacture and Processing	CO_2		0,850	2,00%	75,00%	75,03%	0,01%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
3.D Other	CO_2	20,394	24,962	10,00%	75,00%	75,66%	0,16%	0,06%	0,10%	0,05%	0,01%	0,05%	D	R
6.C Waste Incineration	CO_2		0,339	20,00%	50,00%	53,85%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%		
2.F(a).1 Refrigeration and Air Conditioning Equipment	HFCs		96,133	75,00%	75,00%	106,07%	0,87%	0,37%	0,37%	0,27%	0,39%	0,48%	D	R
2.F(a).2 Foam Blowing	HFCs		0,850	75,00%	75,00%	106,07%	0,01%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
2.F(a).3 Fire Extinguisher	HFCs		0,040	75,00%	75,00%	106,07%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
2.F(a).4 Aerosols/ Metered Dose Inhalers	HFCs		2,471	75,00%	75,00%	106,07%	0,02%	0,01%	0,01%	0,01%	0,01%	0,01%	D	R
2.F(a).8 Electrical Equipment	SF6		12,254	2,00%	10,00%	10,20%	0,01%	0,05%	0,05%	0,00%	0,00%	0,00%	D	R
2.F(a).9 Other	HFCs		5,680	75,00%	75,00%	106,07%	0,05%	0,02%	0,02%	0,02%	0,02%	0,03%	D	R
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	2,529	0,045	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0,916	0,015	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R

IPCC GHG Source and Sink Categories (LULUCF not included)		**1990 Estimate, Gg CO2-eq**	**2010 Estimate, Gg CO2-eq**	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions	Emission factor quality indicator	Activity data quality indicator
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	1,004	0,794	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	0,275	3,207	20,00%	50,00%	53,85%	0,01%	0,01%	0,01%	0,01%	0,00%	0,01%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CH_4	0,021	0,013	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	CH_4	0,994		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0,017	0,018	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	CH_4		0,317	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.a Iron and Steel - Liquid Fuels	CH_4	0,086	0,042	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.a Iron and Steel - Solid Fuels	CH_4	0,011	0,022	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0,445	0,403	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CH_4		0,014	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.b Non-Ferrous Metals - Biomass Fuels	CH_4			15,00%	50,00%	52,20%							D	R
1.A.2.c Chemicals - Liquid Fuels	CH_4	0,153	0,004	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.c Chemicals - Solid Fuels	CH_4			2,00%	50,00%	50,04%							D	R
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0,044	0,064	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.c Chemicals - Biomass Fuels	CH_4		0,118	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0,009		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH_4	0,006		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0,284	0,011	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	CH_4		0,098	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0,443	0,026	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0,224	0,013	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0,331	0,201	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0,144	0,210	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Liquid Fuels	CH_4	1,413	0,122	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Solid Fuels	CH_4	0,094	0,381	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Gaseous Fuels	CH_4	1,585	0,413	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Biomass Fuels	CH_4	0,245	5,749	15,00%	50,00%	52,20%	0,03%	0,02%	0,02%	0,01%	0,00%	0,01%	D	R
1.A.2.f Other - Other Fuels	CH_4		0,595	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.3.c Civil Aviation - Aviation Gasoline	CH_4	0,000	0,000	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.c Civil Aviation - Jet Kerosene	CH_4	0,000	0,000	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Gasoline	CH_4	14,410	2,493	2,00%	50,00%	50,04%	0,01%	-0,02%	0,01%	-0,01%	0,00%	0,01%	D	D

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1.A.3.b Road Transportation - Diesel Oil	CH_4	0,931	1,365	2,00%	50,00%	50,04%	0,01%	0,00%	0,01%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - LPG	CH_4	0,105	0,239	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Lubricants	CH_4	0,003	0,002	10,00%	50,00%	50,99%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Gaseous Fuels	CH_4	0,356		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	D
1.A.3.b Road Transportation - Biomass	CH_4		0,025	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.c Railways - Liquid Fuels	CH_4	0,639	0,249	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.d Naviagtion - Diesel Oil	CH_4	0,001	0,025	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.d Naviagtion - Gasoline	CH_4	0,002	0,003	20,00%	50,00%	53,85%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.e. Other Transportation (Biofuels for 1A3C)	CH_4		0,001	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	3,203	0,350	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	7,365	0,227	2,00%	50,00%	50,04%	0,00%	-0,01%	0,00%	-0,01%	0,00%	0,01%	D	R
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0,641	0,590	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.a Commercial/Institutional - Biomass	CH_4	32,873	30,083	20,00%	50,00%	53,85%	0,14%	0,06%	0,11%	0,03%	0,03%	0,04%	D	R
1.A.4.b Residential - Liquid Fuels	CH_4	1,031	1,079	50,00%	50,00%	70,71%	0,01%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.b Residential - Solid Fuels	CH_4	43,019	6,734	50,00%	50,00%	70,71%	0,04%	-0,05%	0,03%	-0,02%	0,02%	0,03%	D	R
1.A.4.b Residential - Gaseous Fuels	CH_4	0,417	0,548	50,00%	50,00%	70,71%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.b Residential - Biomass	CH_4	126,063	193,687	50,00%	50,00%	70,71%	1,17%	0,52%	0,74%	0,26%	0,52%	0,58%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	4,381	0,937	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	7,008	0,165	2,00%	50,00%	50,04%	0,00%	-0,01%	0,00%	-0,01%	0,00%	0,01%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	1,478	0,103	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	7,686	3,579	2,00%	50,00%	50,04%	0,02%	0,00%	0,01%	0,00%	0,00%	0,00%	D	R
1.A.5.b Mobile - Liquid Fuels	CH_4		0,000	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.B.2.b Natural Gas	CH_4	236,250	92,862	2,00%	2,00%	2,83%	0,02%	-0,05%	0,35%	0,00%	0,01%	0,01%	D	R
1.B.2.d Natural Gas	CH_4	37,800	8,568	2,00%	2,00%	2,83%	0,00%	-0,03%	0,03%	0,00%	0,00%	0,00%	D	R
2.C.1 Iron and Steel Production	CH_4	0,058	0,056	25,00%	10,00%	26,93%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
4.A. Enteric Fermentation	CH_4	2 148,053	672,186	2,00%	20,00%	20,10%	1,15%	-1,10%	2,56%	-0,22%	0,07%	0,23%	D	D
4.B.Manure Management	CH_4	273,758	96,156	2,00%	30,00%	30,07%	0,25%	-0,10%	0,37%	-0,03%	0,01%	0,03%	D	D
6.A.1 Managed Waste Disposal on Land	CH_4		99,079	20,00%	52,00%	55,71%	0,47%	0,38%	0,38%	0,20%	0,11%	0,22%	D	D
6.B.1 Industrial Waste Water	CH_4	307,123	101,036	2,00%	30,00%	30,07%	0,26%	-0,14%	0,39%	-0,04%	0,01%	0,04%	D	D
6.B.2 Domestic and Commercial Waste Water	CH_4	97,860	72,514	10,00%	30,00%	31,62%	0,20%	0,11%	0,28%	0,03%	0,04%	0,05%	D	D
6.D Other	CH_4		1,558	20,00%	100,00%	101,98%	0,01%	0,01%	0,01%	0,01%	0,00%	0,01%	D	D
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	7,466	0,134	2,00%	50,00%	50,04%	0,00%	-0,01%	0,00%	-0,01%	0,00%	0,01%	D	R
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	2,709	0,195	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R

