LATVIA'S

NATIONAL INVENTORY REPORT

Submitted under United Nations Convention on Climate Change

Common Reporting Formats (CRF)
1990 – 2007

2009

PREFACE

Latvia's National Inventory Report under the United Nations Framework Convention on Climate Change (UNFCCC) and the voluntary submission under Kyoto Protocol contains following parts:

1. Latvia's national greenhouse gas emission inventory report (NIR) 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 1990-2007. The CRF tables are compiled with the UNFCCC CRF Reporter software (version 3.2.3).

In the NIR information regarding national system (chapter 1), National registry (chapter 1) as well as recalculations and improvements (chapter 9: under each sub sector) is included. Information on emissions and removals related to Kyoto Protocol Article 3, paragraphs 3 and 4 will be included in the inventory submission from 2010.

Authors: Helēna Rimša, Nora Jermaka, Agita Gancone, Lauris Siņics, Intars Cakars – Latvian Environment, Geology and Meteorology Agency, Division of Environment Pollution

Gaidis Klāvs - Institute of Physical Energetics (FEI)

Andis Lazdiņš, Andis Bārdulis - Latvian State Forest Research Institute "Silava"

Editing: Juris Frīdmanis – Latvian Environment, Geology and Meteorology Agency, Head of Division of Environment Pollution

Lāsma Āboliņa – Ministry of the Agriculture
Department of Forest Resources

Iveta Maslinarska – Ministry of the Environment, Climate and Renewable Energy Department

Contact: Agita Gancone – Latvian Environment, Geology and Meteorology Agency, Maskavas street 165, Riga, LV 1019, Latvia
E-mail: Agita.Gancone@lvgma.gov.lv

CONTENTS

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

AWMS - Animal waste management systems
CRF – Common Reporting Format
CSB – Central Statistical Bureau of Latvia
EMEP/CORINAIR – 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
FEWE – Polish Foundation for Energy Efficiency
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.
LEGMA – Latvian Environment, Geology and Meteorology Agency
LSIAE – Latvian State Institute of Agrarian Economics
LULUCF – Land Use, Land Use Change and Forestry
MoA - Ministry of Agriculture
MoE - Ministry of Environment
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 of Latvia
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

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 [6]. 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.

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 Commission 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 Latvian Ministry of the Environment. 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 1990-2007.

The GHG inventory is prepared according to the UNFCCC reporting guidelines on annual inventories (FCCC/SBSTA/2004/8). For the preparation of the 2009 submission CRF Reporter v.3.2.3 software has been used. Greenhouse gas inventory is compiled according to the methodologies recommended by the IPCC.

ES.2 SUMMARY OF NATIONAL EMISSIONS AND REMOVALS RELATED TRENDS

Latvia's total GHG emissions without LULUCF in 2007 showed a decrease of 55% comparing to the base year. Between 1990 and 2000 GHG emissions decreased significantly as reason of crisis in Latvian national economy in the beginning of 1990-ties. Table 1 shows the trends in the total emissions during the period 1990 – 2007.

In 2007, the most important GHG was CO_2, contributing 71% of total GHG emissions expressed in CO2 eq., then CH_4 – 15% and N_2O – 13%. F- Gases account 0.5% of total emissions.

Table 1 Aggregated GHG emissions by gases and sectors (1990, 1995, 2000 - 2007), Gg CO_2 eq

GREENHOUSE GAS EMISSIONS	Base year (1990)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	CO2 equivalent (Gg)														(%)
CO2 emissions including net CO2 from LULUCF	-2 216.988	-15 044.415	-15 974.558	-15 123.038	-15 142.243	-15 767.202	-17 402.872	-22 536.703	-18 346.206	-18 582.664	-20 428.246	-20 482.629	-24 300.219	-23 410.775	956
CO2 emissions excluding net CO2 from LULUCF	19 222.337	9 120.229	9 192.332	8 663.647	8 271.228	7 689.403	7 054.107	7 475.582	7 477.186	7 647.579	7 679.043	7 800.357	8 287.375	8 608.076	-55
CH4 emissions including CH4 from LULUCF	3 670.463	2 112.322	2 073.554	2 025.469	1 959.499	1 865.522	1 855.578	1 920.580	1 930.972	1 857.530	1 861.520	1 904.678	1 819.208	1 868.701	-49
CH4 emissions excluding CH4 from LULUCF	3 651.181	2 076.319	2 037.458	1 979.241	1 908.017	1 807.992	1 797.192	1 887.770	1 891.816	1 820.042	1 827.509	1 869.883	1 782.115	1 837.456	-50
N2O emissions including N2O from LULUCF	3 807.409	1 377.753	1 394.633	1 403.138	1 342.905	1 237.797	1 248.388	1 368.394	1 361.652	1 435.662	1 419.220	1 516.590	1 559.710	1 580.452	-58
N2O emissions excluding N2O from LULUCF	3 805.395	1 373.965	1 390.726	1 398.329	1 337.593	1 231.533	1 242.100	1 364.850	1 356.787	1 431.255	1 415.446	1 512.965	1 554.376	1 577.091	-59
HFCs	IE,NA,NE,NO	0.285	1.137	2.068	3.978	6.161	7.867	9.298	10.808	12.745	17.070	22.462	40.486	51.341	100
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	0
SF6	NA,NE,NO	0.251	0.287	0.508	0.710	0.977	1.275	1.977	3.382	4.413	5.370	7.530	7.124	8.702	100
Total (including LULUCF)	**5 260.883**	**-11 553.802**	**-12 504.946**	**-11 691.855**	**-11 835.151**	**-12 656.745**	**-14 289.764**	**-19 236.455**	**-15 039.391**	**-15 272.313**	**-17 125.065**	**-17 031.368**	**-20 873.691**	**-19 901.579**	**-478**
Total (excluding LULUCF)	**26 678.913**	**12 571.049**	**12 621.941**	**12 043.793**	**11 521.526**	**10 736.065**	**10 102.541**	**10 739.477**	**10 739.978**	**10 916.035**	**10 944.437**	**11 213.197**	**11 671.475**	**12 082.666**	**-55**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	CO2 equivalent (Gg)														(%)
1. Energy	19 341.826	9 555.744	9 631.097	9 067.039	8 641.643	8 009.161	7 388.900	7 817.923	7 813.509	7 958.167	8 000.956	8 110.759	8 546.262	8 826.755	-54
2. Industrial Processes	510.405	144.543	144.930	152.383	157.602	190.558	148.110	166.086	181.979	198.757	209.904	233.878	254.986	308.827	-39
3. Solvent and Other Product Use	55.698	46.166	48.270	48.904	48.300	49.463	49.106	55.161	53.412	54.074	55.318	54.195	64.083	55.059	-1
4. Agriculture	5 930.505	2 131.440	2 084.338	2 038.175	1 912.932	1 716.997	1 714.034	1 855.327	1 851.458	1 890.347	1 855.693	1 980.852	1 998.828	2 058.994	-65
5. Land Use, Land-Use Change and Forestry(5)	-21 418.030	-24 124.851	-25 126.887	-23 735.648	-23 356.677	-23 392.811	-24 392.305	-29 975.932	-25 779.369	-26 188.348	-28 069.503	-28 244.566	-32 545.166	-31 984.245	49
6. Waste	840.479	693.156	713.306	737.292	761.049	769.886	802.390	844.980	839.620	814.691	822.567	833.513	807.316	833.031	-1
7. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
Total (including LULUCF)	**5 260.883**	**-11 553.802**	**-12 504.946**	**-11 691.855**	**-11 835.151**	**-12 656.745**	**-14 289.764**	**-19 236.455**	**-15 039.391**	**-15 272.313**	**-17 125.065**	**-17 031.368**	**-20 873.691**	**-19 901.579**	**-478**

In 2007 Energy sector accounted for 73% of total GHG emissions, then Agriculture with 17%, Waste - 6.91%, Industrial Processes – 2.56% and Solvent and Other Product Use – 0.46%.

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

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 1. In comparison to 2006, total emissions increase by 3.52%.

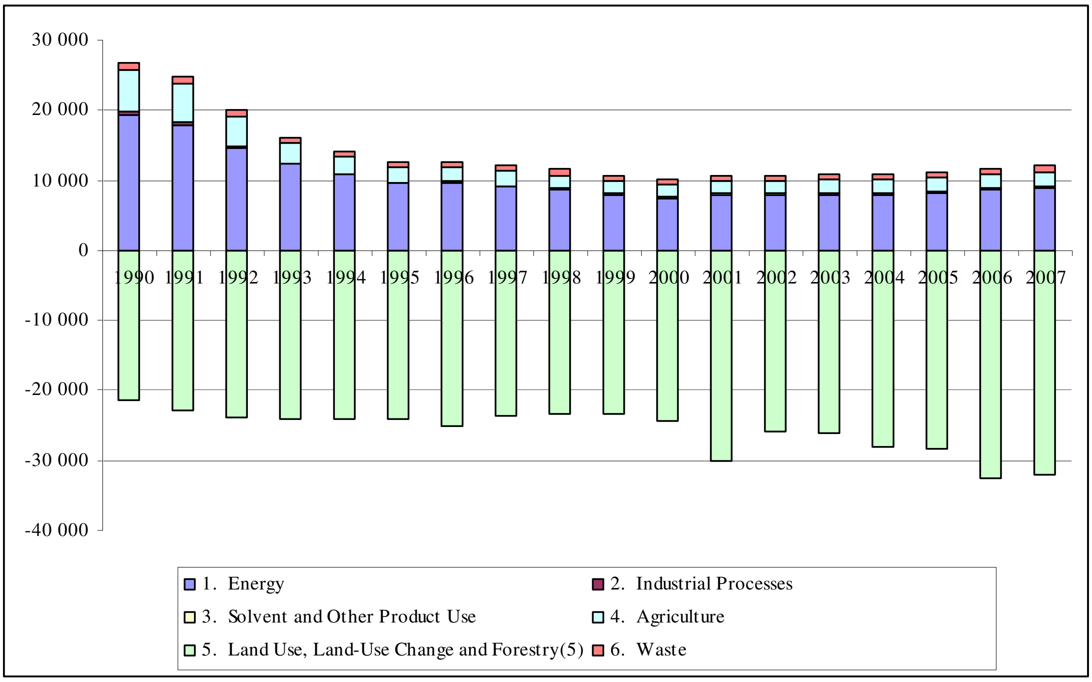


Figure 1 Latvian greenhouse gas emission trends by sector, Gg CO_2 eq.

The **Energy sector** is the most significant source of GHG emissions with 73% share of the total emissions in the 2007. As proved by the data of annual reports, CO_2 emissions from the Energy sector in the latest years are stable, but still CO_2 eq curve of Energy sector has an increasing tendency. Only GHG emissions from Transport sector and Manufacturing Industries sector have increased from 2006 to 2007 that is explained with increasing number of vehicles in Latvia and radical development of industrial production. Transport is the most important Energy sub–sector with 43.25% of total CO_2 eq energy emissions and 31.7% of total CO_2 Gg eq emissions. GHG emissions from Transport sector rose by 9.5% compared to last year.

Agriculture is the second most significant source of GHG emissions, with approximately 17% of Latvia's total emissions. The total emissions from agriculture have a clearly stable trend in the latest years. In the latest years it is observed growing of emissions year by year. The annual emissions have reduced approximately by 65% since 1990 due to decreases in the number of livestock and in nitrogen fertilisation.

The **Industrial Processes** category contributes approximately 2.56% of the total GHG emissions. The largest decrease in emissions occurred between years 1991 and 1993, when industry was going through a crisis. Since 2000 and after the crisis in national economy of Russian Federation with whom Latvia has strength economic relations, CO_2 equivalent emissions from Industrial Processes sector have increased by 52%. It is explained with development of Latvian industry.

Solvent and Other Product Use made only about 0.46% of Latvia's total GHG emissions. Emissions in the Solvent and Other Product Use sector are linked with the economic situation of the country. Decrease in emissions occurred between years 1993 and 1995, when industry was going through a crisis. The annual emissions have reduced approximately by 1.1% since 1990.

GHG emissions from **Waste sector** have been increased since 1990. In 2007, emissions were approximately 0.9% lover than in 1990. In 2007, emissions from the Waste sector were 833.03 Gg CO_2 equivalents; it contributes about 6.91 % of total GHG emissions (excluding LULUCF). In 1993, methane collection from wastewaters was started and emissions from wastewaters decreased. Every year emissions from waste disposal on land increased equable, because First Order Decay (Tier 2) method for calculations is used and methane collection and recovery in landfills is not yet well developed.

Land use, Land use change and forestry (LULUCF) is a net sink in Latvia. In 2007, CO_2 removals were 31984.25 Gg CO_2 compared to 21418.03 Gg CO_2 in the base year that is approximately 49% higher than in 1990. In 2007, the main sink is Forestland with net removals of 31730.57 Gg CO_2.

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 2.

Table 2 Emissions of indirect GHG and SO_2, Gg

	NOx	CO	NMVOC	SO_2
1990	67.03	382.64	89.68	101.48
1991	61.22	328.84	61.07	83.08
1992	51.66	318.54	56.42	71.67
1993	45.10	317.16	55.31	67.33
1994	42.27	315.04	54.63	66.79
1995	39.96	314.20	53.83	48.54
1996	40.03	323.26	55.27	54.65
1997	39.66	313.11	55.35	39.38
1998	39.65	303.21	54.55	35.85
1999	38.77	302.83	54.97	29.35
2000	37.15	303.51	53.44	9.80
2001	37.67	308.20	53.84	8.05
2002	37.77	307.87	55.02	6.37
2003	39.26	316.32	57.29	4.89
2004	45.33	323.35	60.13	3.99
2005	42.54	319.98	60.12	4.60
2006	44.16	317.10	60.41	3.76
2007	42.64	300.27	58.24	3.33

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 wood fuel 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.

1. INTRODUCTION

1.1 BACKGROUND INFORMATION ON CLIMATE CHANGE POLICY AND GREENHOUSE GAS INVENTORIES

Latvia is a country by the Baltic Sea with total area of 64 589 square kilometres and there are 2 281305 (2007) inhabitants. Baltic coastline is approximately 496 km. 45.5% of Latvia's territory is covered by forest, 37.9% of territory is used for agriculture, but 16.6% includes other land, roads, courtyards, bogs, and bushes (data on 01.01.2008). 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 [6].

Since restoration of independence in 1991 economy of Latvia had experienced very significant changes. From 1990-ties Latvia starts up a transition from a centrally planned economy to market based economy. It arises in decreasing of economical activities in all branches. Over that time period GDP decreased approximately by 50%. In 1994, increase of GDP was noticed, but in 1995 it decreased due to the crisis of bank sector. Since 1996, economy of Latvia started to grow [26]. High growth has been observed in Latvia during 2005-2007, which is characterized by annual average increase of GDP of 11% and in 2007 – by 10.3%. Such high growth rates were mostly ensured by domestic demand. Both, private consumption and investment considerably increased. Since the mid-2007, the growth rates have started to decline, both, due to processes influencing (weakening of domestic demand) environment and external (decrease of the growth rates globally) environment [30].

The Parliament of the Republic of Latvia ratified the 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 of 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".

Latvia is a member of EU since May 2004 and Latvia's climate change policy is based on Europe Union climate policy. Ministry of Environment, Climate and Renewable Energy Department coordinate policy related to climate change and renewable energy in Latvia as well as is the designated single national entity. The new legislation act No. 157 of Cabinet of Ministers (17.02.2009) determinates the institutions that are responsible for GHG inventory preparation. The national inventory compiler is the Latvian Environment Geology and Meteorology Agency (LEGMA).

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 2007. The structure of this NIR follows the UNFCCC reporting guidelines on annual inventories.

1.2 A DESCRIPTION OF THE INSTITUTIONAL ARRANGEMENT FOR INVENTORY PREPARATION

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 inventories.

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.

The new Regulation No. 157 was approved and adopted by the Cabinet of Ministers on 17 February 2009. Detailed functions (roles) and responsibilities of institutions that are involved in the preparation of the National inventory are prescribed in the regulation, including the designation of an institution controlling the QA/QC procedures. A schematic model for the national system (NIS) is shown in the Figure 1.1.

Single national entity with overall responsibility for the Latvian GHG inventory is the Latvian Ministry of the Environment (MoE) Climate and Renewable Energy Department. The MoE is responsible for:

- Informing the inventory compilers about the requirements of the national system;
- Final checking and approving the inventory before official submission to the EC and UNFCCC;
- Formal agreements with inventory experts regarding Transport sector and for experts that evaluate quality assurance process;
- Coordinating the work between the inventory compilers, EC and UNFCCC (including coordination the UNFCCC inventory reviews).

Latvian Environment, Geology and Meteorology Agency (LEGMA) is a governmental institution under the supervision of the Ministry of Environment of the Republic of Latvia and are responsible for preparing GHG inventory (Division of Information on Environmental Pollution (head Mr. Juris Fridmanis)):

- Together with MoE coordinates the overall inventory preparation process, including the compilation of National inventory;
- Collects of activity data - activity data are mainly collected from other institutions and LEGMA uses it to calculate emissions;
- Prepares the emission estimates for the Energy, Industrial Processes, Agriculture, Waste and partly LULUCF sectors;
- Prepares sectoral parts of the NIR and compiles the final NIR;
- fills in the sectoral data to the CRF Reporter (for relevant sectors);
- Prepares QC procedures;
- Documents and archives the prepared inventory.

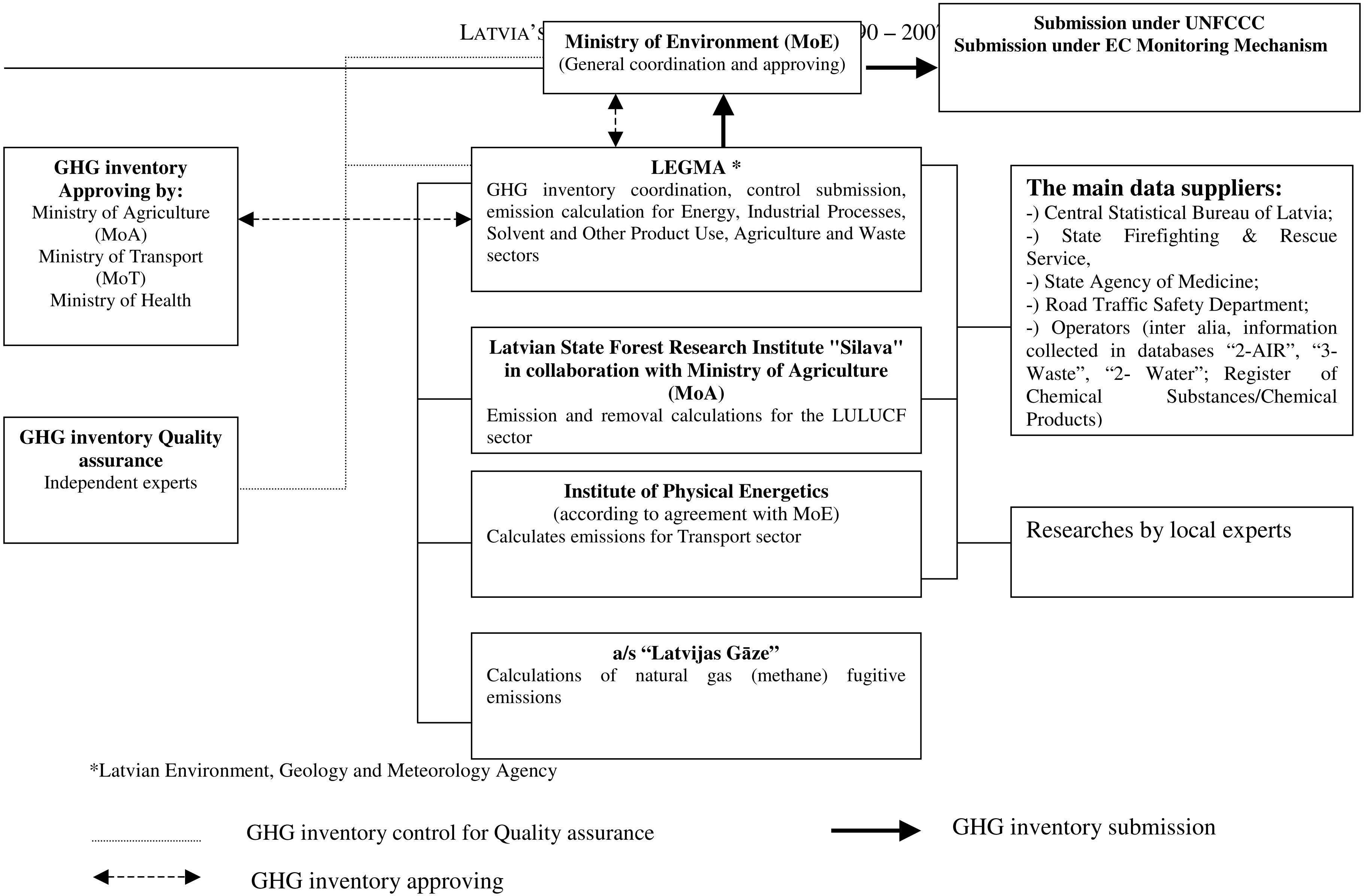


Figure 1.1 Structure of National Inventory System

The main data supplier for the Latvian GHG inventory is the Central Statistical Bureau of Latvia (CSB) with what LEGMA has signed additional agreement for the supply of the necessary data.

For submission 2009, the first emission calculations for the LULUCF sector were done by Latvian State Forest Research Institute "Silava" collaborated with MoA.

For submission 2009, the first time Institute of Physical Energetics (FEI) calculates emissions for Transport sector according to agreement with MoE.

Before GHG inventory are reported to European Commission and UNFCCC secretariat it is forwarded to the MoE for final approval.

One general meeting was held in the June to discuss and agree on the methodological issues, problems that have arisen and improvements that need to be implemented. There was discussion on the different problems that came up during the last inventory preparation to find solutions how to improve the overall system.