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1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	1,482	1,171	2,00%	50,00%	50,04%	0,01%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	0,541	6,310	20,00%	50,00%	53,85%	0,03%	0,02%	0,02%	0,01%	0,01%	0,01%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0,063	0,040	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	N_2O	1,957		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0,025	0,027	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	N_2O		0,624	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.a Iron and Steel - Liquid Fuels	N_2O	0,383	0,187	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.a Iron and Steel - Solid Fuels	N_2O	0,023	0,046	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0,131	0,119	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	N_2O		0,004	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.c Chemicals - Liquid Fuels	N_2O	0,677	0,016	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0,013	0,019	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.c Chemicals - Biomass Fuels	N_2O		0,232	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0,038		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N_2O	0,012		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0,084	0,003	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	N_2O		0,193	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1,962	0,114	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0,464	0,026	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0,098	0,059	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0,283	0,414	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Liquid Fuels	N_2O	2,709	0,362	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Solid Fuels	N_2O	0,195	0,788	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Gaseous Fuels	N_2O	0,468	0,122	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Biomass Fuels	N_2O	0,482	11,315	15,00%	50,00%	52,20%	0,05%	0,04%	0,04%	0,02%	0,01%	0,02%	D	R
1.A.2.f Other - Other Fuels	N_2O		1,171	2,00%	50,00%	50,04%	0,01%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.3.c Civil Aviation - Aviation Gasoline	N_2O	0,000	0,002	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.3.c Civil Aviation - Jet Kerosene	N_2O	0,000	0,002	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Gasoline	N_2O	13,601	6,323	2,00%	50,00%	50,04%	0,03%	0,00%	0,02%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Diesel Oil	N_2O	5,819	13,574	2,00%	50,00%	50,04%	0,06%	0,04%	0,05%	0,02%	0,00%	0,02%	D	D
1.A.3.b Road Transportation - LPG	N_2O	0,170	0,822	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Lubricants	N_2O	0,000	0,001	10,00%	50,00%	50,99%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D

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1.A.3.b Road Transportation - Gaseous Fuels	N_2O	0,011		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	D
1.A.3.b Road Transportation - Biomass	N_2O		0,478	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.c Railways - Liquid Fuels	N_2O	64,964	25,367	2,00%	50,00%	50,04%	0,11%	-0,01%	0,10%	-0,01%	0,00%	0,01%	D	D
1.A.3.d Naviagtion - Diesel Oil	N_2O	0,105	2,762	2,00%	50,00%	50,04%	0,01%	0,01%	0,01%	0,01%	0,00%	0,01%	D	D
1.A.3.d Naviagtion - Gasoline	N_2O	0,000	0,000	20,00%	50,00%	53,85%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.e. Other Transportation (Biofuels for 1A3C)	N_2O		0,015	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	2,823	0,297	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	7,306	0,446	2,00%	50,00%	50,04%	0,00%	-0,01%	0,00%	-0,01%	0,00%	0,01%	D	R
1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0,189	0,174	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.a Commercial/Institutional - Biomass	N_2O	6,470	5,931	20,00%	50,00%	53,85%	0,03%	0,01%	0,02%	0,01%	0,01%	0,01%	D	R
1.A.4.b Residential - Liquid Fuels	N_2O	0,913	0,531	50,00%	50,00%	70,71%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.b Residential - Solid Fuels	N_2O	3,306	0,480	50,00%	50,00%	70,71%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.b Residential - Gaseous Fuels	N_2O	0,123	0,162	50,00%	50,00%	70,71%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.b Residential - Biomass	N_2O	24,812	39,908	50,00%	50,00%	70,71%	0,24%	0,11%	0,15%	0,05%	0,11%	0,12%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	2,468	0,830	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0,508	0,011	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0,436	0,030	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	1,513	0,705	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.5.b Mobile - Liquid Fuels	N_2O		0,011	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
3.D Other	N_2O		4,650	2,00%	2,00%	2,83%	0,00%	0,02%	0,02%	0,00%	0,00%	0,00%	D	D
4.B.Manure Management	N_2O	569,677	129,613	40,00%	30,00%	50,00%	0,55%	-0,48%	0,49%	-0,14%	0,28%	0,31%	D	D
4.D.1. Direct Soil Emissions	N_2O	1 618,317	956,339	40,00%	25,00%	47,17%	3,85%	0,89%	3,65%	0,22%	2,06%	2,07%	D	D
4.D.2 Pasture, Range and Paddock Manure	N_2O	358,351	86,866	40,00%	25,00%	47,17%	0,35%	-0,28%	0,33%	-0,07%	0,19%	0,20%	D	D
4.D.3.Indirect Emissions	N_2O	1 033,873	388,414	30,00%	40,00%	50,00%	1,66%	-0,28%	1,48%	-0,11%	0,63%	0,64%	D	D
6.B.1 Industrial Waste Water	N_2O	2,436	0,246	10,00%	30,00%	31,62%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
6.B.2 Domestic and Commercial Waste Water	N_2O	63,528	53,315	10,00%	30,00%	31,62%	0,14%	0,10%	0,20%	0,03%	0,03%	0,04%	D	D
6.C Waste Incineration	N_2O		0,007	20,00%	90,00%	92,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
6.D Other	N_2O		1,725	20,00%	90,00%	92,20%	0,01%	0,01%	0,01%	0,01%	0,00%	0,01%	D	D
TOTAL	**CO_2 eq**	**26 224,710**	**11 718,789**	**19,430**	**75,320**	**82,109**	**18,741%**	**0,00%**	**44,69%**	**-0,40%**	**7,17%**	**9,81%**		
CONTROL				Percentage uncertainty in total inventory			**43,29%**				Trend uncertainty	**31,33%**		

IPCC GHG Source and Sink Categories (LULUCF not included)		1990 Estimate, Gg CO2-eq	2010 Estimate, Gg CO2-eq	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions	Emission factor quality indicator	Activity data quality indicator
		Input Data	Input Data	Input Data	Input Data	$\sqrt{E^2+F^2}$	$\frac{G \bullet D}{\sum D}$	Note B	$\frac{D}{\sum C}$	$I \bullet F$ Note C	$J \bullet E \bullet \sqrt{2}$ Note D	$\sqrt{K^2+L^2}$	Note E	Note E

Uncertainties with LULUCF

IPCC GHG Source and Sink Categories (LULUCF not included)		1990 Estimate, Gg CO2-eq	2010 Estimate, Gg CO2-eq	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions	Emission factor quality indicator	Activity data quality indicator
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CO_2	3 051,264	55,113	2,00%	10,00%	10,20%	-0,10%	16,38%	0,54%	1,64%	0,02%	1,64%	D	R
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CO_2	338,628	39,722	2,00%	15,00%	15,13%	-0,11%	2,15%	0,39%	0,32%	0,01%	0,32%	D	R
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CO_2	2 644,313	2 088,694	2,00%	5,00%	5,39%	-2,07%	34,13%	20,45%	1,71%	0,58%	1,80%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CO_2	24,784	15,722	2,00%	10,00%	10,20%	-0,03%	0,28%	0,15%	0,03%	0,00%	0,03%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	CO_2	163,886		2,00%	15,00%	15,13%		0,85%		0,13%		0,13%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CO_2	44,672	48,358	2,00%	5,00%	5,39%	-0,05%	0,71%	0,47%	0,04%	0,01%	0,04%	D	R
1.A.2.a Iron and Steel - Liquid Fuels	CO_2	154,094	77,391	2,00%	10,00%	10,20%	-0,15%	1,56%	0,76%	0,16%	0,02%	0,16%	D	R
1.A.2.a Iron and Steel - Solid Fuels	CO_2	4,587	9,298	2,00%	15,00%	15,13%	-0,03%	0,11%	0,09%	0,02%	0,00%	0,02%	D	R
1.A.2.a Iron and Steel - Gaseous Fuels	CO_2	234,464	212,007	2,00%	5,00%	5,39%	-0,21%	3,30%	2,08%	0,16%	0,06%	0,17%	D	R
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	CO_2		7,420	2,00%	5,00%	5,39%	-0,01%	0,07%	0,07%	0,00%	0,00%	0,00%	D	R
1.A.2.c Chemicals - Liquid Fuels	CO_2	276,669	6,289	2,00%	10,00%	10,20%	-0,01%	1,50%	0,06%	0,15%	0,00%	0,15%	D	R
1.A.2.c Chemicals - Gaseous Fuels	CO_2	23,397	33,467	2,00%	5,00%	5,39%	-0,03%	0,45%	0,33%	0,02%	0,01%	0,02%	D	R
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO_2	15,547		2,00%	10,00%	10,20%		0,08%		0,01%		0,01%	D	R
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO_2	2,417		2,00%	15,00%	15,13%		0,01%		0,00%		0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO_2	149,415	5,578	2,00%	5,00%	5,39%	-0,01%	0,83%	0,05%	0,04%	0,00%	0,04%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CO_2	798,124	45,286	2,00%	10,00%	10,20%	-0,09%	4,60%	0,44%	0,46%	0,01%	0,46%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CO_2	91,116	5,120	2,00%	15,00%	15,13%	-0,01%	0,52%	0,05%	0,08%	0,00%	0,08%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CO_2	174,195	106,028	2,00%	5,00%	5,39%	-0,11%	1,94%	1,04%	0,10%	0,03%	0,10%	D	R
1.A.2.f Other - Liquid Fuels	CO_2	944,946	138,399	2,00%	10,00%	10,20%	-0,26%	6,27%	1,36%	0,63%	0,04%	0,63%	D	R
1.A.2.f Other - Solid Fuels	CO_2	38,236	165,519	2,00%	15,00%	15,13%	-0,46%	1,82%	1,62%	0,27%	0,05%	0,28%	D	R
1.A.2.f Other - Gaseous Fuels	CO_2	835,236	217,635	2,00%	5,00%	5,39%	-0,22%	6,47%	2,13%	0,32%	0,06%	0,33%	D	R
1.A.2.f Other - Other Fuels	CO_2		33,809	2,00%	5,00%	5,39%	-0,03%	0,33%	0,33%	0,02%	0,01%	0,02%	D	R
1.A.3.c Civil Aviation - Aviation Gasoline	CO_2	0,011	0,281	2,00%	5,00%	5,39%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R