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

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

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

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	LEGMA, Institute of Physical Energetics (FEI)
Table 1.A(b) – CO_2 from Fuel Combustion Activities – Reference Approach	Activity data	CSB
	Calculations	LEGMA
Table 1.A(d) – Feedstock's and Non-Energy Use of Fuels	Activity data	CSB
	Calculations	LEGMA
Table 1.B.2. – Fugitive Emissions from Oil and Natural Gas	Activity data	CSB
	Calculations	LEGMA, a/s "Latvijas Gāze"
Table 1.C – International Bunkers and Multilateral Operations	Activity data	CSB
	Calculations	LEGMA
Table 2(I).A-G – Industrial Processes	Activity data	CSB, EU Emission Trading Scheme operator
	Calculations	LEGMA, EU Emission Trading Scheme operators

CRF sectors	Data	Responsible institutions
Table 2(II) F – Industrial Processes - HFCs, PFCs AND SF_6	Activity data	Central Statistical Bureau; a/s "Latvenergo"; State Agency of Medicines of Latvia; Enterprises operating with F-gases (reported to Chemicals Register of LEGMA)
	Calculations	LEGMA
Table 3 – Solvent and Other Product Use	Activity data	CSB; State Agency of Medicines of Latvia Research of experts; LEGMA "2-AIR" database
	Calculations	LEGMA
Table 4.A – Agriculture, Enteric Fermentation	Activity data	CSB
	Calculations	LEGMA
Table 4.B(a) - Agriculture, CH_4 Emissions from Manure Management	Activity data	CSB
	Calculations	LEGMA
Table 4.B(b) - Agriculture, N_2O Emissions from Manure Management	Activity data	CSB
	Calculations	LEGMA
Table 4.D - Agriculture, Agricultural Soils	Activity data	CSB
	Calculations	LEGMA
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 with Ministry 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, LEGMA
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, LEGMA
Table 5. (IV) CO_2 emissions from agricultural lime application	Activity data	CSB
	Calculations	LEGMA
Table 5. (V) Biomass Burning	Activity data	CSB; State Firefighting & Rescue Service
	Calculations	Latvian State Forest Research Institute "Silava", LEGMA
Table 6 A - Waste, Solid Waste Disposal on Land	Activity data	LEGMA, Methane recovery installations
	Calculations	LEGMA
Table 6 B - Waste, Wastewater Handling	Activity data	CSB, LEGMA
	Calculations	LEGMA
Table 6 C - Waste, Waste Incineration	Activity data	LEGMA
	Calculations	
Table 6 D – Waste Other (composting)	Activity data	LEGMA
	Calculations	

Annual process of compilation of the Latvia's inventory is shown in the Table 4.

Table 1.2 Inventory production 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
Worksop	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
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 LEGMA	EU Emission Trading Scheme (EU ETS) operators	EU ETS operators send to LEGMA 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. LEGMA uses these data in GHG inventory.	till 30th March
		Operators	LEGMA 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 LEGMA 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

Element	Activity	Responsible performers	Procedures	Due date
		State Firefighting & Rescue Service (SFRS)	SFRS send to LEGMA activity data - area of last years grass (ha).	till 1st October
		Ministry of Health collaborating with State Agency of Medicines of Latvia (SAM)	SAM send to LEGMA activity data.	till 1st October
Emissions and descriptions	Submission to MoE and LEGMA	FEI according to agreement with Ministry of Environment	FEI send to MoE and LEGMA report about emissions from Transport, including information about activity data, which was received from CSB.	till 1st December
		a/s "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 LEGMA	Latvian State Forest Research Institute (LSFRI) "Silava" collaborated with Ministry of Agriculture	LSFRI "Silava" send to MoE and LEGMA report, CRF about CO_2 removals and emissions from LULUCF	till 1st December
CRF tables (XML)	Compilation of the CRF tables and QC by the LEGMA experts	LEGMA	LEGMA experts compile CRF tables, QC and send to national inventory compiler (LEGMA)	till 10th December
CRF data Short NIR according to Decision 280/2004/EC	Draft Inventory preparation, including QC activities	LEGMA	LEGMA send to MoE data in CRF and draft short NIR for approval	10th January
CRF data Short NIR according to Decision 280/2004/EC	Comments by the MoE	MoE	MoE send the comments and approval to LEGMA	10-14 January
CRF data Draft NIR according to Decision 280/2004/EC	CRF, NIR	LEGMA MoE	After corrections made by LEGMA, MoE send to EC CRF tables and draft short NIR through the Permanent Representation. LEGMA uploaded CRF tables, XML and draft NIR in the EIONET CDR, MoE electronically sent to EC notification about applauded data.	15th January
Quality control checks	QA/QC procedures, reports according to QC plan	LEGMA	According to QC plan internal review was carried out.	January - February
NIR 1st draft		sectoral experts	Sectoral experts send NIR 1st draft to LEGMA (national inventory compiler)	23 January
NIR 1st draft		LEGMA	LEGMA send to involved institutions NIR 1st draft for comments and approving.	till 30 January

Element	Activity	Responsible performers	Procedures	Due date
NIR 1st draft		Involved institutions	Involved institutions send to LEGMA 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
CRF data NIR according to Decision 280/2004/EC	CRF, NIR	MoE LEGMA	MoE sends to EC final CRF tables and final NIR according to Decision 280/2004/EC requirements through the Permanent Representation. LEGMA uploaded CRF tables, XML and draft NIR in the EIONET CDR, MoE electronically sent to EC notification about applauded data.	15th March
NIR and emission data in CRF	Inventory submission	MoE, LEGMA	LEGMA coordinating with MoE send approved GHG inventory to UNFCCC (uploaded to ftp).	15th April

1.3 GENERAL DESCRIPTION OF METHODOLOGIES AND DATA SOURCES

Latvia's GHG emissions inventories are 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) and EMEP/CORINAIR Emission Inventory Guidebook – 3rd editions (2002) 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.);
- IPCC 1996;
- IPCC GPG 2000;
- IPCC GPG LULUCF 2003;
- IPCC 2006;
- EMEP/CORINAIR Guidebook.

The updated CRF Reporter version 3.2.3 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 III; 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.

A Tier 2 method was used to estimate emissions from Industrial Processes. Information about used raw materials and production technologies as well as plant specific emission factors was used to estimate emissions.

Emissions from Road Transport sector were estimated by using COPERT III model for 1990 – 2003 and for 2004 – 2007 COPERT IV model. Emissions from other transport categories were calculated according to IPCC Guidelines.

Emissions from Solvent and Other Product Use were estimated according to EMEP/CORINAIR Guidebook, expert research and judgement 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/AIE – EUROSTAT – UNECE Annual questionnaires; LEGMA "2-AIR" database; Research of experts.	LEGMA; plant operators
Transport	Energy balance from Latvian CSB; IEA/AIE – EUROSTAT – UNECE Annual questionnaires; Data of Road Traffic safety Directorate; Research of experts.	FEI according to agreement with Ministry of Environment
Industry	National production and sales statistics; Direct information from enterprises operating with pollutants; Central Statistical Bureau; Chemicals Register; Assumption of experts.	LEGMA; plant operators
Solvent	Central Statistical Bureau; State Agency of Medicines of Latvia; Research of experts; LEGMA "2-AIR" database	LEGMA
Agriculture	National agricultural statistics obtained from CSB; National studies.	LEGMA
LULUCF	National statistical forest inventory (NFI) Central Statistical Bureau; State Firefighting & Rescue Service; National studies and expert judgment.	Latvian State Forest Research Institute "Silava" collaborated with Ministry of Agriculture; LEGMA
Waste	Latvian Environment, Geology and Meteorology Agency "3-Waste" and "2-Water" databases; Expert research was used for wastewater emissions calculations; Methane recovery installations; CSB.	LEGMA

1.4 DESCRIPTION OF KEY SOURCE CATEGORIES

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 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 prioritised 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.

Latvia uses Tier 1 method to identify key sources. 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 Practise Guidance as Table 7.A1 and with LULUCF is presented in Good Practise Guidance for LULUCF as Table 5.4.1. The base year for CO_2, CH_4, and N_2O greenhouse gas emissions was 1990.

Key source categories are those which, when summed together GHG emissions calculated in CO_2 equivalent units in descending order of their magnitude, add up to over 95% of the total emissions estimates in the inventory for each year.

13 key sources of Level Assessment without LULUCF were identified in 1990 and 12 with LULUCF, but in 2007 without LULUCF – 14 and with – 9. The key sources identified according to trend assessment without LULUCF was 12, but with LULUCF – 12.

The key sources for 2007 with LULUCF are shown in Table 1.4 and Table 1.5, but for 1990 and 2006 key sources are included in Annex 1 in the same way as key sources, which determined without LULUCF.

1.4 Key sources - Level Assessment in 2007 with LULUCF

	IPCC Source Categories	Direct Greenhouse Gas	2007, absolute values	Level Assessment	Cumulative
1	Removals from Forest Land	CO2	31730.57	0.72	0.72
2	Mobile Combustion: Road Vehicles	CO2	3495.215	0.08	0.80
3	CO2 Emissions from Stationary Combustion-gas	CO2	3160.78	0.07	0.87
4	CO2 Emissions from Stationary Combustion-oil	CO2	971.24	0.02	0.89
5	Emissions from Agricultural Soils	direct-N2O	775.40	0.02	0.91
6	Emissions from Enteric fermentation in Domestic Livestock's	CH4	592.12	0.01	0.92
7	Emissions from Solid Waste Disposal Sites	CH4	532.88	0.01	0.94
8	CO2 Emissions from Stationary Combustion-coal	CO2	410.34	0.01	0.95
9	Emissions from Nitrogen Used in Agriculture	indirect-N2O	337.70	0.01	0.95

1.5 Key sources - Trend assessment in 2007 with LULUCF

	IPCC Source Categories (LULUCF is included)	Direct Greenhouse Gas	Base year 1990, CO2 eq.Gg	2007, CO2 eq.Gg	Level Assessment	Trend Assessment	Contribution to trend, %	Cumulative, %
1	Removals from Forest Land	CO2	21660.40	31730.57	0.72	0.30	0.43	0.43
2	CO2 Emissions from Stationary Combustion-oil	CO2	7421.58	971.24	0.02	0.14	0.20	0.63
3	CO2 Emissions from Stationary Combustion-coal	CO2	2840.01	410.34	0.01	0.05	0.08	0.71
4	CO2 Emissions from Stationary Combustion-gas	CO2	5537.97	3160.78	0.07	0.05	0.07	0.77
5	Mobile Combustion: Road Vehicles	CO2	2313.57	3473.17	0.08	0.03	0.05	0.82
6	Emissions from Enteric fermentation in Domestic Livestock's	CH4	2057.23	592.12	0.01	0.03	0.05	0.87
7	Emissions from Agricultural Soils	direct-N2O	1649.86	775.40	0.02	0.02	0.03	0.89
8	Emissions from Nitrogen Used in Agriculture	indirect-N2O	1033.87	337.70	0.01	0.02	0.02	0.92
9	Emissions from Manure Management	N2O	551.63	163.99	0.00	0.01	0.01	0.93
10	Emissions from Solid Waste Disposal Sites	CH4	278.79	532.88	0.01	0.01	0.01	0.94
11	Mobile Combustion: Railways	CO2	525.64	242.60	0.01	0.01	0.01	0.95
12	Pasture, Range and Paddock Manure	N2O	358.39	105.52	0.00	0.01	0.01	0.95

1.5 UNCERTAINTIES

Uncertainty estimates are an essential element of a complete emissions inventory. Uncertainty information is not intended to dispute the validity of the inventory estimates, but to help prioritise efforts to improve the accuracy of inventories in the future and guide decisions on methodological choice.

The uncertainty estimate of the inventory 2009 has been done according to the Tier 1 method presented by the IPCC GPG 2000. The Tier 1 method is based on emission estimates and uncertainty coefficients for activity data and emission factors.

In many cases uncertainty coefficients have been assigned based on expert judgement or on default uncertainty estimates according to IPCC GPG 2000, because there is a lack of the information about background data to make actual calculations. For each source, the uncertainty for activity data and emission factors was estimated and given in per cent. 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.

The overall uncertainty (excluding LULUCF) is calculated to be approximately 5% and the trend uncertainty is 2.34%. The Tables 1; 2; 3 in the Annex 2 show the uncertainties separate for each direct GHG. The overall uncertainty for CO_2 is 3.58%, for CH_4 – 16% and for N_2O – 22%. The trend uncertainty is calculated for CO_2 – 1.66%, for CH_4 – 7% and for N_2O – 10%. Uncertainties for CH_4 and N_2O are higher basically due to use default emission factors.

The overall uncertainty (including LULUCF) is calculated to be approximately 22.5% and the trend uncertainty is 10.9%. The overall uncertainty (including LULUCF) for CO_2 is 24.38% and trend uncertainty – 11.91% (Table 4, Annex 2).

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

Quality Assurance and Quality Control

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 Regulation No. 157 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. As legislation act became valid only beginning of 2009 many of determined actions will be implemented for inventory 2010.

New 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.

For submission 2009, many of quality control procedures were done according to LEGMA internal QA/QC program.

QC procedures implemented

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

LEGMA is responsible for coordination of the whole process of annual greenhouse gas inventory and has an overall responsibility for QC.

For submission 2009, 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.

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.

For submission 2009:

-)The sectoral experts sent XML files to national inventory compiler (NIC - LEGMA) who imports all data together in CRF Reporter. NIC performed cross-checking for all sectors to verify that no mistakes occured 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.

-) Experts in LEGMA prepared quality control procedures by using special check-list according to LEGMA internal QA/QC program. After review the check-lists were sent to relevant experts and NIC. Then findings were introduced in GHG inventory. All these QC forms were archived;

-) LSFRI "Silava" checked data according to QC procedures that was outlined in IPCC GPG. MoA reviewed prepared inventory regarding LULUCF. Corrections were sent to NIC and LSFRI "Silava" for including in the inventory;

-) For Transport sector quality control was done by LEGMA and MoT. Findings were documented and introduced in emission evaluation.

Detailed source specific QA/QC descriptions are included under each sub sector.

Quality assurance procedures implemented

The draft of National inventory report was sent to CSB, MoE, MoA, MoT til 20 of January for checking and approving. Received corrections were implemented in the GHG report.

On 28 February the European Commission (EC) consistency report of inventory was received. The possible corrections were elaborate in inventory.

UNFCCC reviews reports indicated the issues where inventory need of improvements. The possible improvements were elaborate in 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. 157 MoE is responsible for ensuring QA procedures for GHG inventory.

Improvement plan

For submission 2009, improvement plan firstly was presented in the end of June 2008 by LEGMA in annual meeting of the institutions involved in GHG inventory preparation. Improvement plan was conformed till August 2008.

After the finalization of annual GHG inventory it is evaluated if planned improvements have been implemented (Annex 9).

Archiving

As part of general QC procedures, it is good practice to document and archive all information that is used for emission estimates.

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

Every annual inventory (CRF tables and NIR) is archived by LEGMA.

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 LEGMA archive. All information is archived on CDs.

1.7 GENERAL ASSESSMENT OF THE COMPLETENESS

CRF-Table 9 (Completeness) has been used to give information on the aspect of completeness.

All territory of Latvia is covered by the inventory. All sources and sinks included in the IPCC Guidelines are covered. No additional sources and sinks identified. Emissions from large part of CRF tables have been estimated.

Both direct GHGs as well as indirect GHGs are covered by the Latvia's inventory.

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.

The completeness is estimated taking into account the usage of notation key NE relation this number to total amount of the subcategories. Completeness is estimated for the direct GHG emissions. Indirect GHG emissions weren't taken into account.

The Table 1.6 shows the Latvia's data submission completeness for the direct GHG emissions in 2007. The completeness comparing to submission 2008 of Energy sector has increased by 11.1%, completeness of the Industrial processes has grown only by 0.5%. Biggest increase of the completeness is observed for the Agriculture sector – 32.3%. Completeness of the LULUCF sector has increased for the 6.4% but for the Waste sector – 2.4%. Completeness of the Solvents sector hasn't changed.

The overall completeness for submission 2009 has improved by 8.8%. Detailed description will be explained in full National Inventory Report, which will be submitted in March 2007.

Table 1.6 Completeness in submission 2009 of GHG emission estimation (excluding indirect GHG emissions)

Sector	Submission 2008		Submission 2009	
	2006		2007	
	NE	Completeness	NE	Completeness
Energy	8	87.9%	0	100%
Industrial Processes	18	92.9%	17	93.4%
Solvents	4	71.4%	4	71.4%
Agriculture	27	63.5%	3	95.9%
LULUCF	119	17.4%	109	25.3%
Waste	14	67.4%	14	69.6%
Total	**190**	**66.4%**	**147**	**83.9%**

1.8 INFORMATION OF LATVIA'S EMISSION TRADING REGISTRY

According to Article 7 of the Kyoto Protocol each Party included in Annex I shall incorporate in its annual greenhouse gas inventory the necessary supplementary information for the purposes of ensuring compliance with Article 3 of the Kyoto Protocol. Decision 15/CMP.1 further specifies this supplementary information stating, among other things, that each Party included in Annex I with a commitment inscribed in Annex B shall include in its national inventory report information on any changes that have occurred in its national registry, compared with information reported in its last submission.

The description for the Latvia's Emission Trading Registry (ETR) for initial report under the Kyoto Protocol has been provided to UNFCCC secretariat as part of Latvia's initial report under the Kyoto Protocol.

According to national legislation Latvian Environment, Geology and Meteorology Agency is responsible for establishing and maintaining Latvia's ETR.

Latvia's ETR is developed with full consistency to "Data Exchange Standards for Registry Systems under the Kyoto Protocol by registry developers from UK DEFRA (GRETA Registry system). Currently version 3.00.00.0083 is used for Latvia's ETR.

The ETR software had passed Annex H testing in 31st October – 1st November 2007 and CITL testing with Latvia's Registry in 6th June 2008 as well as 5 weeks of cycle testing that was performed according to Registry Testing Cycle documentation prepared by the ITL.

The Latvia's ETR successfully passed the "Rehearsal 2 for the ETS Go-Live with ITL" that was performed in 18th July – 4th August 2008 and "Rehearsal 3 for the ETS Go-Live with ITL" that was performed in 23rd September and in 26th September 2008 due to some problems in the 23rd September testing.

Latvia's ETR successfully participated in the real "Go-Live with ITL" process that took place in 29th September – 16th October 2008. So after 16th October 2008 Latvia's ETR is fully operating

In the end of 2007 LEGMA received "Registry Initialization Recommendation" according to whom another package of documents were prepared and sent to UNFCCC on January 23, 2008 – Disaster recovery plan, Test plan, Application logging documentation and Version change management plan were prepared. Test plan of Latvia's Registry was completely revised in the August – September 2008. The test results of the "2nd Rehearsal of the Go-Live with ITL" was included as well as Cycle Testing results of 5 testing weeks when all Registry operations and activities were tested.

According to "Independent Assessment Report of the National Registry of Latvia" the registry has fulfilled all of its obligations regarding conformity with the Data Exchange Standards. These obligations include having adequate transaction procedures; adequate security measures to prevent and resolve unauthorized manipulations; and adequate measures for data storage and registry recovery. The registry is therefore deemed fully compliant with the registry requirements defined in decisions 13/CMP.1 and 5/CMP.1, noting that registries do not have obligations regarding Operational Performance or Public Availability of Information prior to the operational phase. Latvia had completed all Registry Readiness documentation by autumn 2007 and documentation is scored 80% (max. 100) and it means that no significant concerns about the state of registry readiness are identified.

Latvia had fulfilled all the recommendations and requirements prepared by ERT (2007) of assigned amount units calculation. The Initial Review Report for Latvia was published officially on the official Internet page of the UNFCCC on 14th December 2007.

Latvia's National Allocation Plan was approved at 30th September 2008 and therefore it was possible to allocate at that time. Still Latvia decided to allocate allowances only after the official "Go-Live with ITL" that was set to 1st October – 16th October 2008.

The AAU allowances were issued in 9th October 2008 and 119182130 AAUs were issued to Latvia's Party's Holding Account (approved assigned amount). The transaction number is LV-1019.

The EUAs from AAUs were issued in 27th October 2008 according to approved Latvia's National Allocation Plan and 16992415 EUAs were issued to Latvia's Party's Holding Account. Allocation of allowances to Latvia's operators was performed in 31st October 2008 and according to Latvia's National Allocation Plan 2597744 EUAs had to be allocated to Latvia's operators. Still 2569722 EUAs were allocated to Operator's Holding Accounts. Allocation of 28022 EUAs for two operators was prevented due to lack of official decision from Ministry of Environment of Latvia.

Therefore at the end of the year 2008 116612408 AAUs were held in the Latvia's Party's Holding Account and 2752354 EUA_AAUs in the Entity Holding Accounts.

In total 12 external transfers were performed from Latvia's ETR accounts to 5 EU party's accounts and 112 456 EUA_AAUs were transferred in total. 6 external transfers were performed from 6 EU party's accounts to Latvia's ETR accounts and 295088 EUA_AAUs and 110000 CERs were transferred in total. 90000 CERs were transferred from the Switzerland Registry to one of Latvia's Operator's Holding Account and 20000 CERs were transferred from the United Kingdom Registry to the other Latvia's OHA. Therefore 110000 CERs were held in the Latvia's Operator's Holding Account to the end of year 2008.

1.8.1 Changes in national registries in accordance decision 15/CMP.1

The GRETA registry version 3.0.0.83 was used for the "Go-Live process" in the October 2008. Since then Latvia's registry is active with the exceptions when some maintenance or operational problems occurred in the ITL or CITL as well as 3 hours brake in connection between Latvia's ETR and ITL in the 9th December 2008 when some network problems within network equipment occurred at Latvia's side.

1.8.2 The Standard Electronic Format for reporting Kyoto Protocol units

The Standard Electronic Format (SEF) Excel tables were filled manually due to lack of appropriate tool in the registry's software that would allow exporting necessary data in XML format for importing them into SEF tables.

All Excel tables are given in the Annex III of this report as attached file.

1.8.3 Reports on discrepancies, notifications, replacements, commitment period reserve calculation

No discrepancies identified by the transaction log specifying whether the relevant transactions were completed or terminated and, in the case where transactions were not terminated, the transaction number(s) and serial numbers and quantities of ERUs, CERs, tCERs, lCERs, AAUs and RMUs concerned.

No notifications were received from the Executive Board of the clean development mechanism (CDM) to replace lCERs. No notifications were received from the Executive Board of the CDM to replace lCERs in accordance with paragraphs 49 and 50 of the annex to decision 5/CMP.1.

No non-replacement cases identified by the transaction log specifying whether the replacement was subsequently undertaken and, in the case where replacement was not undertaken, the serial numbers and quantities of the tCERs, lCERs concerned were recorded.

There are no invalid ERUs, CERs, tCERs, lCERs, AAUs and RMUs held in the Latvia's registry at the end of the year.