IPCC GHG Source and Sink Categories (LULUCF not included)		1990 Estimate, Gg CO2-eq	2010 Estimate, Gg CO2-eq	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions	Emission factor quality indicator	Activity data quality indicator
1.A.3.c Civil Aviation - Jet Kerosene	CO_2	0,055	0,157	2,00%	5,00%	5,39%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Gasoline	CO_2	1 689,330	844,414	2,00%	2,00%	2,83%	-0,44%	17,04%	8,27%	0,34%	0,23%	0,41%	D	D
1.A.3.b Road Transportation - Diesel Oil	CO_2	616,136	2 031,344	2,00%	2,00%	2,83%	-1,06%	23,08%	19,89%	0,46%	0,56%	0,73%	D	D
1.A.3.b Road Transportation - LPG	CO_2	36,957	61,758	2,00%	5,00%	5,39%	-0,06%	0,80%	0,60%	0,04%	0,02%	0,04%	D	D
1.A.3.b Road Transportation - Lubricants	CO_2	0,091	0,125	10,00%	5,00%	11,18%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Gaseous Fuels	CO_2	19,580		2,00%	5,00%	5,39%		0,10%		0,01%		0,01%	D	D
1.A.3.c Railways - Liquid Fuels	CO_2	531,380	207,496	2,00%	5,00%	5,39%	-0,21%	4,80%	2,03%	0,24%	0,06%	0,25%	D	D
1.A.3.d Naviagtion - Gasoline	CO_2	0,181	0,218	20,00%	5,00%	20,62%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.4.a Commercial/Institutional - Liquid Fuels	CO_2	1 131,478	109,285	2,00%	10,00%	10,20%	-0,21%	6,95%	1,07%	0,70%	0,03%	0,70%	D	D
1.A.4.a Commercial/Institutional - Solid Fuels	CO_2	1 331,987	94,467	2,00%	15,00%	15,13%	-0,26%	7,85%	0,92%	1,18%	0,03%	1,18%	R	R
1.A.4.a Commercial/Institutional - Gaseous Fuels	CO_2	337,481	310,515	2,00%	5,00%	5,39%	-0,31%	4,80%	3,04%	0,24%	0,09%	0,25%	R	R
1.A.4.b Residential - Liquid Fuels	CO_2	329,914	153,568	50,00%	10,00%	50,99%	-1,44%	3,22%	1,50%	0,32%	1,06%	1,11%	D	R
1.A.4.b Residential - Solid Fuels	CO_2	585,452	98,782	50,00%	15,00%	52,20%	-0,95%	4,01%	0,97%	0,60%	0,68%	0,91%	D	R
1.A.4.b Residential - Gaseous Fuels	CO_2	219,607	288,303	50,00%	5,00%	50,25%	-2,67%	3,97%	2,82%	0,20%	2,00%	2,01%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CO_2	694,469	330,152	2,00%	10,00%	10,20%	-0,62%	6,84%	3,23%	0,68%	0,09%	0,69%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CO_2	94,804	2,417	2,00%	15,00%	15,13%	-0,01%	0,52%	0,02%	0,08%	0,00%	0,08%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CO_2	778,520	53,985	2,00%	5,00%	5,39%	-0,05%	4,58%	0,53%	0,23%	0,01%	0,23%	D	R
1.A.5.b Mobile - Liquid Fuels	CO_2		1,205	2,00%	50,00%	50,04%	-0,01%	0,01%	0,01%	0,01%	0,00%	0,01%	D	R
2.A.1 Cement Production	CO_2	366,123	431,197	10,00%	5,00%	11,18%	-0,89%	6,13%	4,22%	0,31%	0,60%	0,67%	D	R
2.A.2 Lime Production	CO_2	8,205	12,815	2,00%	50,00%	50,04%	-0,12%	0,17%	0,13%	0,08%	0,00%	0,08%	D	R
2.A.3 Limestone and Dolomite Use	CO_2	141,005	20,209	2,00%	50,00%	50,04%	-0,19%	0,93%	0,20%	0,47%	0,01%	0,47%	D	R
2.A.5 Asphalt Roofing	CO_2	0,000	0,001	20,00%	70,00%	72,80%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
2.A.6 Road Paving with Asphalt	CO_2	1,463	41,000	20,00%	70,00%	72,80%	-0,55%	0,41%	0,40%	0,29%	0,11%	0,31%	D	
2.A.7 Other	CO_2	69,189	4,772	15,00%	60,00%	61,85%	-0,05%	0,41%	0,05%	0,24%	0,01%	0,24%	D	R
2.C.1 Iron and Steel Production	CO_2	12,829	11,278	25,00%	5,00%	25,50%	-0,05%	0,18%	0,11%	0,01%	0,04%	0,04%	D	R
3.A Paint Aplication	CO_2	23,235	11,464	10,00%	75,00%	75,66%	-0,16%	0,23%	0,11%	0,17%	0,02%	0,18%	D	R
3.B Degreasing and Dry Cleaning	CO_2	7,075	0,022	10,00%	75,00%	75,66%	0,00%	0,04%	0,00%	0,03%	0,00%	0,03%	D	R
3.C Chemical Products, Manufacture and Processing	CO_2		0,850	2,00%	75,00%	75,03%	-0,01%	0,01%	0,01%	0,01%	0,00%	0,01%	D	R
3.D Other	CO_2	20,394	24,962	10,00%	75,00%	75,66%	-0,35%	0,35%	0,24%	0,26%	0,03%	0,27%	D	R
5.A.1 Forest Land remaining Forest Land	CO_2	-16 925,492	-17 572,266	10,08%	30,00%	31,65%	102,40%	-264,56%	-172,05%	-79,37%	-24,52%	83,07%	D	R
5.A.2 Land converted to Forest Land	CO_2	0,630	-494,311	16,45%	30,00%	34,21%	3,11%	-4,84%	-4,84%	-1,45%	-1,13%	1,84%	D	R
5.B.1 Cropland remaining Cropland	CO_2	337,590	219,410	30,00%	90,00%	94,87%	-3,83%	3,90%	2,15%	3,51%	0,91%	3,63%		
5.B.2 Land converted to Cropland	CO_2	215,490	253,917	35,00%	14,60%	37,92%	-1,77%	3,61%	2,49%	0,53%	1,23%	1,34%	D	R
5.C.1 Grassland remaining Grassland	CO_2	40,150	64,269	50,00%	90,00%	102,96%	-1,22%	0,84%	0,63%	0,75%	0,44%	0,88%	D	R
5.D.1 Wetlands remaining Wetlands	CO_2	19,800	19,800	90,00%	95,00%	130,86%	-0,48%	0,30%	0,19%	0,28%	0,25%	0,37%	D	R
5.E.2 Land converted to Settlements	CO_2	62,040	173,323	19,00%	14,60%	23,96%	-0,76%	2,02%	1,70%	0,29%	0,46%	0,54%	D	R
6.C Waste Incineration	CO_2		0,339	20,00%	50,00%	53,85%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
2.F(a).1 Refrigeration and Air Conditioning Equipment	HFCs		96,133	75,00%	75,00%	106,07%	-1,88%	0,94%	0,94%	0,71%	1,00%	1,22%	D	R
2.F(a).2 Foam Blowing	HFCs		0,850	75,00%	75,00%	106,07%	-0,02%	0,01%	0,01%	0,01%	0,01%	0,01%	D	R

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2.F(a).3 Fire Extinguisher	HFCs		0,040	75,00%	75,00%	106,07%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
2.F(a).4 Aerosols/ Metered Dose Inhalers	HFCs		2,471	75,00%	75,00%	106,07%	-0,05%	0,02%	0,02%	0,02%	0,03%	0,03%	D	R
2.F(a).8 Electrical Equipment	SF6		12,254	2,00%	10,00%	10,20%	-0,02%	0,12%	0,12%	0,01%	0,00%	0,01%	D	R
2.F(a).9 Other	HFCs		5,680	75,00%	75,00%	106,07%	-0,11%	0,06%	0,06%	0,04%	0,06%	0,07%	D	R
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	CH_4	2,529	0,045	2,00%	50,00%	50,04%	0,00%	0,01%	0,00%	0,01%	0,00%	0,01%	D	R
1.A.1.a Public Electricity and Heat Production - Solid Fuels	CH_4	0,916	0,015	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	CH_4	1,004	0,794	2,00%	50,00%	50,04%	-0,01%	0,01%	0,01%	0,01%	0,00%	0,01%	D	R
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	CH_4	0,275	3,207	20,00%	50,00%	53,85%	-0,03%	0,03%	0,03%	0,02%	0,01%	0,02%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	CH_4	0,021	0,013	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	CH_4	0,994		2,00%	50,00%	50,04%		0,01%		0,00%		0,00%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	CH_4	0,017	0,018	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	CH_4		0,317	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.a Iron and Steel - Liquid Fuels	CH_4	0,086	0,042	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.a Iron and Steel - Solid Fuels	CH_4	0,011	0,022	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.a Iron and Steel - Gaseous Fuels	CH_4	0,445	0,403	2,00%	50,00%	50,04%	0,00%	0,01%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.c Chemicals - Liquid Fuels	CH_4	0,153	0,004	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.c Chemicals - Gaseous Fuels	CH_4	0,044	0,064	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.c Chemicals - Biomass Fuels	CH_4		0,118	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH_4	0,009		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH_4	0,006		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH_4	0,284	0,011	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	CH_4		0,098	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	CH_4	0,443	0,026	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	CH_4	0,224	0,013	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	CH_4	0,331	0,201	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	CH_4	0,144	0,210	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Liquid Fuels	CH_4	1,413	0,122	2,00%	50,00%	50,04%	0,00%	0,01%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Solid Fuels	CH_4	0,094	0,381	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Gaseous Fuels	CH_4	1,585	0,413	2,00%	50,00%	50,04%	0,00%	0,01%	0,00%	0,01%	0,00%	0,01%	D	R
1.A.2.f Other - Biomass Fuels	CH_4	0,245	5,749	15,00%	50,00%	52,20%	-0,06%	0,06%	0,06%	0,03%	0,01%	0,03%	D	D
1.A.2.f Other - Other Fuels	CH_4		0,595	2,00%	50,00%	50,04%	-0,01%	0,01%	0,01%	0,00%	0,00%	0,00%	D	D
1.A.3.c Civil Aviation - Aviation Gasoline	CH_4	0,000	0,000	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.c Civil Aviation - Jet Kerosene	CH_4	0,000	0,000	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Gasoline	CH_4	14,410	2,493	2,00%	50,00%	50,04%	-0,02%	0,10%	0,02%	0,05%	0,00%	0,05%	D	D