According to decision 15/CMP.1 Latvia has to report:

- R-1: Standard electronic format (SEF)
- R-2: List of discrepant transactions
- R-3: List of CDM notifications
- R-4: List of non-replacements
- R-5: List of invalid units

The reports have to be reported in following formats:

- Report R-1 (SEF) shall be submitted in the format established by the SEF specifications (currently, as a MS Excel application);
- R-2 to R5 shall be submitted in one Excel file, with five sheets named respectively "R2","R3","R4" and "R5".

Report R-1 is submitted as Excel file attached to this report

National commitment period reserve for Latvia is estimated as follows:

$$CPR = 5 * 12\,082.6657228849\ Gg\ CO_2\ eq. = 60413.3286144245\ Gg\ CO_2\ eq.$$
$$or\ 60413328.6144245\ tonnes\ CO_2\ eq.$$

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 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).

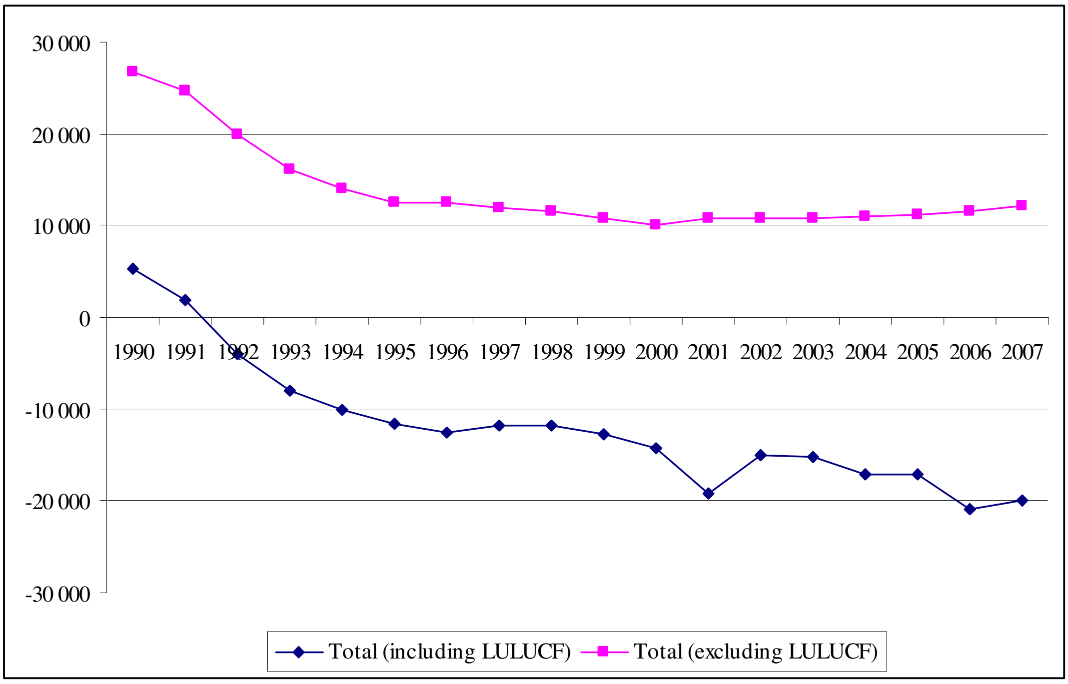


Figure 2.1 Latvia's aggregated greenhouse gas emissions in 1990-2007 (Gg CO_2 eq.)

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. Figure 2.2 shows the trend in CO_2 equivalent emissions compared to the emission target of the Kyoto Protocol.

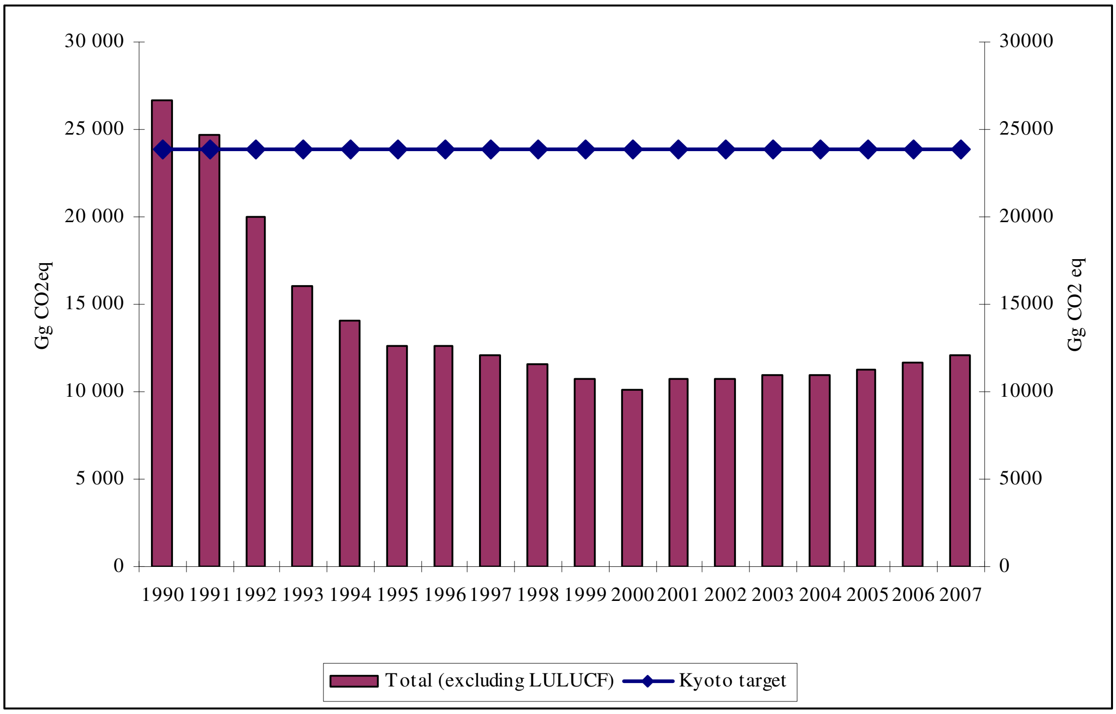


Figure 2.2 Trends in Gg CO_2 eq. emissions and emission target of the Kyoto Protocol

Latvia's total base year emissions for 1990 under Kyoto Protocol are 25909.16 Gg CO_2 eq., assigned amount (revised value) – 119182130 tonnes CO_2 eq. and commitment period reserve (CPR) – 53369492 tonnes CO_2 eq. according to UNFCCC Report of the review of the initial report of Latvia (FCCC/IRR/LVA, 14 December 2007); UNFCCC Kyoto Protocol Reference manual.

According to Decision 15/CMP.1, annex, paragraph 18 parties should also calculate CPR on the basis of the most recently submitted inventory.

$$CPR = 5 * 12\,082.6657228849\ Gg\ CO_2\ eq. = 60413.3286144245\ Gg\ CO_2\ eq.$$
$$or\ 60413328.6144245\ tonnes\ CO_2\ eq.$$

2.2 DESCRIPTION OF EMISSION TRENDS BY GAS AND SOURCE

In the Annex 6, Tables 1; 2; 3; and 4 the trends of CO_2, CH_4, N_2O and HFCs, SF_6 emissions are shown.

Carbon dioxide (CO_2) is the main greenhouse gas causing the climate change. In 2007, CO_2 emissions contribute 71.48% of Latvia's total greenhouse gas emissions. In 2007, total CO_2 emissions had decreased by approximately 55% since 1990.

The most important source of CO_2 emissions (Gg) in 2007 was fossil fuel combustion – 96.5%, including Energy Industries – 23.7%; Manufacturing Industries and Construction – 14.8%; Transport – 44.9%, Other sectors (Agriculture, Forestry, etc.) – 16.5%.

Other anthropogenic emission sources of CO_2 are Industrial Processes – 2.9%, Solvent and Other Product Use approximately 0.59%.

CO_2 removals take place by green plants absorbing CO_2 in the process of photosynthesis. In 2007, forests in Latvia removed 31984.25 Gg.

Main sources of CH_4 emissions in Latvia are Solid Waste Disposal Sites, Enteric Fermentation of Livestock 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 2007 contribute approximately 14.9% of total GHG emissions. The methane emissions (Gg) decreased by 49% in 2007 since 1990.

Agricultural soils are the main source of N_2O emission in Latvia generating 77.27% of all N_2O emissions (Gg) in 2007. 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 59% in 2007, mainly due the decrease in the emissions from agriculture.

Emissions from HFCs and sulphur hexafluoride (SF_6) consumption are reported for the period 1995-2007. Total HFCs emissions (Gg CO_2 eq) increased by 21.14% in 2007 compared with 2006. SF_6 emissions from electrical equipment are reported and contribute 8.70 Gg CO_2 eq in 2007.

Emissions by sources are illustrated in the following Figure 2.3. As it is shown, the Energy sector covers the largest part of all greenhouse gas emissions in Latvia.

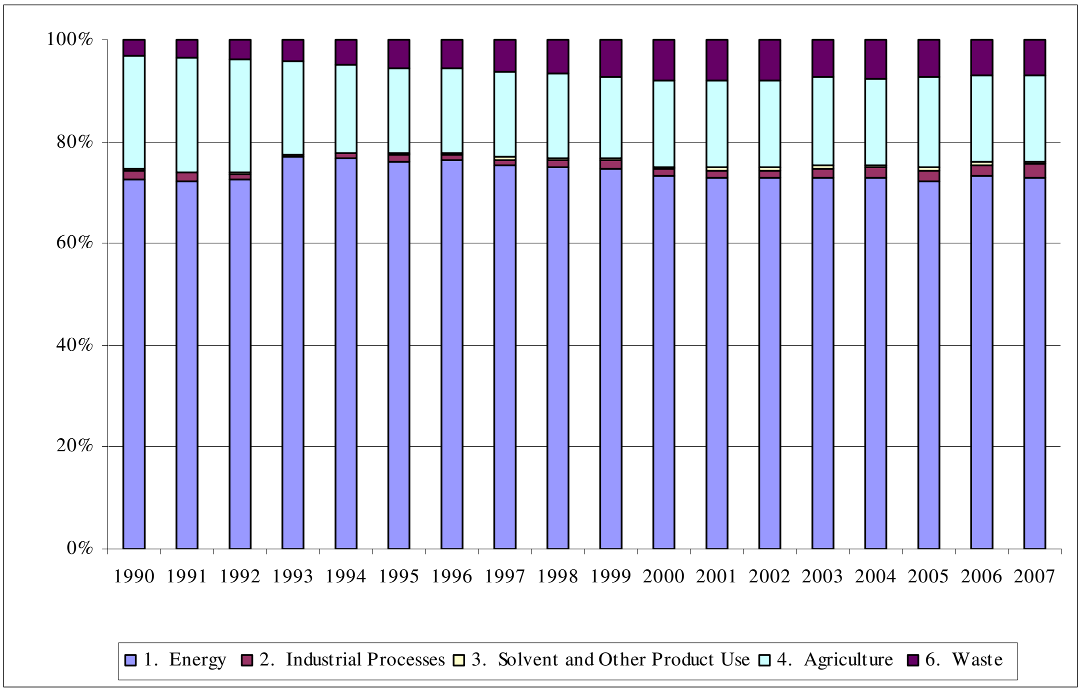


Figure 2.3 Latvia's greenhouse gas emissions by source 1990–2007 excluding LULUCF

2.3 DESCRIPTION OF EMISSION TRENDS OF INDIRECT GREENHOUSE GASES AND SULPHUR DIOXIDE

The emissions trends of the indirect greenhouse gases, sulphur dioxide, nitrogen oxides, carbon monoxide and non-methane volatile organic compounds, are presented in Figure 2.4.

In 2007, the **sulphur dioxide emissions** were 3.33 Gg from which 92.6% originated in the Energy sector, where Energy Industries generated 38.5%, but Other sectors 24.3% of total Energy sector SO_2 emissions.

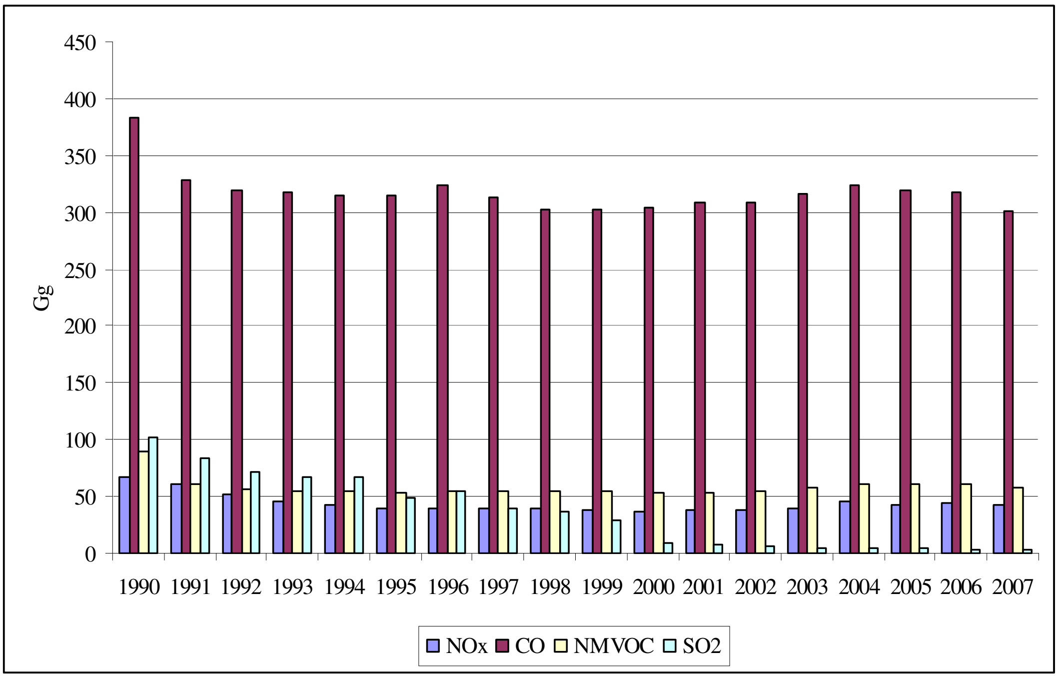


Figure 2.4 Total indirect greenhouse gas emissions trend 1990-2007 (Gg)

Nitrogen oxides were generated generally in the Energy sector 91.3% and 7.7% in the Industrial Processes. In 2007, the total emissions were 42.64Gg. The Transport sector was responsible for 60.1% of the total emissions.

In 2007, **Carbon monoxide** emissions were 300.27 Gg, originated generally in the Energy sector, where Other sectors (including Commercial/Institutional, Residential, Forestry, Agriculture and Fishery) generated the biggest part of the total emissions 72.9% and Transport 16.1%.

In 2007, total emissions of **non-methane volatile organic compounds** were 58.24 Gg from which Energy sector generated 57.3%, Solvent and Other Product Use approximately 28.2%, but Industrial Processes 14.5%.

3. ENERGY (CRF 1)

3.1 OVERVIEW OF SECTOR

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 3.1.1). 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 and 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 37.9% in 2007, including heavy fuel with about 0.9%. The biggest consumers of heavy oil are public heat and electricity supply (65%) and industry (27.5%). This consumption is basically concentrated in the biggest cities. 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%.

Table 3.1.1 Consumption of energy resources in Latvia (PJ) [3, 25]

	1990	1995	2000	2004	2005	2006	2007
Energy consumption – total (excluding losses)	320.70	182.73	156.63	180.24	184.02	189.76	193.54
of which:							
Natural gas	99.52	41.31	45.05	55.32	56.76	58.61	56.69
Light fuel products and other oil products	84.02	40.91	44.35	57.13	58.57	65.20	71.57
Heavy oil, shale oil	63.09	36.21	11.90	3.85	3.32	2.27	1.74
Coal	25.98	7.17	2.76	2.57	3.15	3.41	4.25
Peat, coke and other types of solid fuel	4.47	4.45	2.77	0.59	0.45	0.36	0.41
Firewood, wood products and other solid biofuels	27.58	42.1	39.7	49.46	49.46	49.79	4877
Liquid biofuels					0.11	0.10	0.07
Gaseous biofuels				0.3	0.3	0.3	0.3
Electrical power (HPPs, wind generators)	29.09	18.69	16.59	18.92	19.87	18.91	20.83

Solid fuels used in Latvia are coal imported from Commonwealth of Independent States (countries of former Union of Soviet Socialist Republics) and local fuels – peat and peat briquettes. Peat briquettes is mainly produced inside country but not imported; enterprises reported these data in quite small amount. Use of peat is decreasing. Total share of solid fuels in national market is quite low – approximately 2.3%.

Biomass fuels are fuelwood, straw, charcoal and biofuels. In the total fuel consumption the share of firewood and other wood products is quite substantial and has reached to 25.2% in 2007 by the side of 1990 when fuelwood consumption was only about 8.6% from total energy consumption. The biggest users of fuelwood are households – 62.5%, commercial / institutional consumers – 14.3%, industry (including autoproducers and mainly wood processing companies) – 11.1%, and public heat and electricity supply companies – 9.3%.

Hydroelectric power plants (HPP) and CHPs produce part of the electrical power, while part is imported (Table 3.1.2). 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 3.1.2 Electricity and heat production and consumption in Latvia (TJ) [25]

		Production	Own use and losses	Import	Export	Final consumption			
						CRF 1.A.2	CRF 1 A.3	CRF 1.A.4	TOTAL
1990	Electricity	23932.8	6883	25700	12798	11484	918	17550	29952
	Heat	99439	15171	-	-	32929	-	51339	84268
1995	Electricity	14324.4	6372	9529	1408	5130	677	10268	16075
	Heat	46112	8215	-	-	1969	-	35928	37897
2000	Electricity	14889.6	5202	7589	1159	5159	547	10411	16117
	Heat	31867	7160	-	-	659	-	24048	24707
2004	Electricity	16880.4	4975	9839	2290	5882	500	13071	19453
	Heat	31093	6512	-	-	608	-	23973	24581
2005	Electricity	17658	4767	10278	2545	6120	533	13971	20624
	Heat	31144	6124	-	-	684	-	24336	25020
2006	Electricity	17607.6	4522	10116	1087	6332	540	15243	22115
	Heat	30056	5670	-	-	634	-	23752	24386
2007	Electricity	17175.6	4194	17870	7070	6538	504	16740	23782
	Heat	28685	5091	-	-	554	-	23040	23594

Emissions from fuel combustion comprise all in-country fuel combustion, including point sources, transport and other fuel combustion. Direct and indirect GHG are reported.

The **Energy sector** is the most significant source of GHG emissions with 73% share of the total emissions in the 2007 (Figure 3.1.1).

There are 4 key source categories of stationary fuel combustion in 2007 with respect to Level assessment without LULUCF sector – CO_2 emissions from natural gas combustion is second biggest key source category with 26%; CO_2 emissions from liquid fuels combustion is third key source category with 8%; CO_2 emissions from solid fuels combustion – 3%; as well as CH_4 emissions from biomass combustion – 2%. In 2007 with respect to Trend Assessment without LULUCF sector there are also 4 key source categories in stationary fuel combustion sector – CO_2 emissions from liquid fuels – 44%; from solid fuels – 16%, from natural gas – 12% and CH_4 emissions from biomass – 3%.

Road transport is key source for 2007 according to Level and Trend assessment and consists 8% and 3% respectively.

CO_2 emissions from the Energy sector in the latest years are stable, but still CO_2 eq curve of Energy sector has an increasing tendency. Only GHG emissions from Transport sector and Manufacturing Industries sector have increased from 2006 to 2007 that is explained with increasing number of vehicles in Latvia and radical development of industrial production. Transport is the most important Energy sub–sector with 43.25% of total CO_2 eq energy emissions and 31.57% of total CO_2 Gg eq emissions. GHG emissions from Transport sector rose by 10.6% compared to last year.

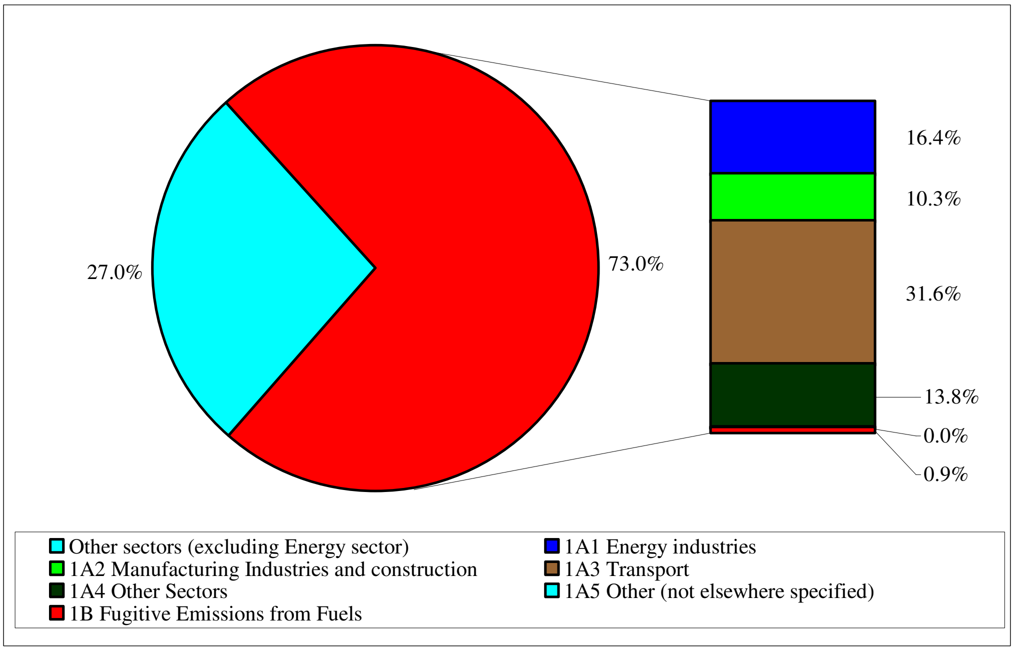


Figure 3.1.1 Emissions from the Energy sector in 2007

Emissions from the Energy sector come from different sources. Emissions from fuel combustion include direct and indirect GHG emissions including point sources and Transport sector, but direct fugitive emissions arise from natural gas transmission and distribution (Table 3.1.3).