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1.A.3.b Road Transportation - Diesel Oil	CH_4	0,931	1,365	2,00%	50,00%	50,04%	-0,01%	0,02%	0,01%	0,01%	0,00%	0,01%	D	D
1.A.3.b Road Transportation - LPG	CH_4	0,105	0,239	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Lubricants	CH_4	0,003	0,002	10,00%	50,00%	50,99%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Gaseous Fuels	CH_4	0,356		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	D
1.A.3.b Road Transportation - Biomass	CH_4		0,025	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.c Railways - Liquid Fuels	CH_4	0,639	0,249	2,00%	50,00%	50,04%	0,00%	0,01%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.d Naviagtion - Gasoline	CH_4	0,002	0,003	20,00%	50,00%	53,85%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.a Commercial/Institutional - Liquid Fuels	CH_4	3,203	0,350	2,00%	50,00%	50,04%	0,00%	0,02%	0,00%	0,01%	0,00%	0,01%	D	R
1.A.4.a Commercial/Institutional - Solid Fuels	CH_4	7,365	0,227	2,00%	50,00%	50,04%	0,00%	0,04%	0,00%	0,02%	0,00%	0,02%	D	R
1.A.4.a Commercial/Institutional - Gaseous Fuels	CH_4	0,641	0,590	2,00%	50,00%	50,04%	-0,01%	0,01%	0,01%	0,00%	0,00%	0,00%	D	R
1.A.4.a Commercial/Institutional - Biomass	CH_4	32,873	30,083	20,00%	50,00%	53,85%	-0,30%	0,47%	0,29%	0,23%	0,08%	0,25%	D	R
1.A.4.b Residential - Liquid Fuels	CH_4	1,031	1,079	50,00%	50,00%	70,71%	-0,01%	0,02%	0,01%	0,01%	0,01%	0,01%	D	R
1.A.4.b Residential - Solid Fuels	CH_4	43,019	6,734	50,00%	50,00%	70,71%	-0,09%	0,29%	0,07%	0,14%	0,05%	0,15%	D	R
1.A.4.b Residential - Gaseous Fuels	CH_4	0,417	0,548	50,00%	50,00%	70,71%	-0,01%	0,01%	0,01%	0,00%	0,00%	0,01%	D	R
1.A.4.b Residential - Biomass	CH_4	126,063	193,687	50,00%	50,00%	70,71%	-2,52%	2,55%	1,90%	1,28%	1,34%	1,85%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	CH_4	4,381	0,937	2,00%	50,00%	50,04%	-0,01%	0,03%	0,01%	0,02%	0,00%	0,02%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	CH_4	7,008	0,165	2,00%	50,00%	50,04%	0,00%	0,04%	0,00%	0,02%	0,00%	0,02%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	CH_4	1,478	0,103	2,00%	50,00%	50,04%	0,00%	0,01%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	CH_4	7,686	3,579	2,00%	50,00%	50,04%	-0,03%	0,08%	0,04%	0,04%	0,00%	0,04%	D	R
1.A.5.b Mobile - Liquid Fuels	CH_4		0,000	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.B.2.b Natural Gas	CH_4	236,250	92,862	2,00%	2,00%	2,83%	-0,05%	2,14%	0,91%	0,04%	0,03%	0,05%	D	R
1.B.2.d Natural Gas	CH_4	37,800	8,568	2,00%	2,00%	2,83%	0,00%	0,28%	0,08%	0,01%	0,00%	0,01%	D	R
2.C.1 Iron and Steel Production	CH_4	0,058	0,056	25,00%	10,00%	26,93%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
4.A. Enteric Fermentation	CH_4	2 148,053	672,186	2,00%	20,00%	20,10%	-2,49%	17,73%	6,58%	3,55%	0,19%	3,55%	D	D
4.B.Manure Management	CH_4	273,758	96,156	2,00%	30,00%	30,07%	-0,53%	2,37%	0,94%	0,71%	0,03%	0,71%	D	D
5.A.1 Forest Land remaining Forest Land	CH_4	19,371	40,305	14,14%	70,00%	71,41%	-0,53%	0,50%	0,39%	0,35%	0,08%	0,36%	D	D
5.C.1 Grassland remaining Grassland	CH_4		0,126	100,00%	70,00%	122,07%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
6.A.1 Managed Waste Disposal on Land	CH_4		99,079	20,00%	52,00%	55,71%	-1,02%	0,97%	0,97%	0,50%	0,27%	0,57%	D	D
6.B.1 Industrial Waste Water	CH_4	307,123	101,036	2,00%	30,00%	30,07%	-0,56%	2,59%	0,99%	0,78%	0,03%	0,78%	D	R
6.B.2 Domestic and Commercial Waste Water	CH_4	97,860	72,514	10,00%	30,00%	31,62%	-0,42%	1,22%	0,71%	0,37%	0,10%	0,38%	D	R
6.D Other	CH_4		1,558	20,00%	100,00%	101,98%	-0,03%	0,02%	0,02%	0,02%	0,00%	0,02%	D	R
1.A.1.a Public Electricity and Heat Production - Liquid Fuels	N_2O	7,466	0,134	2,00%	50,00%	50,04%	0,00%	0,04%	0,00%	0,02%	0,00%	0,02%	D	R
1.A.1.a Public Electricity and Heat Production - Solid Fuels	N_2O	2,709	0,195	2,00%	50,00%	50,04%	0,00%	0,02%	0,00%	0,01%	0,00%	0,01%	D	R
1.A.1.a Public Electricity and Heat Production - Gaseous Fuels	N_2O	1,482	1,171	2,00%	50,00%	50,04%	-0,01%	0,02%	0,01%	0,01%	0,00%	0,01%	D	R
1.A.1.a Public Electricity and Heat Production - Biomass Fuels	N_2O	0,541	6,310	20,00%	50,00%	53,85%	-0,06%	0,06%	0,06%	0,03%	0,02%	0,04%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Liquid Fuels	N_2O	0,063	0,040	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R

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1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Solid Fuels	N_2O	1,957		2,00%	50,00%	50,04%		0,01%		0,01%		0,01%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Gaseous Fuels	N_2O	0,025	0,027	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries - Biomass Fuels	N_2O		0,624	15,00%	50,00%	52,20%	-0,01%	0,01%	0,01%	0,00%	0,00%	0,00%	D	R
1.A.2.a Iron and Steel - Liquid Fuels	N_2O	0,383	0,187	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.a Iron and Steel - Solid Fuels	N_2O	0,023	0,046	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.a Iron and Steel - Gaseous Fuels	N_2O	0,131	0,119	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.b Non-Ferrous Metals - Gaseous Fuels	N_2O		0,004	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.c Chemicals - Liquid Fuels	N_2O	0,677	0,016	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.c Chemicals - Gaseous Fuels	N_2O	0,013	0,019	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.c Chemicals - Biomass Fuels	N_2O		0,232	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N_2O	0,038		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N_2O	0,012		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N_2O	0,084	0,003	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.d. Pulp, Paper and Print - Biomass Fuels	N_2O		0,193	15,00%	50,00%	52,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels	N_2O	1,962	0,114	2,00%	50,00%	50,04%	0,00%	0,01%	0,00%	0,01%	0,00%	0,01%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Solid Fuels	N_2O	0,464	0,026	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Gaseous Fuels	N_2O	0,098	0,059	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.e Food Processing, Beverages and Tobacco - Biomass Fuels	N_2O	0,283	0,414	15,00%	50,00%	52,20%	0,00%	0,01%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Liquid Fuels	N_2O	2,709	0,362	2,00%	50,00%	50,04%	0,00%	0,02%	0,00%	0,01%	0,00%	0,01%	D	R
1.A.2.f Other - Solid Fuels	N_2O	0,195	0,788	2,00%	50,00%	50,04%	-0,01%	0,01%	0,01%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Gaseous Fuels	N_2O	0,468	0,122	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.2.f Other - Biomass Fuels	N_2O	0,482	11,315	15,00%	50,00%	52,20%	-0,11%	0,11%	0,11%	0,06%	0,02%	0,06%	D	D
1.A.2.f Other - Other Fuels	N_2O		1,171	2,00%	50,00%	50,04%	-0,01%	0,01%	0,01%	0,01%	0,00%	0,01%	D	D
1.A.3.c Civil Aviation - Aviation Gasoline	N_2O	0,000	0,002	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.c Civil Aviation - Jet Kerosene	N_2O	0,000	0,002	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Gasoline	N_2O	13,601	6,323	2,00%	50,00%	50,04%	-0,06%	0,13%	0,06%	0,07%	0,00%	0,07%	D	D
1.A.3.b Road Transportation - Diesel Oil	N_2O	5,819	13,574	2,00%	50,00%	50,04%	-0,13%	0,16%	0,13%	0,08%	0,00%	0,08%	D	D
1.A.3.b Road Transportation - LPG	N_2O	0,170	0,822	2,00%	50,00%	50,04%	-0,01%	0,01%	0,01%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Lubricants	N_2O	0,000	0,001	10,00%	50,00%	50,99%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.b Road Transportation - Gaseous Fuels	N_2O	0,011		2,00%	50,00%	50,04%		0,00%		0,00%		0,00%	D	D
1.A.3.b Road Transportation - Biomass	N_2O		0,478	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
1.A.3.c Railways - Liquid Fuels	N_2O	64,964	25,367	2,00%	50,00%	50,04%	-0,23%	0,59%	0,25%	0,29%	0,01%	0,29%	D	R
1.A.3.d Naviagtion - Gasoline	N_2O	0,000	0,000	20,00%	50,00%	53,85%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.a Commercial/Institutional - Liquid Fuels	N_2O	2,823	0,297	2,00%	50,00%	50,04%	0,00%	0,02%	0,00%	0,01%	0,00%	0,01%	D	R
1.A.4.a Commercial/Institutional - Solid Fuels	N_2O	7,306	0,446	2,00%	50,00%	50,04%	0,00%	0,04%	0,00%	0,02%	0,00%	0,02%	D	R