Table 3.1.3 GHG emissions from Energy sector in 1990 – 2007 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
A Fuel combustion																		
CO_2,	18656.3	17129.0	13861.6	11753.6	10156.4	8934.6	9005.7	8470.3	8074.0	7460.1	6868.1	7271.8	7261.7	7417.5	7422.4	7541.0	8026.3	8285.1
CH_4	12.2	13.6	12.4	13.0	12.9	13.3	13.7	13.1	12.2	12.0	11.3	12.4	12.2	12.8	13.2	13.3	13.0	12.9
N_2O	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5
B Fugitive emissions from fuels																		
CH_4	13.1	12.6	11.5	11.0	10.7	10.4	10.1	9.4	9.0	8.6	7.9	7.7	8.0	6.3	6.2	6.9	5.0	5.2

Total GHG emissions from Energy sector are presented in Figure 3.1.2.

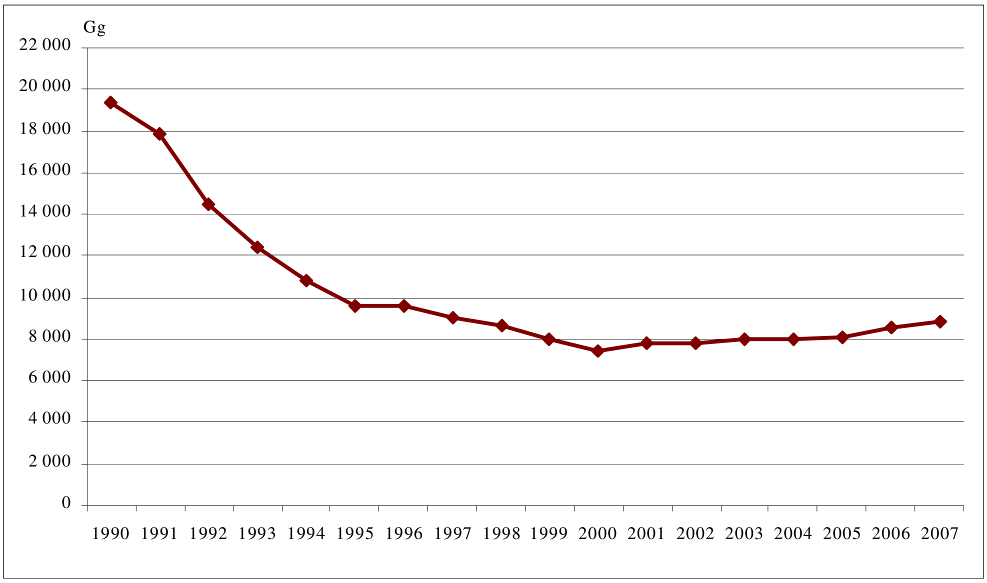


Figure 3.1.2 GHG emissions from Energy sector 1990 – 2007 (Gg CO_2 eq)

It is seen that emissions expressed in CO_2 equivalents in Energy sector decreased till 2000. 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.

CO_2 emissions from fuel combustion were 8 285.092 Gg (including Transport sector) in 2007 and accounted 96.5% of the total CO_2 emissions.

CH_4 emissions from fuel combustion were 12.88 Gg (including Transport sector) in 2007. The biggest part of CH_4 emissions contributes Other sectors – 11.89 Gg. It is related with wood fuel combustion, especially in the Residential sector. Until now Latvia uses IPCC default CH_4 emission factor for wood combustion in Residential sector and it's quite high as it was noticed by Review Team in the Report of the individual review of GHG inventory submitted in the 2003/2004. Latvia should reassess CH_4 emission factor as advised Review Team, but due to lack of financial resources it is further work.

N_2O emissions from fuel combustion were 0.45 Gg (including Transport sector) and accounted 8.9% of the total N_2O emissions in 2007.

Emissions from fuel combustion are presented in the Figure 3.1.3.

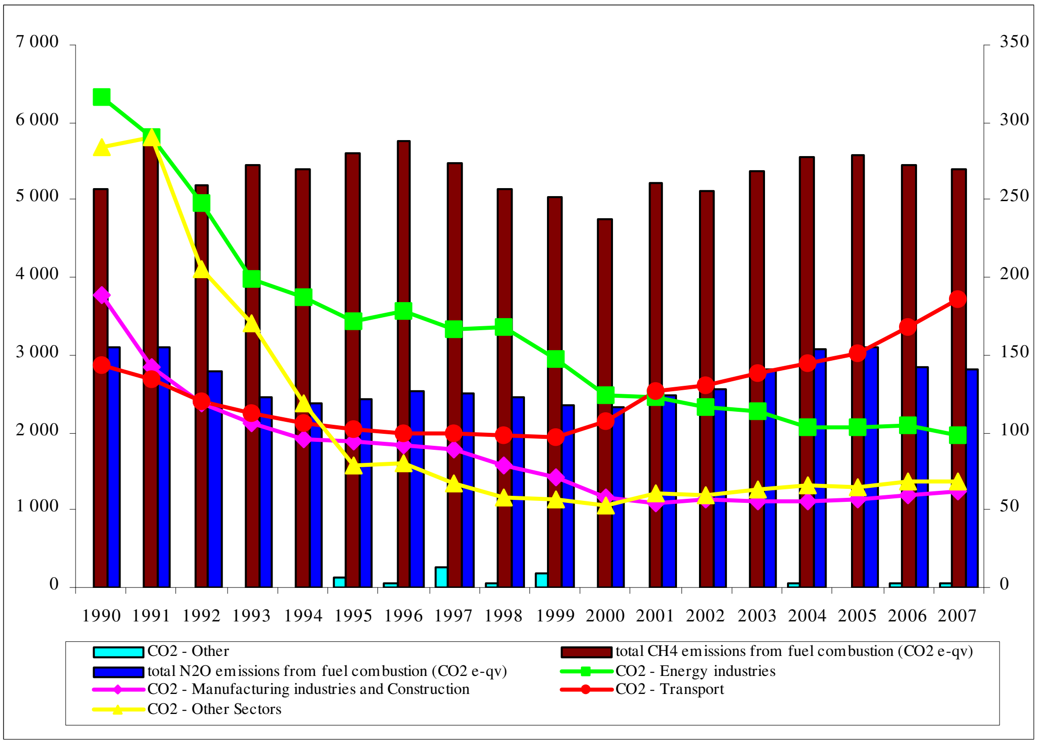


Figure 3.1.3 Total direct GHG emissions from fuel combustion in 1990 – 2007 (Gg)*

* CO_2 emissions from Other Sectors, total N_2O emissions and total CH_4 emissions on the secondary axis

The following indirect greenhouse gases NO_x, CO, NMVOC, SO_2 are calculated. Total emissions from Energy sectors for 1990 – 2007 are presented in Figure 3.1.4.

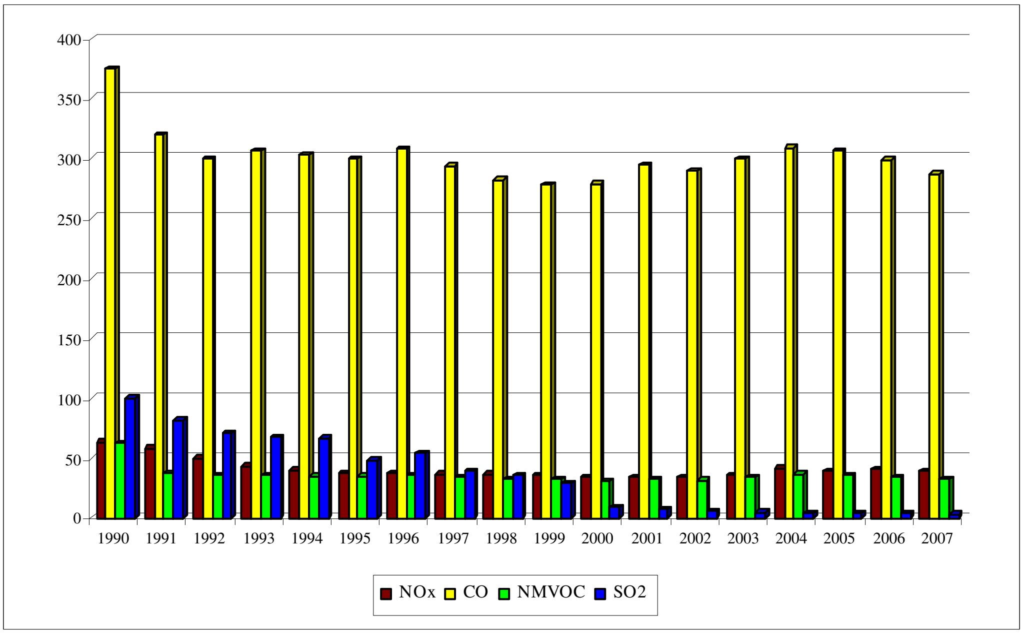


Figure 3.1.4 Total indirect GHG emissions from fuel combustion in 1990 – 2007 (Gg)

In 2007, the largest part of indirect emissions contributes CO then NO_x and NMVOC emissions. Most CO and NMVOC emissions come from wood combustion in the Residential sector. The biggest decrease is observed in SO_2 emissions where emissions decreased from 100.1 Gg in 1990 to 3.1 Gg emissions in 2007. 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.

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 – covers emissions from 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).

3.2 ENERGY INDUSTRIES AND MANUFACTURING INDUSTRIES (CRF 1.A.1, 1.A.2)

3.2.1 Source category description

Energy industries (CRF 1.A.1) and Manufacturing Industries and Construction (CRF 1.A.2) include emissions from fuel combustion in point sources in energy production and industrial sectors including emissions from off–road. Energy industries 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 plant). Manufacturing Industries and Construction sector includes emissions from fuel use in autoproducers plants.

The emissions from 1.A.1 and 1.A.2 sectors in 1990–2007 are presented in Table 3.2.1.

Table 3.2.1 Emissions from Energy and Manufacturing Industries in 1990–2007 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1.A.1 Energy industries																		
CO_2	6332.2	5805.7	4955.1	3990.0	3748.8	3440.4	3565.9	3327.3	3368.3	2944.8	2490.2	2442.6	2335.1	2269.7	2077.4	2067.8	2091.2	1964.1
CH_4	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
N_2O	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
1.A.2 Manufacturing industries and construction																		
CO_2	3777.2	2833.6	2385.2	2112.2	1913.6	1876.2	1836.5	1789.8	1568.0	1421.0	1170.1	1077.6	1130.0	1119.4	1121.7	1140.0	1198.8	1227.6
CH_4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
N_2O	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

Emissions from CRF 1.A.1 and 1.A.2 sectors are decreasing year by year (Figure 3.2.1) although emissions from 1.A.2 sector are increasing since 2003. 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. At the end of 90-ties emissions started to decrease till 2005. Emissions slightly increased in 2006 but then decreased again in 2007. Decrease in the end of 90-ties is explained with economical crisis in Russian Federation with whom Latvia has close economical collaboration. 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.

Emissions from CRF 1.A.2 are increasing due to 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 fuel and other fuels (used tires) consumption that mostly is combusted in mineral and steel production industry. Emissions from CRF 1.A.1 are constantly decreasing due to fuel switch to environment friendly fuels and decrease of central heating consumers.

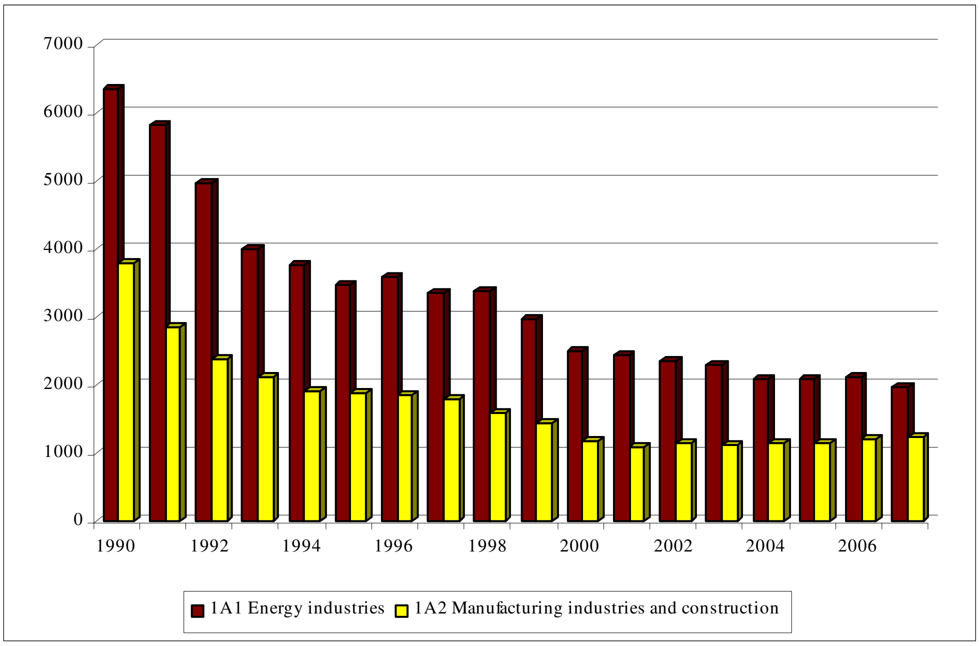


Figure 3.2.1 Total direct GHG emissions from Energy Industries and Manufacturing industries and construction in 1990 – 2007 (Gg CO_2 eq)

Also indirect GHG emissions from Energy Industries and Manufacturing industries and Construction were estimated (Figure 3.2.2). SO_2 had biggest decrease by 96.4% in time period 1990 – 2007. It is explained with fuel switching to natural gas and biomass from what sulphur dioxide emissions aren't emitted. Also other indirect GHG emissions in 2006 – 2007 decreased that is explained with the decrease of total fuel consumption combusted in stationary combustion installations.

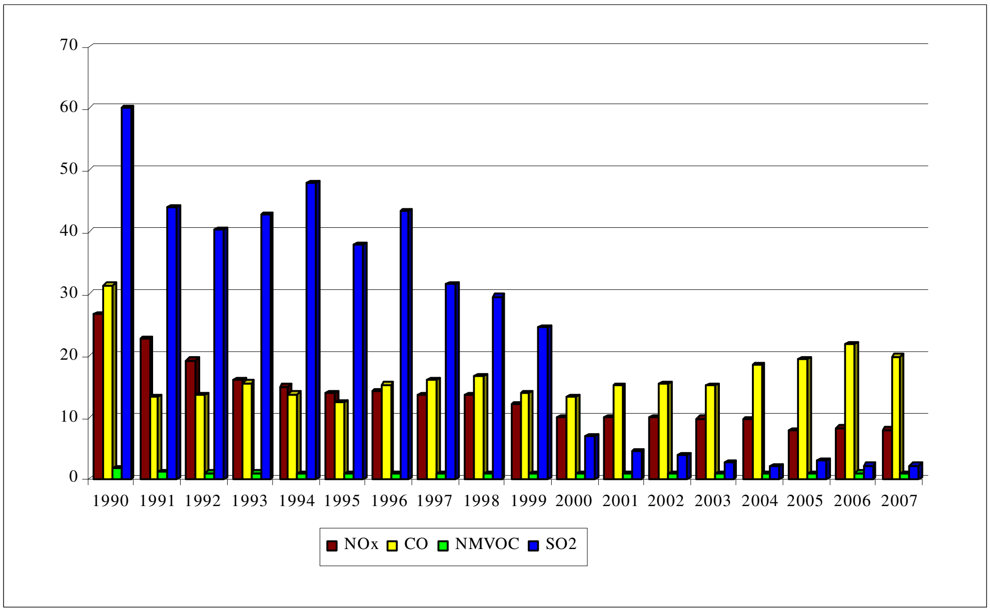


Figure 3.2.2 Total indirect GHG emissions from Energy industries and Manufacturing industries and construction in 1990 – 2007 (Gg)

3.2.2 Methodological issues

Methods

IPCC 1996 Tier1 Sectoral approach and Reference approach for the comparison of CO_2 emissions as well as EMEP/CORINAIR Guidebook were used to calculate GHG emissions from the Energy sector. IPCC 2006 was used in the calculation of emissions from biofuels. Calculation of all emissions from fuel combustion is done with Excel databases developed by experts from LEGMA. CRF Reporter software developed by experts from UNFCCC was used to report emission data.

The general method for preparing inventory data was used:

$$Emission = EF \times \text{activity data}_{ab}$$

where:
Emissions – total emissions of fuel type in sub-sector (Gg)
EF – emission factor (Gg/PJ; Mg/PJ)
activity data – energy input (TJ, PJ)
a – fuel type;
b – sector activity

Oxidation factor is included in the calculations CO_2 emissions.

NOx and SO_2 emission data in 2005-2007 from large combustion plants (total capacity is more than 50MW) 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. This is bottom-up method because enterprises data are used. NOx and SO_2 emissions from other combustion installations within these two sectors are estimated with IPCC 1996 Tier1 method.

Emission factors and other parameters

The main sources for emission factors are:

- National studies for country specific parameters and emission factors;
- IPCC 1996;
- IPCC 2006;
- EMEP/CORINAIR Guidebook.

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

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 (Table 3.2.2).

For calculating CO_2 emission factors following equation was used [13].

$$EF_{CO_2} = \frac{C^d \times M_{CO_2} \times 1000}{Q_Z^d \times M_C \times 100} = \frac{C^d}{Q_Z^d} \times 36.6413$$

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)

Oxidation factor is used according to IPCC.

Table 3.2.2 CO_2 emission factors, oxidation factors and net caloric values by fuel

Type of fuel	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	26.22	94.08	0.98	**92.20**
Peat, W^{d*} = 40%	10.05	105.99	0.98**	**103.87**
Peat briquettes***	15.49	97.00	0.98	**95.06**
Coke	26.37	88.75	0.98	**86.98**
Motor gasoline (for off-roads)	43.96	69.29	0.99	**68.60**
Diesel oil	42.49	74.74	0.99	**74.00**
LPG	45.54	62.75	0.995	**62.44**
Residual fuel oil	40.60	77.36	0.99	**76.59**
Jet fuel	43.60	71.58	0.99	**70.86**
Shale oil	39.35	76.19	0.99	**75.43**
Lubricants	41.86	73.33	0.99	**72.60**
Other kerosene	43.20	72.24	0.99	**71.52**
Natural gas	33.66****	56.10	0.995	**55.82**
Wood, W^{d*} = 55%	6.70*****	109.98	0.98	**107.78**

* moisture content
** for electricity production p = 0.99
*** emission factor was taken from GHG inventory of Finland
**** natural gas – Q_z^d is MJ/m^3
***** for wood – Q_z^d is TJ/1000m^3

EF for CO_2 emissions estimation from sludge gas combustion in CRF 1.A.1.a Combined heat and power plants starting 2004 is taken from IPCC 2006, as there is no national expert research done for sludge gas combustion.

EF for CO_2, CH_4 and N_2O emissions estimation for liquid biofuels combusted in CRF 1.A.2.c Chemicals sector for year 2007 is taken from IPCC 2006, as there is no national expert research done for biofuels combustion.

EF for CO_2 emission estimation for other fuels – used tires, combusted in CRF 1.A.2.f Other Manufacturing Industries – cement production, sector for years 1999 – 2007 is taken from GHG emission reports that plant submit under EU ETS. 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.

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.

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 (%).

The default CH_4, N_2O, NO_x, CO, NMVOC emission factors used in estimation of emission were taken from IPCC Guidelines (Table 3.2.3).

Table 3.2.3 CO_2, CH_4, N_2O, NO_x, CO, NMVOC emission factors (Gg/PJ)

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1.A.1 Energy Industries						
Gasoline	68.6	0.05	0.002	0.21	27	1
Diesel oil	74.0	0.003	0.0006	0.2	0.015	0.005
RFO	76.59	0.003	0.0006	0.2	0.015	0.005
LPG	62.44	0.003	0.0006	0.2	0.015	0.005
Jet fuel	70.86	0.003	0.0006	0.2	0.015	0.005
Other kerosene	71.52	0.003	0.0006	0.2	0.015	0.005
Other liquid	72.6	0.003	0.0006	0.2	0.015	0.005
Shale oil	75.43	0.003	0.0006	0.2	0.015	0.005
Coal	92.2	0.001	0.0014	0.3	0.02	0.005
Coke	86.98	0.01	0.0014	0.3	0.15	0.02
Peat briquettes	95.06	0.03	0.004	0.1	1	0.05
Peat	103.87	0.03	0.004	0.1	1	0.05
Natural gas	55.82	0.001	0.0001	0.15	0.02	0.005
Wood	107.78	0.03	0.004	0.1	1	0.05
Sludge gas	54.6	0.001	0.0001	0.150	0.020	0.005
1.A.2 Manufacturing Industries and Construction						
Gasoline	68.6	0.05	0.002	0.21	27	1
Diesel oil	74.0	0.002	0.0006	0.2	0.01	0.005
RFO	76.59	0.002	0.0006	0.2	0.01	0.005
LPG	62.44	0.002	0.0006	0.2	0.01	0.005
Jet fuel	70.86	0.002	0.0006	0.2	0.01	0.005
Other kerosene	71.52	0.002	0.0006	0.2	0.01	0.005
Other liquid	72.6	0.002	0.0006	0.2	0.01	0.005
Shale oil	75.43	0.002	0.0006	0.2	0.01	0.005
Coal	92.2	0.01	0.0014	0.3	0.15	0.02
Coke	86.98	0.01	0.0014	0.3	0.15	0.02
Peat briquettes	95.06	0.03	0.004	0.1	1	0.05
Peat	103.87	0.03	0.004	0.1	1	0.05
Natural gas	55.82	0.005	0.0001	0.15	0.03	0.005
Wood	107.78	0.03	0.004	0.1	2	0.05
Liquid biofuels	79.6	0.003	0.004	0.1	2	0.05
Other solid fuels (used tires)	82.7556* 79.4**	0.03	0.004	-	-	-

* for year 1999-2004
** for years 2005-2007

SO_2 emission factors for fuel combustion are presented in Table 1 in Annex 3.

Activity data

Mainly emissions from fuel combustion are calculated using activity data – fuel consumption, from the CSB – Energy Balance for Latvia and Annual questionnaires for 1990-2007 sent to EUROSTAT by CSB. The CSB data collection system is based on a detailed compulsory survey 1–EK. This form "Survey on stocks, receipts and consumption of energy resources semi-annual) 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.

CSB collects and assesses fuel consumption data with annual questionnaires for 1.A.4.b Residential Sector.

Table 3.2.4 Fuel consumption in Energy industries, Manufacturing Industries and Construction and Other Sectors in 1990 – 2007 (PJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1.A.1 Energy industries																		
Liquid fuels	40.48	33.25	28.44	27.17	30.86	20.52	27.34	17.44	20.66	17.49	7.90	5.28	5.08	3.62	3.17	2.40	1.51	1.39
Solid fuels	5.26	4.75	5.51	5.58	4.52	5.21	4.15	3.96	2.78	1.77	2.75	1.64	1.29	0.87	0.28	0.24	0.14	0.37
Gaseous fuels	49.03	50.29	40.18	24.41	16.77	24.11	18.83	28.45	27.08	25.73	28.86	33.57	32.55	34.14	32.41	33.35	35.17	32.67
Biomass	0.44	0.59	0.67	0.83	1.30	1.05	1.60	3.39	4.09	3.66	3.19	3.62	4.10	5.50	5.48	4.71	5.31	5.31
1.A.2 Manufacturing industries and construction																		
Liquid fuels	28.96	18.77	16.01	16.56	16.02	16.34	15.98	15.69	12.67	11.16	7.50	4.89	4.61	4.73	4.48	3.65	4.26	4.04
Solid fuels	1.60	1.01	1.11	1.75	1.65	0.82	0.77	0.74	0.69	0.70	0.52	0.52	0.50	0.40	0.41	1.11	1.50	2.13
Gaseous fuels	25.83	23.69	19.19	12.51	9.76	10.00	9.89	9.55	9.79	9.15	9.86	11.60	12.85	12.75	13.09	13.55	13.24	12.89
Biomass	0.62	0.60	0.62	1.78	2.10	2.41	2.66	2.74	3.19	3.18	2.70	3.86	3.39	3.31	4.71	5.54	6.43	5.39
Other Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.04	0.13	0.25	0.33	0.29	0.31	0.18	0.13	0.21

The biggest decrease in time period 1990 – 2007 for these two sectors was for liquid fuel consumption – 92.2% (Table 3.2.4, Figure 3.2.3). 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. And that's why also consumption of solid fuels decreased. In the last years consumption of solid fuels is increasing that is explained with increase of coal consumption in Energy industries – 225% in 2006-2007, and in mineral production sector – for 60.5% in 2006-2007. Total solid fuels consumption in these two sectors had increased for 52.9% in 2006-2007.

Consumption of biomass fuel increased by 916% in 1990 – 2007. Since 1999 gaseous fuel consumption is increasing but till 2006. These are types of fuels with lower cost to whom liquid and solid fuels were switched. In 2006-2007 also biomass and natural gas consumption had decreased. That is explained with total decrease of fuel consumption when manufacturing industries faced problems with sales. Fuel consumption decrease in Energy industries is explained with decrease of central heating supply consumers when they switched to individual heating supply.

Consumption of used tires in Mineral production reported as Other Fuels is increasing till 2004 but for the last year in time series consumption of used tires has decreased due to fuel and technology switch in cement production enterprise. Still consumption of used tires had increased again in 2006-2007 due to sharp increase of cement production that was caused by increasing demand of construction materials and sharp development of construction sector.

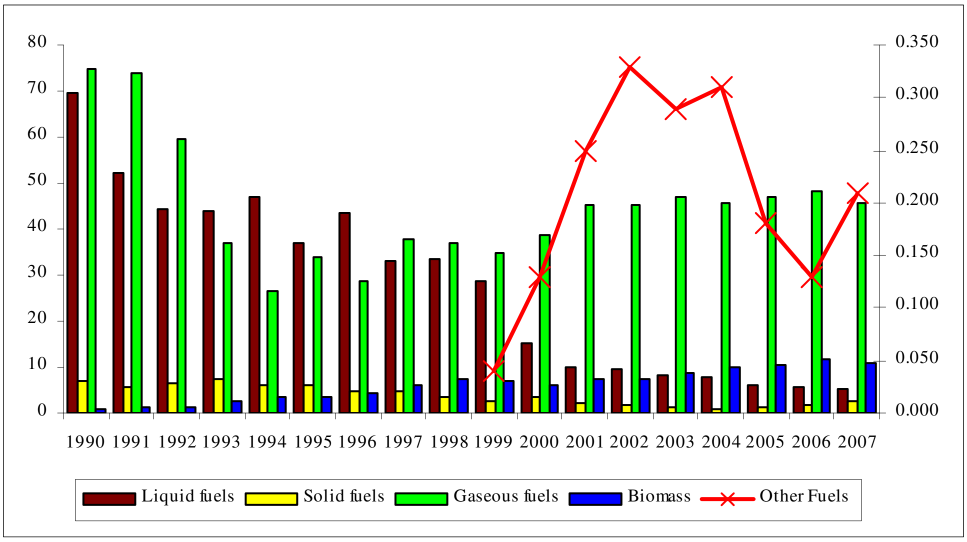


Figure 3.2.3 Total fuel consumption in Energy industries and Manufacture industries and Construction in 1990 – 2007 (PJ)

3.2.3 Uncertainties and time series consistency

Uncertainty in activity data of fuel combustion in sectors CRF 1.A.1, CRF 1.A.2 and CRF 1.A.4 is ±2% in 2007. 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 biomass combustion was assigned as 15% because biomass activity data were collected by CSB with questionnaires sent by enterprises consumed biomass. Uncertainty of biogas and liquid biofuels stationary combusted in enterprises covered by 1.A.1 Energy Industries sector was assumed rather low – 5% because biofuels are combusted together with other types of fossil fuel and uncertainty of 2% (as for all statistical data) couldn't be assumed. So it gives average uncertainty 10% for activity data.

In fuel combustion, the CO_2 emission factor mainly depends on the carbon content of the fuel instead of on combustion technology. Therefore, uncertainty in CO_2 emissions was calculated at a rather aggregated level, i.e. by fuel type rather than by sector.

CO_2 emission factor was estimated by national expert according physical characterization of used fuels in country so uncertainty was assigned as quite low about 5%. For combustion of solid fuels uncertainty of CO_2 emission factor was assigned higher to 10% because CO_2 emission factor of peat briquettes was taken from GHG inventories of Finland. As well as CO_2 emission factor from biogas and liquid biofuels consumption was assigned as 10% because default emission factor taken from the IPCC 2006 was 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.

CH_4 and N_2O emission factor used in estimation of emissions was 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. Emissions from all sectors are estimated or reported as not occurring / not applicable therefore there are no "not estimated" sectors.

3.2.4 Source-specific QA/QC and verification

Activity data for the Energy sector is taken from the Annual Questionnaires that Central Statistical Bureau prepares and reports to the EUROSTAT. CSB has the internal QA/QC procedures based on mathematical model and analysis to avoid logic mistakes. CSB now is working on the development of documentation system that will serve as centralised knowledge base of the calculations and surveys carried out by the CSB because the whole business cycle of data will be described, including quality assessment.

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 LEGMA 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 checked and filled in QC form for each category taking into account criteria given in Quality Control and Quality Assurance program made by LEGMA.

3.2.5 Source-specific recalculations

Structural changes are made also in the CRF tables for liquid fuels, solid fuels and in some sectors also for biomass. Previously aggregated data for these fuels were reported but for submission 2009 these fuels were subdivided in particular fuels. This was done for clear and foreseeable reporting.

Activity data changes in CRF 1.A.2 Manufacturing Industries and Construction sector for all years in 1990 – 2006. For submission 2009 coke consumption is included in CRF 1.A.2.a Iron & Steel sector according to "Report of the individual review of the greenhouse gas inventories of Latvia submitted in 2007 and 2009". Coke consumption is excluded from CRF 1.D Feedstocks and non-energy use of fuels sector, as it is combusted as reductant in iron and steel production. CO_2 emission from steel production (CRF 2.C.1 Iron and Steel production sector) is estimated with IPCC GPG Tier2 method that doesn't contain an input of coke. Method is based on loses of carbon during technological processes within open – heart furnaces as well as carbon emission from electric arc furnaces have to be taken into account.

CO_2 EF for industrial wastes (used tires) was changed to the EF reported by the cement production plant combusting tires for energy recovery. The plant participates in Emission Trading System and reports verified annual GHG reports to Latvian Environment, Geology and Meteorology agency with all data needed for CO_2 emission estimation. Also oxidation factor for used tires is changed to 1 according to GHG report of the plant.

CO_2, CH_4 and N_2O emission factors for sludge and landfill gas were changed. For submission 2008 these emission factors were equated to natural gas emission factors but for submission 2009 these emission factors were taken from IPCC 2006.

For submission 2009, data of liquid biofuels combusted in CRF 1.A.2.c Chemicals were reported for the 2006-2007.

According to latest information from CSB about fuel consumption small changes in the activity data occur only in the year 2006 particularly in sectors CRF 1.A.1 Energy Industries and 1.A.2.f Other.

Difference for submission 2008 and submission 2009 in reported direct GHG emissions is insignificant for all years in time series 1990 – 2006 fluctuating from 0.05% in 1990 to 0.67% in 2001 with average difference 0.37%.

3.2.6 Source-specific planned improvements

The summarized necessary improvements are:

- Researches on use of the national emission factors;
- 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.

3.3 TRANSPORT (CRF 1.A 3)

3.3.1 Source category description

The Transport sector is the fastest growing sector in Latvia and amount of the emissions is increased compared to 1990 (Figure 3.3.1). Emissions from Transport sector include following sectors:

- Civil Aviation (1.AA.3.A);
- Road Transport (1.AA.3.B);
- Railway (1.AA.3.C);
- Domestic Navigation (1.AA.3.D).

The most important reason of this growing tendency is that the economical situation and the welfare of population are developing. It is also the reason that the number of vehicles and private boats are growing and the number of flights is growing too.

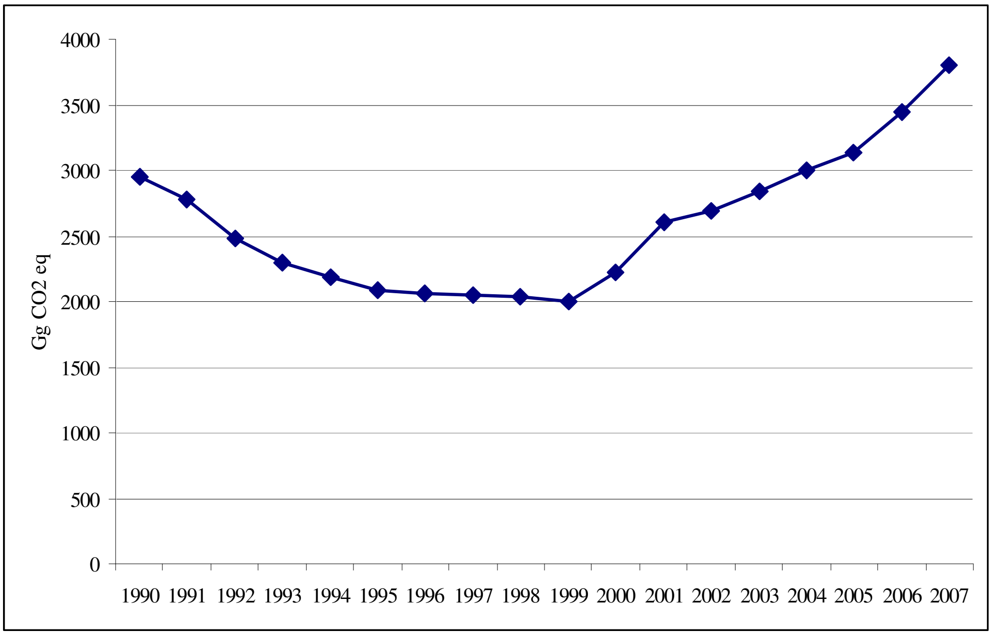


Figure 3.3.1 Total emissions from Transport sector for 1990 – 2007 (Gg CO_2 eq.)

Emissions from Road Transport increase yearly (Figure 3.3.2) and the reason of it is the growing number of vehicles. Emissions from Railway became stable in the last years. Since 1990, emissions from Domestic Aviation are increasing because the numbers of flights had increased. In spite of increasing of aviation the total consumption of fuel is decreased in 2007 comparison with 2006, 7 TJ and 19 TJ respectively.

Emissions from Domestic Navigation also are more or less stable, significant fluctuations are not observed in last years still emissions have increasing tendency in the last years.

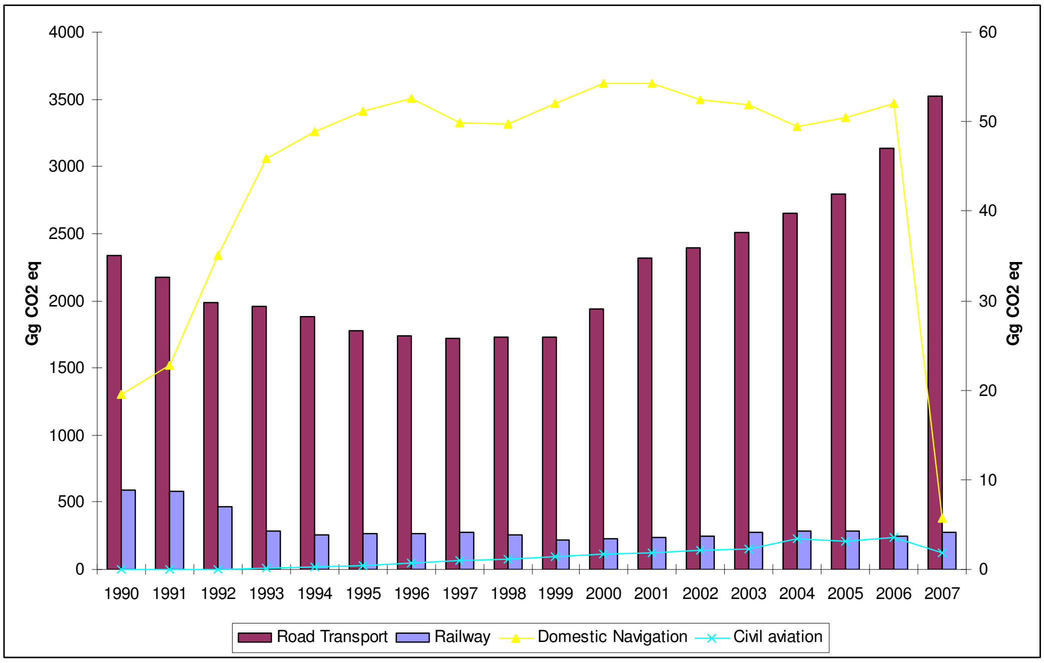


Figure 3.3.2 Emissions from the Transport sector in 1990 – 2007 by sub-sectors ($Gg\ CO_2$ eq.)*

*Civil aviation and Domestic navigation – secondary axis

In 2007, Transport sector contributed 32% from total CO_2 eq emissions, excluding LULUCF and 43% CO_2 eq. emissions from the total Energy sector. The biggest part of Transport GHG emissions contributes Road Transport (93%), then Railways (7%), Domestic Navigation (0.2%) and Civil Aviation, which contribute a very small part of transport emissions (0.04%).

Road Transport includes all transportation types of vehicles on roads: passenger cars, light duty vehicles, buses, heavy-duty vehicles and motorcycles and also mopeds are now included.

The source category does not cover farm and forest tractors driving occasionally on the roads because they are included in Other sectors (agriculture, forestry etc.) and military vehicles are included in Commercial/Institutional.

Railway transport includes railway transport operated by diesel locomotives.

Domestic Aviation includes helicopters, airplanes with turbojet engine and airplanes with piston engines.

Domestic Navigation includes all domestic waterway transport – leisure boats, sea-going ships and towboats.

The main indirect GHG emission source in Transport sector is Road transport. The most significant emissions that releases Transport sector are NO_x emissions, especially Road transport. NO_x emissions contribute 57.6% from national total NO_x emissions in 2007.

SO_2 emissions from Transport sector are inessential, because of sulphur limitation in fuels. Sulphur limitation in fuels is well presented in Figure 3.3.2; first limitation was in 1999 and next in 2005. Figure 3.3.2 presents indirect GHG emissions from Transport sector.

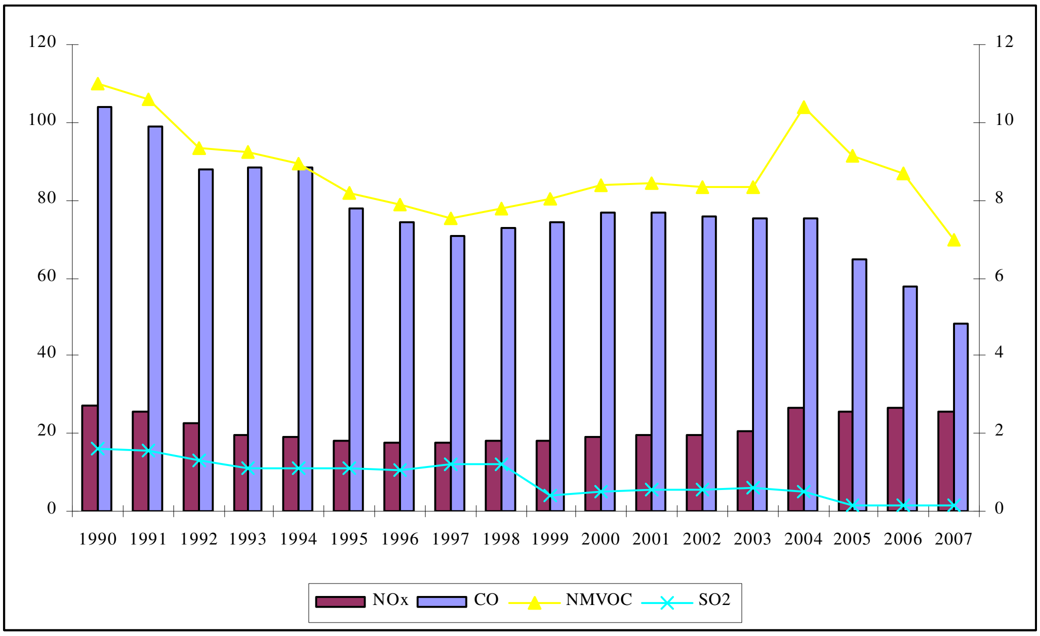


Figure 3.3.2 Indirect GHG emissions from Transport sector (Gg)*

*NMVOC; SO_2 – secondary axis

3.3.2 Methodological issues

Methods

Emission calculation from **Road transport** is made using the "Computer Programme to calculate Emissions from Road Transportation" (for 1990 – 2003 - COPERT III, but for 2004-2007 COPERT IV), which is proposed to be used by EEA member countries for the compilation of CORINAIR emission inventories. COPERT III and COPERT IV methodologies can be applied for the calculation of traffic emission estimates at a relatively high aggregation level, both temporally and spatially.

Calculation of emissions is based on fuel consumption of road vehicles and of average mileage of vehicles and the fixed emission factors. Road traffic vehicles use four different fuels – gasoline, diesel oil, liquid petroleum gases (LPG) and since 2005 also biofuels. Emissions from LPG for period 1990 -2003 are calculated using Tier1 method from IPCC 1996, but for period 2004-2007 using COPERT IV model. LPG for 1990 – 2003 is calculated with Tier1, due to problems concerned to inconsistency in statistical data.

In the COPERT model emissions are calculated for passenger cars and heavy-duty trucks taking into account the mileage (km/a) of each vehicle categories and groups and specific fuel consumption (l/km). Vehicles are divided in groups according to used fuel type, the relevant EC Directives, engine capacity (passenger cars) and tonnage (heavy duty truchs). Total emissions are a sum of hot driving, cold start-ups and also urban, rural and highway driving emissions.

Emission factors are depended from structure of vehicles (for 2007, Annex 3) entered in COPERT model. For COPERT III and COPERT IV the structure of vehicles is different, therefore so big fluctuation of emission factors are observed.

Exception in emission calculation by using COPERT III; COPERT IV is made for CO_2 emissions from gasoline use in road transport. During the In-Country visit in 21st – 26th May 2007 the ERT had prepared the recommendations of improvement of Latvia's Greenhouse Gas inventory – "Potential Problems and Further Questions from the ERT (2007) formulated in the course of the in-country review of Latvia's Initial Report under the Kyoto Protocol and 2006 Inventory Submission" [16].

As ERT (2007) found out following problem:

- The country-specific CO_2 emission factor was not inputted to the COPERT III model. The CORINAIR default emission factor is approximately 72 t/TJ, while the 2004 Latvia study is reported as 68.6 t/TJ in Table 3.3.2 of the submission 2006 NIR. Use of the higher EMEP/CORINAIR default CO_2 emission factor, rather than the country-specific CO_2 emission factor, appears to overestimate the base year estimates [16].

Latvia has recalculated CO_2 emissions from Gasoline use in 1.A.3.b with country-specific CO_2 emission factor as it was recommended by ERT (2007) that was assumed as Tier2 from IPCC 1996.

CO_2 emissions from diesel oil use in Transport sector are estimated by using default EMEP/CORINAIR emissions factors that are included in COPERT III and COPERT IV model for Road Transport or default CO_2 emission factors from IPCC 1996 for other Transport sector sub-categories. Default CO_2 emission factors of diesel oil are used because country specific CO_2 emission factor for diesel oil reported in national expert research "Guidance manual for CO_2 emission estimations (developed in accordance with UNFCCC and IPCC recommendations and physical characteristics of fuels used in Latvia)" is determined as for stationary fuel combustion installations. CO_2 emission factors from Transport sector have to differ from ones used for emission estimations from stationary fuel combustion installations due to different combustion conditions.

To calculate emissions from **Railway, Civil Aviation and Domestic Navigation** are used the Tier1 method from IPCC 1996. The calculation includes CO_2, N_2O and CH_4 emissions and also indirect GHG emissions.

$$\boxed{\text{Emissions} = \text{Activity Data} \times \text{Emissions Factor}}$$

Emission factors and other parameters

Emission factors in **Road transport** are given as default EMEP/CORINAIR emissions factors that are included in COPERT III and COPERT IV model.

For biodiesel oil are used following emission factors:

- CO_2 - 70.8 t/TJ;
- CH_4 – 2.2 kg/TJ;
- N_2O – 3.9 kg/TJ.

Estimation of evaporative emissions of hydrocarbons and the inclusion of cold start emission effects are dealt with in the Latvian inventory by using LEGMA meteorological input data for ambient temperature variations during months; the distribution of evaporate emissions in the driving modes are used default by COPERT.