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1.A.4.a Commercial/Institutional - Gaseous Fuels	N_2O	0,189	0,174	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.a Commercial/Institutional - Biomass	N_2O	6,470	5,931	20,00%	50,00%	53,85%	-0,06%	0,09%	0,06%	0,05%	0,02%	0,05%	D	R
1.A.4.b Residential - Liquid Fuels	N_2O	0,913	0,531	50,00%	50,00%	70,71%	-0,01%	0,01%	0,01%	0,00%	0,00%	0,01%	D	R
1.A.4.b Residential - Solid Fuels	N_2O	3,306	0,480	50,00%	50,00%	70,71%	-0,01%	0,02%	0,00%	0,01%	0,00%	0,01%	D	R
1.A.4.b Residential - Gaseous Fuels	N_2O	0,123	0,162	50,00%	50,00%	70,71%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.b Residential - Biomass	N_2O	24,812	39,908	50,00%	50,00%	70,71%	-0,52%	0,52%	0,39%	0,26%	0,28%	0,38%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Liquid Fuels	N_2O	2,468	0,830	2,00%	50,00%	50,04%	-0,01%	0,02%	0,01%	0,01%	0,00%	0,01%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Solid Fuels	N_2O	0,508	0,011	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Gaseous Fuels	N_2O	0,436	0,030	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
1.A.4.c Agriculture/Forestry/Fisheries - Biomass Fuels	N_2O	1,513	0,705	2,00%	50,00%	50,04%	-0,01%	0,01%	0,01%	0,01%	0,00%	0,01%	D	D
1.A.5.b Mobile - Liquid Fuels	N_2O		0,011	2,00%	50,00%	50,04%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	D
3.D Other	N_2O		4,650	2,00%	2,00%	2,83%	0,00%	0,05%	0,05%	0,00%	0,00%	0,00%	D	D
4.B.Manure Management	N_2O	569,677	129,613	40,00%	30,00%	50,00%	-1,19%	4,23%	1,27%	1,27%	0,72%	1,46%	D	D
4.D.1. Direct Soil Emissions	N_2O	1 618,317	956,339	40,00%	25,00%	47,17%	-8,31%	17,76%	9,36%	4,44%	5,30%	6,91%	D	D
4.D.2 Pasture, Range and Paddock Manure	N_2O	358,351	86,866	40,00%	25,00%	47,17%	-0,75%	2,72%	0,85%	0,68%	0,48%	0,83%	R	R
4.D.3.Indirect Emissions	N_2O	1 033,873	388,414	30,00%	40,00%	50,00%	-3,58%	9,18%	3,80%	3,67%	1,61%	4,01%	R	R
5.A.1 Forest Land remaining Forest Land	N_2O	146,369	147,146	14,14%	70,00%	71,41%	-1,93%	2,20%	1,44%	1,54%	0,29%	1,57%	R	R
5.B.2 Land converted to Cropland	N_2O	71,342		35,00%	90,00%	96,57%		0,37%		0,33%		0,33%	R	R
5.C.1 Grassland remaining Grassland	N_2O		0,093	100,00%	70,00%	122,07%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	R	R
5.D.2 Land converted to Wetlands	N_2O	1,315	1,315	90,00%	95,00%	130,86%	-0,03%	0,02%	0,01%	0,02%	0,02%	0,02%	R	R
6.B.1 Industrial Waste Water	N_2O	2,436	0,246	10,00%	30,00%	31,62%	0,00%	0,02%	0,00%	0,00%	0,00%	0,00%	D	R
6.B.2 Domestic and Commercial Waste Water	N_2O	63,528	53,315	10,00%	30,00%	31,62%	-0,31%	0,85%	0,52%	0,26%	0,07%	0,27%	D	R
6.C Waste Incineration	N_2O		0,007	20,00%	90,00%	92,20%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	D	R
6.D Other	N_2O		1,725	20,00%	90,00%	92,20%	-0,03%	0,02%	0,02%	0,02%	0,00%	0,02%	D	R
TOTAL	**CO_2 eq**	**10 213,209**	**-5 430,900**	**25,158**	**79,462**	**88,641**	**54,530%**	**-4,701%**	**-53,175%**	**-39,698%**	**-3,564%**	**135,859%**		
CONTROL				Percentage uncertainty in total inventory			**73,84%**				Trend uncertainty	**116,56%**		
		Input Data	Input Data	$\sqrt{E^2+F^2}$	$\frac{G \bullet D}{\sum D}$	Note B	$\frac{D}{\sum C}$	$I \bullet F$ Note C	$J \bullet E \bullet \sqrt{2}$ Note D	$\sqrt{K^2+L^2}$	Note E	Note E	Note E	Note E

ANNEX 8: OTHER

Additional information on CSB **Integrated Statistical Data Management System (ISDMS)**

ISDMS contents:

Following business application software modules are covering and supporting all phases of the statistical data processing:

Core metadata base module – the key part of the system ensures metadata collection and storage, defines all entire system processes starting from data collection and ending with output reports preparation. All System software modules are linked with the Core Metadata module.

Registers module – ensure system users with the full range of respondents data.

Data entry and validation module – generates date entry and validation applications, executes validation and data editing processes and storage clean data sets in the Micro Data Base.

Web based data collection module – ensures electronic data collection via Web.

Data aggregation module – ensures data aggregation on different conditions and storage of the aggregated data sets in the Macro Data Base.

Data analysis module – via micro data export to MS Excel and/or Access ensures data analysis processes, MS OLAP tools are available for data analysis as well.

Data dissemination module – ensures data storage for publication at CSB web.

User's administration module – administrates user roles and rights.

ISDMS advantages:

1. Standardized data entry, processing and storage procedures => process oriented data processing.
2. Centralized processing and storage of all types of statistical data, including metadata, by using data warehouse technologies and OLAP tools.
3. The system is connected to Business Register => direct respondent basic data retrieval and updating.
4. Special import and export procedure is created for data exchange with other systems.
5. A link with PC Axis is created for electronic data dissemination.