Default emission factors for **Railway** (Table 3.3.3) are taken from IPCC 1996. The SO_2 emissions factors are used consistent with sulphur content in diesel oil (Table 3.3.4).

Table 3.3.3 Emission factors used in the calculation of emissions from Railway

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ
Diesel oil	73,2	0,00415	0,0286	0,93	0,25	0,11

Table 3.3.4 Diesel oil emission factors used for SO_2 emission calculation from Railway

Diesel oil	Sulphur content	NCV	EF (Gg/PJ)
1990-1998	0,2	42,49	0,0941
1999-2003	0,05	42,49	0,0235
2004-2007	0,035	42,49	0,0165

Default emission factors for **civil aviation and domestic navigation** are taken from IPCC 1996 and are presented in Table 3.3.5 and Table 3.3.6.

Table 3.3.5 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
Jet fuel	72,1	0,0005	0,002	0,25	0,10	0,05	0,023
Aviation petrol	70,2	0,0005	0,002	0,25	0,10	0,05	0,023

Table 3.3.6 Emission factors for emissions estimation from Domestic Navigation

	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
Gasoline	69,7	0,04	0,00	0,22	23,24	0,78	0,01
Diesel oil	74,0	0,00	0,03	1,00	0,25	0,11	0,02

Activity data

Fuel consumption in road transport in 2007 was about 67.5% from total fuel consumption in Energy sector. In last years the consumption of gasoline in road transport becomes stable still gasoline consumption increased by approximately 9% from 2006 to 2007. The consumption of diesel oil since 2000 is increased more than 54% (Figure 3.3.5). In 2006, biofuels were included in energy balance for the first time. Biodiesel and biogasoline contributes very small part from total fuel used in road transport, just 0.3%, but amount of biofuels will grow in next years, because it is an environmental friendly fuel. According to national legislation in 2010 the amount of biofuels will contribute 5.75% from fuel used in Transport sector.

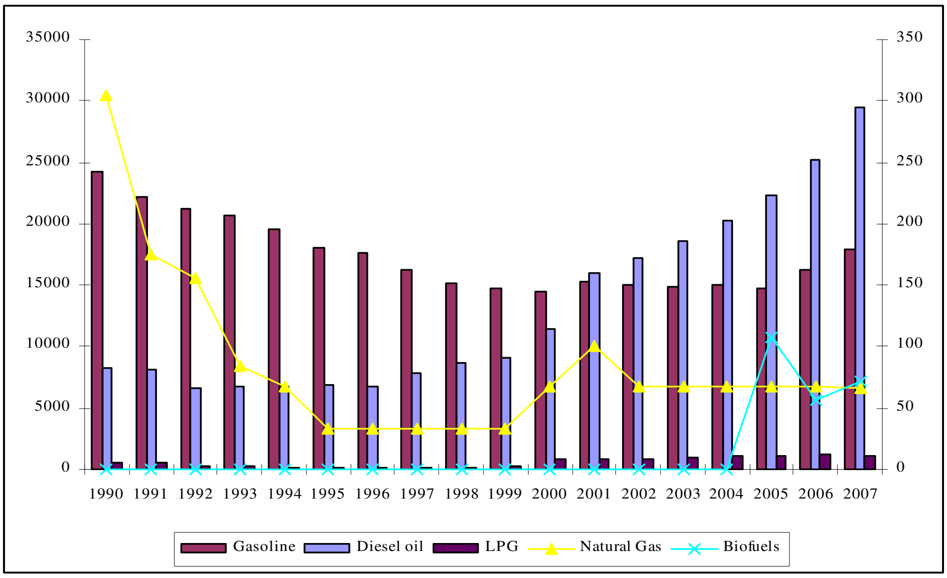


Figure 3.3.3 Fuel consumption in road transport in 1990 – 2007 (Gg)
(Biofuels and Natural Gas - secondary axes)

Till 2000 the main fuel used by Road transport in Latvia was gasoline (Figure 3.3.5). In 1997, a differentiated excise tax on fuel was introduced, but since 1999 trading in leaded fuel with lead content >0.15 g/l has been prohibited. By 2004 there is a full transfer to trading in non-leaded fuel.

Railways

Emissions are calculated using fuel consumption form Energy balance prepared by CSB of Latvia (Table 3.3.7). In 2007, amount of traffic was increased therefore amount of consumption of diesel oil increased by 8% if comparison with 2006.

Table 3.3.7 Fuel consumption in railway transport (TJ) [3]

	Diesel oil
1990	7180.81
1991	7010.85
1992	5693.66
1993	3526.67
1994	3101.77
1995	3229.24
1996	3229.24
1997	3399.2
1998	3101.77
1999	2676.87
2000	2761.85
2001	2846.83
2002	2974.3
2003	3399.2
2004	3484.18
2005	3484.18
2006	3059.28
2007	3314.22

Civil Aviation

First, emissions were calculated separately for LTO and cruise activities. Despite growing of passenger and cargo carriage in 2007 consumption of fuel was decreased if comparison with 2006. Aviation gasoline was used for small airplanes. Generally was used jet kerosene.

In the end of 2005 a research "Research about fuel consumption in domestic navigation and aviation 1990-2004" was made [10]. This research performed very good results for 2004. The expert had collected the data from all available planes, which are included in Register of Latvian Aircrafts.

All domestic airplanes, helicopters and even sailplanes have been included in this calculation. Also the precise information from the enterprise Latvian Air Traffic about registered flights in Latvian airspace in the biggest airports "Rīga", "Liepāja" and "Ventspils" are taken into account. Additionally was used the information about number of flayed hours from all Latvian enterprises and individual persons linked with domestic aviation.

Emissions from domestic aviation are still insignificant just 0.05% from total transport GHG emissions. The fuel consumption is still insignificant from total Transport fuel consumption too (Table 3.3.8).

Table 3.3.8 Fuel consumption in civil aviation (TJ) [10]

	Aviation Gasoline	Jet Kerosene
1990	0.16	0.76
1991	0.16	0.78
1992	0.17	0.81
1993	0.29	1.34
1994	0.57	2.68
1995	1.14	5.35
1996	1.71	8.04
1997	2.28	10.72
1998	2.85	13.40
1999	3.42	16.07
2000	3.99	18.76
2001	4.56	21.44
2002	5.13	23.73
2003	5.42	25.46
2004	5.70	43.00
2005	6.00	38.00
2006	6.40	43.00
2007	7.00	19.00

Domestic Navigation

Until 1998 there happened the gradually registration of ships from Latvian flags to other country flags. Therefore CSB does not collect the fuel consumption from this sector.

In the end of 2005 a research "Research about fuel consumption in domestic navigation and aviation 1990-2004" was made [10]. The research was dealt into two parts – inland waterways and maritime navigation. There were difficulties to get the data from inland waterways, because the biggest part of this contributes the private boats and motorcycles. CSB does not collect any fuel consumption data from individual persons.

On the bases of this calculation was taken the data from RTSD about the registered small navigation for 2004 and expert judgment was used to divide power of engines for rowboats with engine, motorboats, launches and water craft. The main factors, which define the fuel consumption, are the specific fuel consumption per hour and the number of hours spent for navigation. Also the number of hours spent for navigation is not known; therefore this quantity was simulated, based on some assumptions about seasonality.

The gasoline consumption was simulated for 2004; the consumption for other years was extrapolated (Table 3.3.9). To get the fuel consumption from maritime navigation was easier. The CSB collect data about ships that is registered under all kind of flags in Latvia. The expert decided to include in calculation all towboats and supporter fleet, because other ships aren't classified under domestic navigation. The all needed ships were split up per horsepower and so can define the specific fuel consumption per horsepower. The assumption was made about worked hours to ships. In this regard was calculating the fuel consumption from maritime navigation (Table 3.3.9).

For 2006 and 2007, consumption of diesel oil was obtained from CSB, but consumption of gasoline was determined using expert's studies.

Table 3.3.9 Fuel consumption in domestic navigation, TJ [10]

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
diesel oil	212.5	251.0	398.4	527.7	562.4	588.3	605.9	571.8	568.9	595.1	621.7	621.7	598.9	590.4	560.8	572.0	589.2	43
gasoline	24.9	25.7	26.5	27.3	28.1	29	29.9	30.8	31.8	32.8	33.8	34.8	35.9	37	38.2	39.3	40.5	30.5

3.3.3. Uncertainties and time series consistency

The activity data uncertainty for **Road transportation** is 10% for the estimation of CO_2, N_2O and CH_4, because the data is not distributed like in COPERT III model, and there are made some assumptions. The default uncertainties are used for emission factors presented by IPCC GPG 2000.

The CSB has quite precise data about fuel consumption used in **Railway**; therefore the uncertainty used for activity data for the estimation of CO_2, N_2O and CH_4 is 2%. The default uncertainties are used for emissions factors presented by IPCC GPG 2000.

Very precise activity data in 2004 was obtained from research in **Civil Aviation**, therefore in last submission 2007 the uncertainty was very small, just 2%, but in submission 2008 data for 2006 are calculated based on made assumptions, therefore the uncertainty for activity data is 20%. The default uncertainties are used for emission factors presented by IPCC GPG 2000.

The uncertainty in **domestic navigation** is high – 50%, because the activity data are simulated. The default uncertainties are used for emissions factors presented by IPCC GPG 2000.

3.3.4. Source specific QA/QC and verification

Expert reviewer checked and filled in QC form for each category according to internal QA/QC program.

3.3.5 Source-specific recalculations

For emission calculation from **road transport** COPERT IV version only for years 2004 – 2007 was used.

Based on more detailed data concerning **domestic aviation** it is recalculated emissions for year 2004-2006 by implementing T1 methodology and IPCC emission factors.

3.3.6 Source-specific planned improvements

It is planned to use the new version of COPERT for all time series (1990-2007).

3.4 OTHER SECTORS (CRF 1.A.4)

3.4.1 Source category description

Other Sectors (CRF 1.A.4) 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.

The emissions from CRF 1.A.4 sector in 1990 – 2007 are presented in Table 3.4.1.

Table 3.4.1 Emissions from Other Sectors in 1990 – 2007 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1.A.4 Other sectors																		
CO_2,	5690.2	5803.0	4114.1	3416.8	2369.1	1580.6	1600.9	1349.5	1165.6	1144.0	1056.1	1212.7	1180.0	1269.1	1324.5	1301.3	1374.9	1367.3
CH_4	11.2	12.7	11.5	12.2	12.0	12.6	12.9	12.2	11.4	11.2	10.5	11.6	11.3	11.9	12.2	12.3	11.9	11.9
N_2O	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Decrease of CO_2 emissions from CRF 1.A.4 Other Sectors in 1991-2000 can be observed and it is explained with changes and redistribution of structure of national economy (Figure 3.2.1). Increase of CO_2 emissions in 2000 – 2006 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 CRF 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. Methane emissions from CRF 1.A.4 Other sectors had increased for 13.3% in time period 2000 – 2007 that is explained with increase of wood and wood waste consumption as well as natural gas consumption. As it can be seen in Figure 3.4.1 total GHG emissions from CRF 1.A.4 Other Sectors increased in 2000 – 2007 by 26.2%. It can be explained with development of CRF 1.A.4.a Commercial / Institutional sector where fuel consumption increased by 38% in 2000-2007 and CRF 1.A.4.c Agriculture / Forestry and Fisheries sector in second place where fuel consumption increased by 23.8% in 2000-2007. Decrease of central heating system role in residential households increase emissions from 1.A.4.b sector.

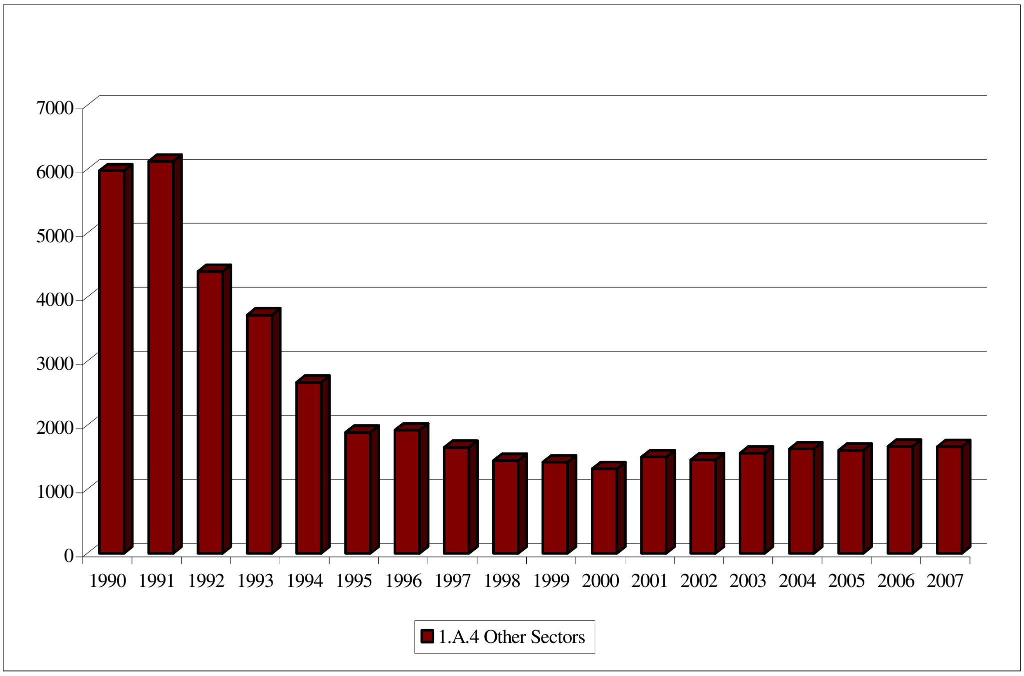


Figure 3.4.1 Total GHG emissions from Other Sectors in 1990–2007 (Gg CO_2 eq)

Also indirect GHG emissions from Other Sectors were estimated (Figure 3.4.2). SO_2 had biggest decrease by 97.2% in time period 1990 – 2007. It is explained with fuel switching to natural gas and biomass from what sulphur dioxide emissions aren't emitted. Also other indirect GHG emissions in 2006 – 2007 decreased that is explained with the decrease of total fuel consumption combusted in stationary combustion installations.

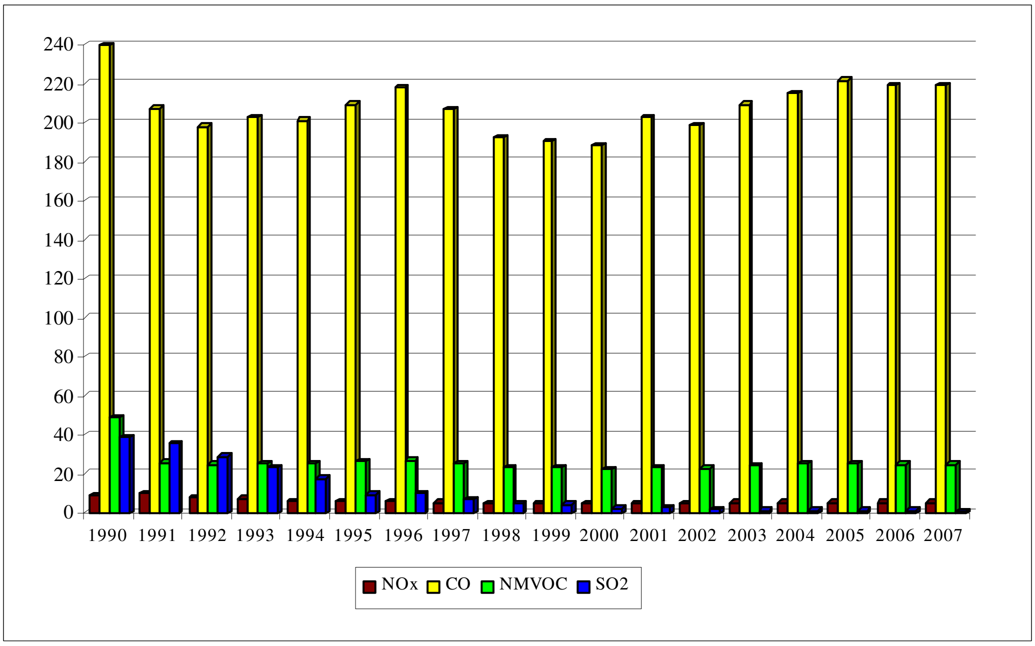


Figure 3.4.2 Total indirect GHG emissions from Other Sectors in 1990 – 2007 (Gg)

3.4.2 Methodological issues

Methods

IPCC 1996 Tier1 Sectoral approach and Reference approach for the comparison of CO_2 emissions as well as EMEP/CORINAIR Guidebook were used to calculate GHG emissions from the Energy sector. IPCC 2006 was used in the calculation of emissions from biofuels. Calculation of all emissions from fuel combustion is done with Excel databases developed by experts from LEGMA. CRF Reporter software developed by experts from UNFCCC was used to report emission data.

The general method for preparing inventory data was used:

$$\boxed{Emission = EF \times \text{activity data}_{ab}}$$

where:
Emissions – total emissions of fuel type in sub-sector (Gg)
EF – emission factor (Gg/PJ; Mg/PJ)
activity data – energy input (TJ, PJ)
a – fuel type;
b – sector activity

Oxidation factor is included in the calculations CO_2 emissions.

Emission factors and other parameters

The main sources for emission factors are:

- National studies for country specific parameters and emission factors;
- IPCC 1996;
- IPCC 2006;
- EMEP/CORINAIR Guidebook.

Country specific emission factors were used to calculate carbon dioxide (CO_2) and sulphur dioxide (SO_2) emissions (Chapter 3.2.2).

EF for CO_2, CH_4 and N_2O emissions estimation from landfill and sludge gas combustion in CRF 1.A.4.a Commercial / Institutional sector starting 1993 is taken from IPCC 2006, as there is no national expert research done for biogas combustion.

The default CH_4, N_2O, NO_x, CO, NMVOC emission factors used in estimation of emission were taken from IPCC Guidelines (Table 3.4.3).

Table 3.4.3 CO_2, CH_4, N_2O, NO_x, CO, NMVOC emission factors (Gg/PJ)

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1.A.4.a Commercial/Institutional						
Gasoline	68.6	0.05	0.002	0.21	27	1
Diesel oil	74	0.01	0.0006	0.1	0.02	0.005
RFO	76.59	0.01	0.0006	0.1	0.02	0.005
LPG	62.44	0.01	0.0006	0.1	0.02	0.005
Jet fuel	70.86	0.01	0.0006	0.1	0.02	0.005
Other kerosene	71.52	0.01	0.0006	0.1	0.02	0.005
Other liquid	72.6	0.01	0.0006	0.1	0.02	0.005
Shale oil	75.43	0.01	0.0006	0.1	0.02	0.005
Coal	92.2	0.01	0.0014	0.1	2	0.2
Coke	86.98	0.01	0.0014	0.3	0.15	0.02
Peat briquettes	95.06	0.3	0.004	0.1	5	0.6
Peat	103.87	0.3	0.004	0.1	5	0.6
Natural gas	55.82	0.005	0.0001	0.05	0.05	0.005
Landfil gas	54.600	0.001	0.0001	0.050	0.050	0.005
Sludge gas	54.600	0.001	0.0001	0.050	0.050	0.005
Wood	107.78	0.005	0.0001	0.05	0.05	0.005
1.A.4.b Residential and Agriculture/Forestry/Fishery						
Gasoline	68.6	0.05	0.002	0.21	27	1
Diesel oil	74	0.01	0.0006	0.1	0.02	0.005
RFO	76.59	0.01	0.0006	0.1	0.02	0.005
LPG	62.44	0.01	0.0006	0.1	0.02	0.005
Jet fuel	70.86	0.01	0.0006	0.1	0.02	0.005
Other kerosene	71.52	0.01	0.0006	0.1	0.02	0.005
Other liquid	72.6	0.01	0.0006	0.1	0.02	0.005
Shale oil	75.43	0.01	0.0006	0.1	0.02	0.005
Coal	92.2	0.3	0.0014	0.1	2	0.2
Coke	86.98	0.3	0.0014	0.3	0.15	0.02
Peat briquettes	95.06	0.3	0.004	0.1	5	0.6
Peat	103.87	0.3	0.004	0.1	5	0.6
Natural gas	55.82	0.005	0.0001	0.05	0.05	0.005
Wood	107.78	0.005	0.0001	0.05	0.05	0.005

SO_2 emission factors for fuel combustion are presented in Annex 3.

Activity data

Mainly emissions from fuel combustion are calculated using activity data – fuel consumption, from the CSB – Energy Balance for Latvia and Annual questionnaires for 1990-2007 sent to EUROSTAT by CSB. The CSB data collection system is based on a detailed compulsory survey 1–EK.

This form "Survey on stocks, receipts and consumption of energy resources semi-annual) 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.

CSB collects and assesses fuel consumption data with annual questionnaires for 1.A.4.b Residential Sector.

Table 3.4.4 Fuel consumption in Other Sectors in 1990 – 2007 (PJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1.A.4 Other Sectors																		
Liquid fuels	29.45	34.04	25.65	21.85	14.54	9.14	9.08	8.00	7.15	7.55	6.97	7.48	7.02	7.95	8.08	7.84	8.66	7.90
Solid fuels	23.53	20.77	16.88	13.96	9.88	5.57	6.03	5.00	3.60	2.88	2.20	3.00	2.39	2.21	2.15	2.07	2.01	1.95
Gaseous fuels	24.35	24.69	11.92	9.46	7.03	7.18	6.83	5.51	5.75	5.95	6.27	7.08	8.12	8.82	9.75	9.79	10.13	11.07
Biomass	26.45	31.06	30.87	33.30	33.83	38.73	39.83	38.07	36.35	35.99	33.90	36.63	36.37	38.38	39.64	39.59	38.42	38.40

The biggest decrease in time period 1990 – 2007 was for liquid fuel consumption – 73.2% (Table 3.4.4, Figure 3.4.3). 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. And that's why also consumption of solid fuels decreased. Solid fuel consumption decreased by 91.7% in 1990– 2007.

Since 1992, biomass as fuel dominates in Other Sectors. Biggest part of biomass consumption goes to Residential sector where biomass is main fuel in small capacity burning installations. Consumption of biomass fuel increased by 45.2% in the time period 1990 – 2007. In 2006-2007 also biomass consumption had slightly decreased by 0.1%. Since 1997 gaseous fuel consumption is constantly increasing.

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.

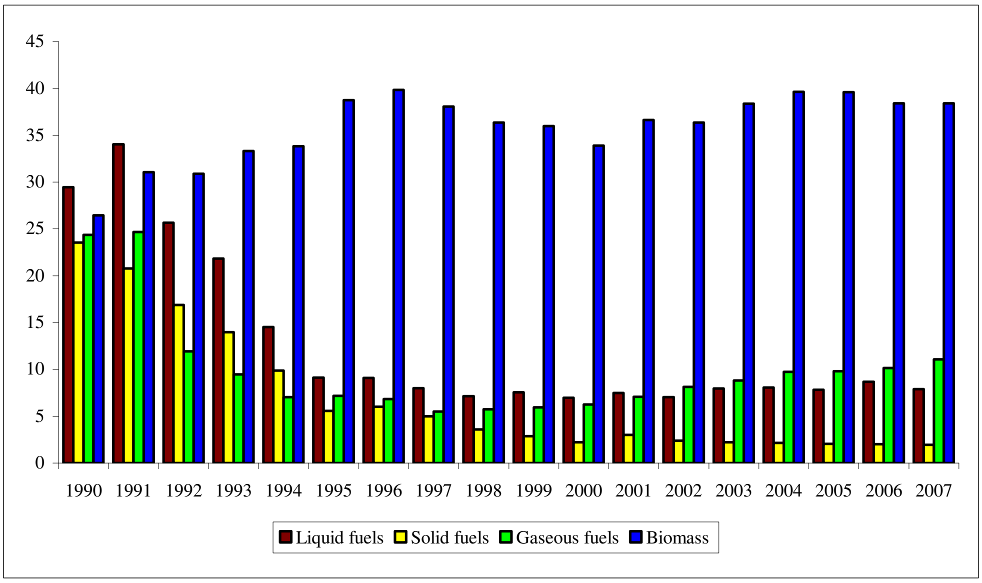


Figure 3.4.3 Total fuel consumption in Other Sectors in 1990 – 2007 (PJ)

3.4.3 Uncertainties and time series consistency

Uncertainty in activity data of fuel combustion in sectors CRF 1.A.1, CRF 1.A.2 and CRF 1.A.4 is ±2% in 2007. 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 biomass combustion was assigned as 15% because biomass activity data were collected by CSB with questionnaires sent by enterprises consumed biomass. Uncertainty of biogas and liquid biofuels stationary combusted in enterprises covered by 1.A.4.a Commercial / Institutional sector was assumed rather low – 5% because biofuels are combusted together with other types of fossil fuel and uncertainty of 2% (as for all statistical data) couldn't be assumed. So it gives average uncertainty 10% for activity data.

In fuel combustion, the CO_2 emission factor mainly depends on the carbon content of the fuel instead of on combustion technology. Therefore, uncertainty in CO_2 emissions was calculated at a rather aggregated level, i.e. by fuel type rather than by sector.

CO_2 emission factor was estimated by national expert according physical characterization of used fuels in country so uncertainty was assigned as quite low about 5%. For combustion of solid fuels uncertainty of CO_2 emission factor was assigned higher to 10% because CO_2 emission factor of peat briquettes was taken from GHG inventories of Finland. As well as CO_2 emission factor from biogas and liquid biofuels consumption was assigned as 10% because default emission factor taken from the IPCC 2006 was 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.

CH_4 and N_2O emission factor used in estimation of emissions was 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. Emissions from all sectors are estimated or reported as not occurring / not applicable therefore there are no "not estimated" sectors.

3.4.4 Source-specific QA/QC and verification

The source specific QA/QC procedures are the same as for CRF 1.A.1 and 1.A.2 sectors (see Chapter 3.2.4).

3.4.5 Source-specific recalculations

Structural changes are made also in the CRF tables for liquid fuels, solid fuels and in some sectors also for biomass. Previously aggregated data for these fuels were reported but for submission 2009 these fuels were subdivided in particular fuels. This was done for clear and foreseeable reporting.

CO_2, CH_4 and N_2O emission factors for sludge and landfill gas were changed. For submission 2008 these emission factors were the same as natural gas emission factors but for submission 2009 these emission factors were taken from IPCC 2006.

Natural gas consumption for year 1990 – 1993 was included in CRF 1.A.4.a Commercial / Institutional sector because it is combusted for the energy in the support and operation of pipelines transporting gases, liquids, slurries and other commodities, including the energy used for pump stations and maintenance of the pipeline. Previously this consumption was reported in Pipeline Transport.

According to latest information from CSB about fuel consumption small changes in the activity data occur only in the year 2006 particularly in sector 1.A.4.a Commercial / Institutional.

Significant difference for submission 2008 and submission 2009 in reported direct GHG emissions from Other Sectors could be observed only in 1990 – 1993 from 0.71% in 1992 to 1.44% in 1993 with average difference 1.04 in 1990 – 1993.

3.4.6 Source-specific planned improvements

The summarized necessary improvements are:

- Researches on use of the national emission factors;
- 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.

3.5 OTHER SOURCES (CRF 1.A.5.B)

3.5.1 Source category description

Under the CRF 1.A.5.b Other Mobile sources emissions from jet kerosene used in military aircrafts are reported. These emissions appear in 1995-1999, in 2004 and in 2006-2007. For other years the consumption of jet kerosene is less that 500 tonnes and therefore the CSB doesn't report this consumption within EUROSTAT Annual Questionnaire reporting.

The emissions from CRF 1.A.5.b sector in time period 1990 – 2007 are presented in Table 3.5.1.

Table 3.5.1 Emissions from Military aircrafts in 1995 – 2007 (Gg)

	1995	1996	1997	1998	1999	2004	2006	2007
CO_2	6.2294	3.1147	12.4589	3.1147	9.3442	3.1154	3.1154	3.1154
CH_4	0.00004	0.00002	0.00009	0.00002	0.00006	0.00002	0.00002	0.00002
N_2O	0.00017	0.00009	0.00035	0.00009	0.00026	0.00009	0.00009	0.00009
GHG emissions in CO_2 e-qv.	**6.28392**	**3.14196**	**12.56783**	**3.14196**	**9.42587**	**3.14268**	**3.14268**	**3.14268**
NO_x	0.0216	0.0108	0.0432	0.0108	0.0324	0.0108	0.0108	0.0108
CO	0.0086	0.0043	0.0173	0.0043	0.0130	0.0043	0.0043	0.0043
NMVOC	0.0043	0.0022	0.0086	0.0022	0.0065	0.0022	0.0022	0.0022
SO_2	0.0020	0.0010	0.0040	0.0010	0.0030	0.0010	0.0010	0.0010

Emissions from this sector aren't influenced by the changes in national economy or in the economy of Latvia's trade partners. That's why emission fluctuation isn't so easy explicable.

3.5.2 Methodological issues

Methods

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

The general method for preparing inventory data was used:

$$\boxed{Emission = EF \times \text{activity data}_{ab}}$$

where:
Emissions – total emissions of fuel type in sub-sector (Gg)
EF – emission factor (Gg/PJ; Mg/PJ)
activity data – energy input (TJ, PJ)
a – fuel type;
b – sector activity

Emission factors and other parameters

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

Default emission factors for Military aircrafts are taken from IPCC 1996 and are presented in Table 3.5.2.

Table 3.5.2 Emission factors for the calculation of emissions from Military aircrafts

	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
Jet fuel	72.1	0.0005	0.002	0.25	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 (see chapter 3.2.2).

SO_2 emission factors for fuel combustion are presented in Annex 3.

Activity data

Mainly emissions from fuel combustion are calculated using activity data – fuel consumption, from the CSB – Energy Balance for Latvia and Annual questionnaires for 1995-2007 sent to EUROSTAT by CSB.

Table 3.5.3 Fuel consumption in Military aircrafts in 1995 – 2007 (TJ)

	1995	1996	1997	1998	1999	2004	2006	2007
1.A.5.b Other Mobile								
Liquid fuels	86.4	43.2	172.8	43.2	129.6	43.21	43.21	43.21

3.5.3 Uncertainties and time series consistency

Uncertainty in activity data of fuel combustion in sectors CRF 1.A.5.b is ±2% in 2007 because official statistical information from CSB is used.

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.

3.5.4 Source-specific QA/QC and verification

This source category is covered by the general QA/QC procedures of the greenhouse gas inventory.

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 LEGMA 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.

3.6 REFERENCE APPROACH (CRF 1.A(B))

3.6.1 Source category description

Reference approach (RA) is carried out using import, export, production and stock change data from the CSB – Energy Balance for Latvia and Annual questionnaires for 1990-2007 sent to EUROSTAT by CSB.

In the EB sheets stock changes, statistical differences and distribution losses are reported for certain fuels, whereas in the RA table only stock changes are possible to input. Data from these EB sheets are taken account and input in stock changes cells of CRF Reporter RA tables for better comparison. Also EB include "Interproduct transfers" category, data from this category is included in stock change category of RA tables for right result.

Total difference between Sectoral and Reference approaches of fuel consumption and CO_2 emissions can be seen in Table 3.5.1. Total fuel consumption difference reaches 1% only in 2006 with average 0.47%. Total difference of CO_2 emissions exceeds 1% only in year 2006 – 1.4% but have average difference 0.56%.

For emissions estimation by Reference approach CRF Reporter software were used.

Table 3.6.1 Difference between Sectoral and Reference approach data

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Fuel consumption - Liquid fuels																		
Reference approach (PJ)	144.0	125.9	105.1	98.2	92.7	76.0	82.1	71.4	70.9	66.5	56.2	55.2	56.0	57.6	59.0	59.4	64.3	69.9
Sectoral approach (PJ)	139.4	124.1	104.3	97.4	91.6	74.9	80.8	69.5	68.3	63.7	52.7	53.3	53.3	54.9	56.2	56.2	61.0	65.2
Difference (%)	0.9	0.1	-0.3	-0.5	-0.6	-0.8	-0.8	-0.9	-0.9	-1.0	0.8	-1.3	-0.9	-1.2	-1.2	-1.4	-2.1	-0.1
CO_2 emissions - Liquid fuels																		
Reference approach (Gg)	10374.1	9151.4	7650.9	7124.1	6724.8	5472.3	5926.7	5064.6	4974.4	4624.1	3849.7	3797.6	3824.0	3936.6	4035.7	4004.2	4305.6	4700.9
Sectoral approach (Gg)	10278.3	9135.7	7668.4	7159.5	6765.7	5515.4	5971.4	5106.9	5016.7	4669.4	3815.0	3845.6	3851.6	3956.1	4050.7	4046.9	4412.4	4697.3
Difference (%)	0.9	0.2	-0.2	-0.5	-0.6	-0.8	-0.7	-0.8	-0.8	-1.0	0.9	-1.2	-0.7	-0.5	-0.4	-1.1	-2.4	0.1
Fuel consumption - Solid fuels																		
Reference approach (PJ)	30.4	26.5	23.5	21.3	16.0	11.6	10.9	9.7	7.1	5.4	5.5	5.2	4.2	3.5	2.8	3.4	3.6	4.4
Sectoral approach (PJ)	30.4	26.5	23.5	21.3	16.0	11.6	10.9	9.7	7.1	5.4	5.5	5.2	4.2	3.5	2.8	3.4	3.6	4.4
Difference (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO_2 emissions - Solid fuels																		
Reference approach (Gg)	2829.6	2474.0	2199.5	1991.3	1504.3	1099.5	1036.5	920.6	668.6	502.4	520.7	484.0	390.9	325.1	261.2	314.4	335.2	409.9
Sectoral approach (Gg)	2840.0	2485.6	2213.3	2004.9	1517.7	1114.6	1050.0	934.4	678.4	508.1	531.2	489.4	395.3	328.1	261.6	314.8	335.6	410.3
Difference (%)	-0.4	-0.5	-0.6	-0.7	-0.9	-1.4	-1.3	-1.5	-1.5	-1.1	-2.0	-1.1	-1.1	-0.9	-0.1	-0.1	-0.1	-0.1
Fuel consumption - Gaseous fuels																		
Reference approach (PJ)	99.5	98.8	71.5	46.5	33.6	41.3	35.6	43.6	42.6	40.9	45.1	52.3	53.6	55.8	55.3	56.8	58.6	56.7
Sectoral approach (PJ)	99.5	98.8	71.5	46.5	33.6	41.3	35.6	43.6	42.6	40.9	45.1	52.3	53.6	55.8	55.3	56.8	58.6	56.7
Difference (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO_2 emissions - Gaseous fuels																		
Reference approach (Gg)	5555.0	5517.3	3988.5	2593.7	1876.7	2306.0	1986.1	2431.0	2380.6	2281.5	2514.8	2922.1	2991.1	3113.0	3087.9	3168.5	3271.6	3164.5
Sectoral approach (Gg)	5538.0	5507.6	3979.9	2589.2	1873.0	2304.7	1984.3	2429.1	2378.8	2279.6	2511.1	2916.4	2987.3	3109.3	3084.2	3164.8	3267.9	3160.8
Difference (%)	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Fuel consumption - Other fuels																		
Reference approach (PJ)	-	-	-	-	-	-	-	-	-	0.0	0.1	0.2	0.3	0.3	0.3	0.2	0.1	0.2
Sectoral approach (PJ)	-	-	-	-	-	-	-	-	-	0.0	0.1	0.2	0.3	0.3	0.3	0.2	0.1	0.2
Difference (%)	-	-	-	-	-	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO_2 emissions - Other fuels																		
Reference approach (Gg)	-	-	-	-	-	-	-	-	-	3.0	10.8	20.3	27.5	24.1	26.0	14.5	10.4	16.7
Sectoral approach (Gg)	-	-	-	-	-	-	-	-	-	3.0	10.8	20.3	27.5	24.1	26.0	14.5	10.4	16.7
Difference (%)	-	-	-	-	-	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fuel consumption – Total																		
Reference approach (PJ)	273.9	251.3	200.0	165.9	142.3	129.0	128.6	124.7	120.6	112.8	106.9	113.0	114.1	117.1	117.4	119.8	126.7	131.3
Sectoral approach (PJ)	269.3	249.5	199.2	165.1	141.3	127.8	127.3	122.7	118.0	110.0	103.3	111.0	111.4	114.4	114.7	116.5	123.3	126.6
Difference (%)	0.5	0.1	-0.2	-0.3	-0.4	-0.5	-0.5	-0.5	-0.5	-0.6	0.4	-0.6	-0.4	-0.6	-0.6	-0.7	-1.0	0.0
CO_2 emissions – Total																		
Reference approach (Gg)	18758.7	17142.6	13838.9	11709.2	10105.8	8877.9	8949.3	8416.2	8023.7	7411.0	6896.1	7223.9	7233.5	7398.8	7410.8	7501.6	7922.8	8292.0
Sectoral approach (Gg)	18656.3	17129.0	13861.6	11753.6	10156.4	8934.6	9005.7	8470.3	8074.0	7460.1	6868.1	7271.8	7261.7	7417.5	7422.4	7541.0	8026.3	8285.1
Difference (%)	0.5	0.1	-0.2	-0.4	-0.5	-0.6	-0.6	-0.6	-0.6	-0.7	0.2	-0.9	-0.8	-0.6	-0.5	-0.7	-1.4	-0.1

3.6.2 Methodological issues

Methods

The IPCC 1996 Tier1 Reference approach for the CO_2 emission estimations and comparison of CO_2 emissions were used. Calculation of all emissions from fuel combustion is done with Excel databases developed by experts from LEGMA. CRF Reporter software developed by experts from UNFCCC was used to report emission data. Generally emissions from fuel combustion are calculated by multiplying fuel consumption with country specific or IPCC default emission factor. Calculating CO_2 emissions oxidation factor is included.

All emissions within CRF 1.B are based on top-down data.

Emission factors and other parameters

Carbon emission factors from national expert research "Methodological instructions for CO_2 emissions determination" (Annex 2) are used to estimate CO_2 emissions for Reference approach. If emission factors for some types of fuels were not available from the research emission factors from IPCC Guidelines or emission factors for neighbourhood countries submitted in their NIR were used (Table 3.6.2).

Table 3.6.2 Carbon emission factors (t/TJ)

Fuel type	Carbon emission factor
Liquid Fuels	
Gasoline	18.8973
Jet Kerosene	19.5218
Other Kerosene	19.7018
Shale oil	20.7791
Gas / Diesel Oil	20.3836
Residual Fuel Oil	21.0982
LPG	17.1136
Bitumen	22.0
Lubricants	10.0
Petroleum Coke	27.5000
Other Oil	20.0
Parrafin Wax	22.0
White Spirit	20.0
Gasoline type jet fuel	18.8973
Solid Fuels	
Other Bituminous Coal	25.6582
Peat	27.6805
Coke Oven / Gas Coke	24.2045
Peat Briquettes	26.4545
Gaseous Fuels	
Natural Gas	15.3
Biomass	
Solid Biomass	29.9945
Liquid Biomass	19.3
Gas Biomass	14.8909
Other Fuels	
Industrial Wastes (used tires)	23.0303* 21.6545**

* for year 1999-2004
** for years 2005-2007

Activity data

Coke consumption in steel production is included in CRF 1.A.2.a Iron & Steel sector and excluded from 1D sector according to ERT recommendations because coke is used for alloying with burn-off as energy source.

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 estimate 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 1B tables are higher that it should be.

So difference between CO_2 emissions estimated with Reference approach and Sectoral approach for liquid fuels is quite high from 0.2% in 1991-1992 to 2.4% in 2006.

No problems occurred with gaseous fuels and other fuels where difference for activity data and estimated CO_2 emissions between Reference approach and Sectoral approach is within 0.3% for all years.

3.6.3 Uncertainties and time series consistency

Uncertainty in activity data of fuel combustion in is ±2% in 2007. CSB gives approximately 2% statistical frame mistake 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 biomass combustion was assigned as 15% because biomass activity data were collected by CSB with questionnaires sent by enterprises consumed biomass. Uncertainty of biogas and liquid biofuels stationary combusted in enterprises covered by 1.A.1 Energy Industries sector was assumed rather low – 5% because biofuels are combusted together with other types of fossil fuel and uncertainty of 2% (as for all statistical data) couldn't be assumed. So it gives average uncertainty 10% for activity data.

In fuel combustion, the CO_2 emission factor mainly depends on the carbon content of the fuel instead of on combustion technology. Therefore, uncertainty in CO_2 emissions was calculated at a rather aggregated level, i.e. by fuel type rather than by sector. Carbon emission factors for all types of fuels for emission estimation with Reference approach were taken from national expert research and are assumed as country specific so uncertainty was assigned as quite low about 5%.

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

3.6.4 Source-specific QA/QC and verification

Activity data for the Energy sector is taken from the Annual Questionnaires that Central Statistical Bureau prepares and reports to the EUROSTAT. CSB has the internal QA/QC procedures based on mathematical model and analysis to avoid logic mistakes. CSB now is working on the development of documentation system that will serve as centralised knowledge base of the calculations and surveys carried out by the CSB because the whole business cycle of data will be described, including quality assessment.

This source category is covered by the general QA/QC procedures of the GHG inventory.

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.

3.6.5 Source-specific recalculations

Emission factors for Reference Approach (for all fuels) were changed according to ERT recommendations reported during Centralized review in 8^{th} – 13^{th} September 2008. The carbon emission factors (for Reference Approach) were changed according to Latvia's national EF without oxidation factor as it was stated in ERT recommendations.

Peat briquettes data for Reference Approach were excluded from Other Solid fuels and were reported under BKB & Patent Fuels category. Production of peat and peat briquettes was included in "Production" category under Peat fuel according to ERT recommendations.

For submission 2009, data of liquid biofuels combusted in CRF 1.A.2.c Chemicals were reported under Liquid Biomass for the 2006-2007.

According to latest information from CSB about fuel consumption small changes in the activity data of some fuels occur only in the year 2006 and for Gas/Diesel Oil for 2005-2006 due to updated statistical information. Data of fuel consumption from IEA/AIE – EUROSTAT – UNECE *Annual questionnaires* were used.

3.7 FEEDSTOCKS AND NON-ENERGY USE OF FUELS (CRF 1.A(D))

3.7.1 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 – 2007. Paraffin Waxes and White Spirits are not default types of fuels in CRF 1.D tables so these fuels are reported under "Other Fuels" what caused some discrepancies with 1.B tables that is described in Chapter 3.6.

3.7.2 Methodological issues

Methods

The IPCC 1996 Tier1 Reference approach were used to calculate emissions from feedstocks and non-energy use of fuels. Calculation of all emissions from fuel combustion is done with Excel databases developed by experts from LEGMA. CRF Reporter software developed by experts from UNFCCC was used to report emission data.

Generally emissions from fuel combustion are calculated by multiplying fuel consumption with country specific or IPCC default emission factor.

Emission factors and other parameters

Emission factors used in different neighbourhood countries during preparation of submission were used in emission estimations due to lack of national carbon emission factors:

- 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 (Table 3.4.2).

Activity data

Activity data prepared by CSB and reported to EUROSTAT in EUROSTAT Annual Questionnaire formats were used (Table 3.7.1).

Table 3.7.1 Activity data for Feedstocks and non-energy use of fuels in 1990–2007 (TJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Bitumen	1632.5	544.2	83.7	167.4	544.2	711.6	879.1	1632.5	2051.1	2344.2	2009.3	1507.0	2093.0	2176.7	2009.3	2511.6	3097.6	3348.8
Lubricants	1632.5	1046.5	920.9	1088.4	1004.6	962.8	962.8	879.1	1004.6	879.1	879.1	837.2	837.2	920.9	1004.6	1088.4	1088.4	1088.4
Paraffin Wax	-	-	-	-	-	-	-	-	-	125.6	125.6	167.4	167.4	167.4	251.2	334.9	251.2	251.2
White Spirit	83.7	83.7	83.7	83.7	83.7	83.7	83.7	83.7	125.6	83.7	125.6	125.6	83.7	83.7	125.6	125.6	125.6	83.7
Coke	52.7	105.5	131.9	105.5	184.6	158.2	158.2	263.7	263.7	263.7	263.7	263.7	241.1	134.0	187.5	160.7	134.0	134.0

3.7.3 Uncertainties and time series consistency

Uncertainty in activity data of fuel combustion is ±2% in 2007. CSB gives approximately 2% statistical frame mistake for statistical data. In Latvia all fossil fuels (oil, natural gas, and coal) are imported, and import and export statistics are fairly accurate.

Carbon emission factors for all types of fuels for emission estimation with Reference approach were taken from national expert research and are assumed as country specific so uncertainty was assigned as quite low about 5%.

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

3.7.4 Source-specific QA/QC and verification

This source category is covered by the general QA/QC procedures of the greenhouse gas inventory.

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.

3.7.5 Source-specific recalculations

Emission factors for Lubricants as feedstocks in 1.D sector were changed according to ERT recommendations reported during Centralized review in 8^{th} – 13^{th} September 2008. Fraction of carbon stored in Lubricants is changed from 1 to 0.5 according to ERT recommendations.

For submission 2009 coke consumption is included in CRF 1.A.2.a Iron & Steel sector according to "Report of the individual review of the greenhouse gas inventories of Latvia submitted in 2007 and 2009" and excluded from CRF 1.D sector.

3.7.6 Source-specific planned improvements

It is necessary to assign country specific carbon emission factors to correct estimate CO_2 not emitted emissions amount. Detailed information of activity data for fuel consumption that is not combusted but used as feedstock or for non-energy use is necessary. For this submission it was assumed that all Paraffin Wax and White Spirit consumption isn't combusted.

Also it is necessary to improve structure of CRF Reporter 1.B and 1.D tables so data of Paraffin Wax and White Spirit reported in both tables would be linked.

3.8 FUGITIVE EMISSIONS FROM FUELS (CRF 1.B)

3.8.1 Source category description

Under fugitive emissions from fuels, Latvia reports following CRF categories:

- 1.B.2 Fugitive emissions from oil and natural gas include CH_4 emissions from category 1.B.2.b ii. Transmission/Distribution; iii. Other Leakage (in residential and commercial sectors) and 1.B.2.d. Other – underground storage;
- 1.B.2 Fugitive emission from oil and natural gas includes NMVOC emissions from category 1.B.2.a. Oil storage.

There is one key source category in 2007 with respect to Level assessment without LULUCF sector – CH_4 fugitive emissions from operations of natural gas, with 1%.

Fugitive CH_4 emissions decreases comparing with 1990 – 2001, only started from 2002 it fluctuates and continues to decrease (Table 3.8.1). 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. CH4 emission increase in 2005 is explained with transmission pipeline accident in Valmieras district in April 2005 when significant amount of natural gas leaked.

Table 3.8.1 Fugitive CH_4 emissions from natural gas 1990 – 2007 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
CH_4 emissions	13.05	12.57	11.46	10.96	10.71	10.43	10.05	9.38	9	8.581	7.94	7.7	8.03	6.281	6.213	6.944	5.035	5.164
NO_x emissions	-	-	-	-	-	-	-	-	-	-	-	0.0000013	0.0000013	-	0.0000013	-	-	-
CO emissions	-	-	-	-	-	-	-	-	-	-	-	0.0000046	0.0000046	-	0.0000046	-	-	-

There are no oil refineries in Latvia; therefore NMVOC emissions from gasoline distribution (Table 3.8.2) were only calculated for the time period 1990 – 2001. For the years 1990 till 1999 it was impossible to acquire precise data on fuel storage technologies (vapour filters, vapour storage, etc.), 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 3.8.2 Fugitive NMVOC emissions from oil products 1990 – 2007 (Gg)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
2.98	2.53	2.41	2.34	2.24	2.02	1.99	1.83	1.72	1.66	1.32	1.39	1.35	1.32	1.41	0.86	0.64	0.63

For 2002 – 2007 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.

CRF 1.B.1 Solid Fuels sector emissions aren't included in inventory. It is possible to get data from hard coal transportation via railways but it is not possible to estimate any emissions from this kind of source due to lack of methodology and emission factors. 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 leaking CH_4 emissions from peat bog manufacturing. Still, since there are no methodology and emission factors for estimations, these emissions are not estimated.

3.8.2 Methodological issues

Methods

LEGMA are receiving data about CH_4 emissions from the natural gas holding company "Latvijas Gāze" for the time period 1990 – 2007. Consequently company "Latvijas Gāze" calculates emissions by itself. LEGMA 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.

EMEP/CORINAIR methodology is used to estimate fugitive NMVOC emissions from operations with gasoline in 1990 – 2001. For time period 2002 – 2007 NMVOC emission data are taken from operator's reported in database "2-AIR" so this is bottom-up reporting.

Emission factors and other parameters

CH_4 emission calculation from natural gas is described above.

NMVOC emission factor for emission from gasoline transportation and storage estimation in the time period 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 3.8.3)

Table 3.8.3 NMVOC emission factors (g/kg)

1990-1999	2000-2001
4.9	3.93

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.

Activity data for NMVOC emission calculation was used from CSB Energy Balance (Table 3.8.4). Activity data for 2002 – 2007 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 Environment State Bureau. Mostly these emissions are obtained by using measurement or estimated using mass balance method.

Table 3.8.4 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

3.8.3 Uncertainties and time series consistency

Uncertainty of methane emission from natural gas consumption is assigned as quite low so emissions were 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.

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 2007 from operations with oil products are assumed as 50% because emission data are taken from database "2-AIR" where enterprises report their emission data by themselves. 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 CH_4 emission is consistent and complete because the same methodology, emission factors and data sources are used for all years in time series. Time series of the NMVOC emissions are consistent for 1990 – 2006 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 2007 NMVOC emissions data are taken from enterprises – petrol stations and oil terminals that is bottom-up method.

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

3.8.4 Source-specific QA/QC and verification

Activity data of the gasoline consumption is taken from the Annual Questionnaires that Central Statistical Bureau prepares and reports to the EUROSTAT. CSB has the internal QA/QC procedures based on mathematical model and analysis to avoid logic mistakes. CSB now is working on the development of documentation system that will serve as centralised knowledge base of the calculations and surveys carried out by the CSB because the whole business cycle of data will be described, including quality assessment.

"Latvijas Gāze", that reports fugitive CH_4 emissions from the operations with natural gas, is ISO standard organization and all the information obtaining procedures are controlled and verified.

The activity data used in estimations is repeatedly 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 LEGMA 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.

3.8.5 Source-specific recalculations

Activity data for gasoline consumption changed for year 1993 due to updated statistical information reported by CSB.

3.9 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.

Emissions from marine activities have big fluctuations, due to economical reasons. While emissions from aviation are stable and in last three years there can see very small increase. Total emissions of International Bunkering are shown in the Figure 3.9.1. It can project that also in next years the increase in aviation will be, because essential focus to this sector development is at present actual action.

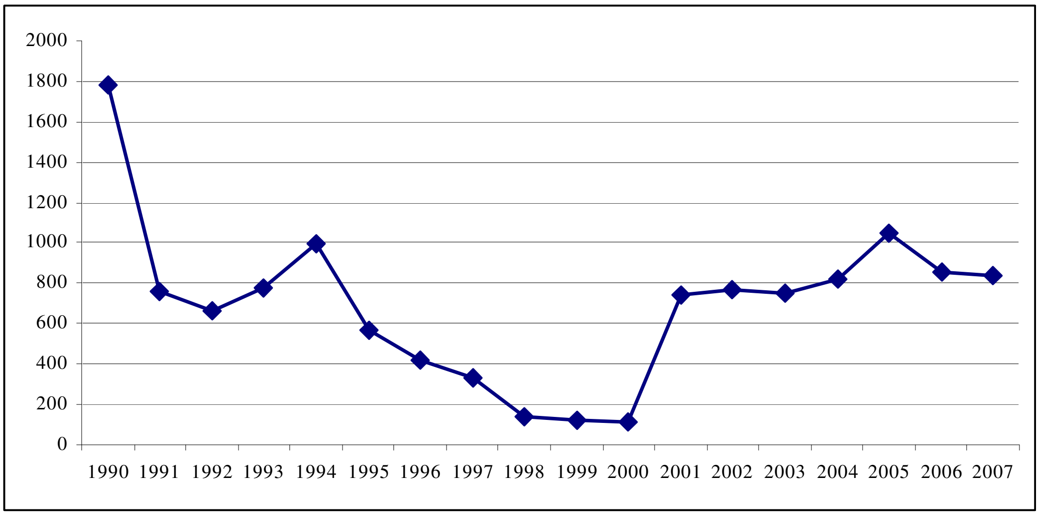


Figure 3.9.1 Emissions from International Bunkers, CO_2-eq (Gg)

Fuel consumption is obtained from CSB (Table 3.9.1).

Table 3.9.1 Energy consumption in international transport, TJ [3]

	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

The emission factors are shown in Table 3.9.2.

Table 3.9.2 Emission factors used in the calculation of emissions from International Bunkering

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
	Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ
Diesel oil	74	0,004	0,03	1,0	0,25	0,11
RFO	76,6	0,005	0,002	1,6	0,5	0,11
Jet fuel	72,1	0,0005	0,002	0,25	0,1	0,05

The SO_2 emissions factors are used consistent with sulphur content in diesel oil (Table 3.9.3 and 3.9.4).

Table 3.9.3 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
2004-2006	0,035	42,49	0,016

Table 3.9.4 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
2000-2006	0,2	40,6	0,097

4. INDUSTRIAL PROCESSES (CRF 2)

4.1 OVERVIEW OF SECTOR

Output growth of manufacturing in 1995-2007 equaled to approximately 7.54% annually. It should be taken into consideration, that 1999 was unfavorable for industry as production outputs declined under the impact of the Russian crisis (Figure 4.1.1). In the last eight years stable growth of manufacturing output is observed when output growth in average 1999-2007 is 8.78%. Still in 2006-2007 manufacturing output increases only by 1%.

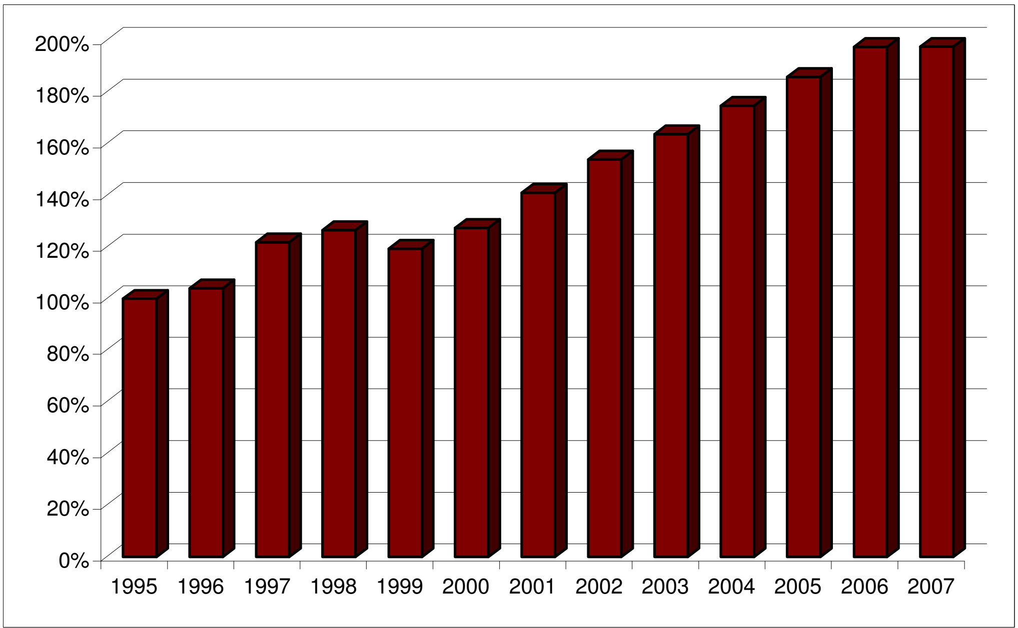


Figure 4.1.1 Manufacturing output (1995 = 100% in 2000 prices)

The share of industry in the whole structure of the national economy in Latvia is smaller than in the majority of EU member states and candidate countries. The share of manufacturing industries in GDP of Latvia in 2007 was only 9.54% and it decreases constantly from 2000. Despite the fact that growth rates of industry in Latvia are faster than the average growth of economy the share of industry is not growing as the producer prices lag behind the general price rise (Table 4.1.1).

Table 4.1.1 Key indicators of manufacturing industries

	2000	2004	2005	2006	2007
Share of only manufacturing industries in GDP (% in actual prices)	12.29	11.79	11.15	10.38	9.54
Share of industrial sector* in GDP (% in actual prices)	21.10	19.95	19.12	19.29	19.41
Share of industrial sector* in total employment (%)**	18.10	16.10	14.90	15.60	15.65
Share of industrial sector in fixed investment (%)***	22.0	24.6	24.2	22.5	25.7
Investment (% change against the preceding year)***	0.54	21.60	14.01	1.72	17.91

* mining industry, manufacturing industry, supply of electric energy, natural gas and water and construction
** data of labour survey (aged 15 – 74 years)
*** long-term investment in intangible and fixed assets

Industrial greenhouse gas emissions contribute 2.56% of the total anthropogenic GHG emissions in Latvia in 2007 (Table 4.1.2). The most important emission source of the Industrial Processes in 2007 is CO_2 emissions from Mineral products with the 2.75% from total CO_2 emissions, CO_2 emissions from Metal production with 0.15% from total CO_2 emissions. F-gases contribute 0.5% of the total GHG emissions.

Sources of emissions from Industrial Processes are:

- Mineral products (CRF 2.A);
- Metal production (CRF 2.C);
- Other production (CRF 2.D);
- Consumption of halocarbons and SF_6 – actual and potential (CRF 2.F).

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.

Under Mineral products emissions from cement production (clinker production), lime production, asphalt roofing, road paving with asphalt and other – use of mineral products in glass, ceramics and metal production are reported. Under Metal production carbon dioxide emissions from coke use as a reducing agent and emissions from use of crude iron as input material are reported as well as methane emissions from total iron and steel production. The CRF category 2.F includes F-gases emissions from refrigeration, fire extinguishers, aerosols, electric equipment and other (SF_6 from shoes). Under Other production Latvia reports NMVOC emissions from food and drink production as well as SO_2 emissions from Pulp and Paper production for time period 1990 – 1996.

Table 4.1.2 Greenhouse gas emission trend in 1990 – 2007 (Gg CO_2 e-qv)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Industrial Processes	**510.4**	**430.5**	**189.5**	**46.4**	**132.5**	**144.5**	**144.9**	**152.4**	**157.6**	**190.6**	**148.1**	**166.1**	**182.0**	**198.8**	**209.9**	**233.9**	**255.0**	**308.7**
2.A Mineral Products	497.5	421.8	183.7	39.3	125.9	139.5	140.0	141.8	144.4	175.7	130.5	146.7	160.1	169.4	174.5	191.5	194.7	235.9
2.C Metal Production	12.9	8.8	5.8	7.0	6.6	4.5	3.5	8.1	8.6	7.8	8.5	8.1	7.7	12.2	13.0	12.4	12.6	12.8
2.F HFCs	NA	NA	NA	NA	NA	0.3	1.1	2.1	4.0	6.2	7.9	9.3	10.8	12.7	17.1	22.5	40.5	51.3
2.F SF_6	NA	NA	NA	NA	NA	0.3	0.3	0.5	0.7	1.0	1.3	2.0	3.4	4.4	5.4	7.5	7.1	8.7

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 4.1.2), when industry was going through a crisis. It has to be noted that in the beginning of 1990-ties 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.

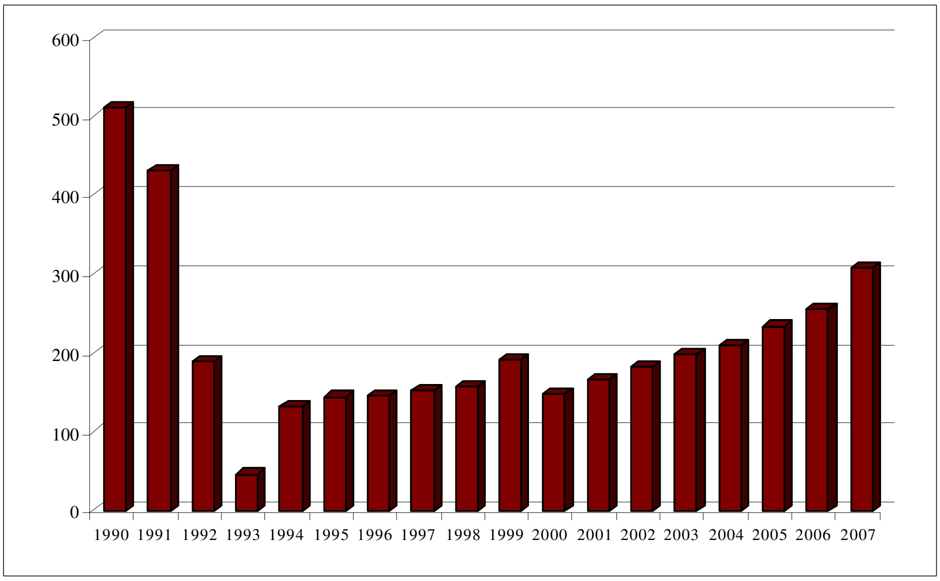


Figure 4.1.2 GHG emissions from Industrial Processes in 1990 – 2007 (Gg CO_2 eq.)

4.2 MINERAL PRODUCTS (CRF 2.A)

4.2.1 Source category description

CRF 2.A Mineral Products sector is main source of GHG emissions in Industrial Processes sector with 76.41% from total Industrial Processes sector GHG emissions. At the moment the most important for non-energy CO_2 emission sources from Industrial Processes sector are cement, lime production, bricks and tiles production and limestone use for glass and metal production.

CO_2 emission from CRF 2.A.1 Cement production sector is key source category with respect to Level assessment without LULUCF sector with 1%. CO_2 emission from CRF 2.A.2 Lime production sector is key source category in 2007 with respect to Trend Assessment without LULUCF sector with 1%.

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 (Figure 4.2.1). 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.

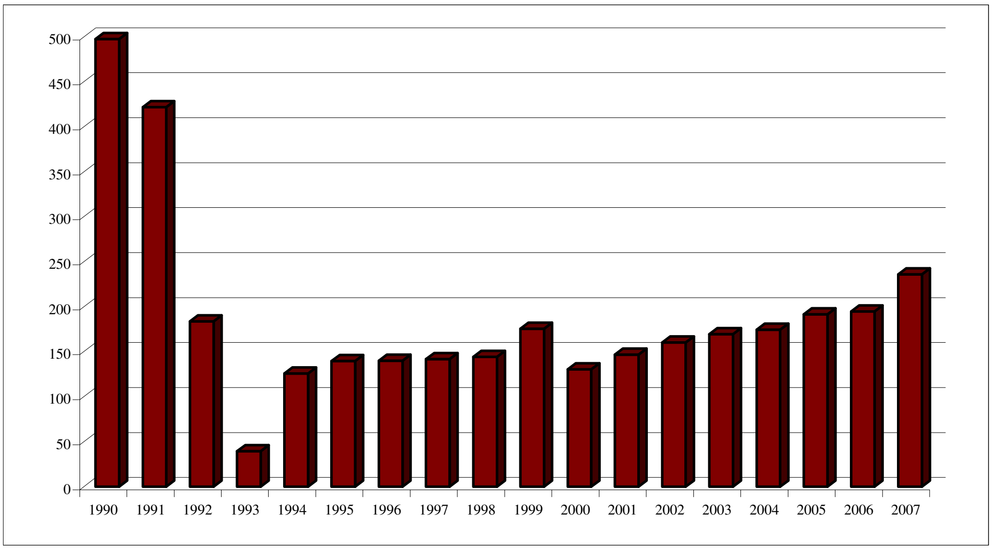


Figure 4.2.1 CO_2 emissions from 2.A Mineral Products in 1990 – 2007 (Gg)

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 CO emissions from cement production are reported in CRF 2.A.7 Other sector due to structure of CRF Reporter software when it is not possible to report NO_x and CO emissions in CRF 2.A.1 Cement Production sector.

4.2.2 Methodological issues

Methods

IPCC 1996, IPCC GPG 2000 Tier2 and EMEP/CORINAIR are used to calculate GHG emissions from the CRF 2.A Mineral Products sector. Calculation of all emissions from processes is done with Excel databases developed by experts from LEGMA. CRF Reporter software developed by experts from UNFCCC was used to report emission data.

Emissions were estimated in view of used raw materials and technology of production processes. For NO_x and NMVOC emissions from cement clinker production EMEP/CORINAIR Guidebook methodology was used.

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. It is not a good practice still activity data calculation is based on final cement production data (imported cement amount is not taken into account) due to unavailability of statistics of produced clinker amount. So activity data is estimated by using Tier1 method from IPCC GPG but for CO_2 emission factor as well as emission estimations IPCC GPG Tier2 method is used.

CO_2 emissions from clinker production are estimated using following equation from IPCC GPG 2000 [7].

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

CO_2 emissions from Lime production are calculated based on data of dolomite use in lime production. Purity factor from IPCC GPG 2000 was taken into account in CO_2 emission calculation. There is only one industrial lime producer in Latvia and only dolomite that is national easy available raw material for production of lime is used for production.

CO_2 emissions from Limestone and Dolomite Use in Glass and Metal industry are estimated with Tier2 method based on plant specific activity data and emission factors.

CORINAIR methodology (simple approach) was used to estimate NMVOC emissions from the 2.A.6. Road Paving with Asphalt. It was assumed that content of bitumen in bitumen composite, which is used for road paving and in the construction, is 45%, and that it is applied as rapid cure of cutback (Table 4.2.4).

Emission factors

The main sources for emission factors are:

- Plant specific emissions factor for CO_2 emission estimations reported by facilities developed and used for CO_2 Emission Trading Scheme;
- IPCC 1996;
- IPCC GPG 2000;
- EMEP/CORINAIR Emission Inventory Guidebook 2006.

<u>CO_2 Emission factor for Clinker Production (IPCC GPG 2000 Tier2 method)</u>

CO_2 emission factor is calculated for all years in time series 1990 – 2007 according to CaO content in used limestone that is measured in laboratory of cement production facility (Table 4.2.1). LEGMA is able to use all laboratory measurements data from cement production plant even it is not accredited and certified as requested in EU ETS Guidelines 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 factors were recalculated using equation from IPCC GPG 2000 [7]:

$$EF_{clinker} = 0.785 \times \text{CaO Content (Weight Fraction) in Clinker}$$

Table 4.2.1 Average CaO content in used limestone (%) and average CO_2 emission factor in 1990 – 2007 (t CO_2 / t clinker)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Average CaO content	64.6	64.65	63.77	64.19	63.78	64.06	57.51	57.51	57.51	57.51	57.51	57.51	57.51	57.51	57.51	57.51	50.95	64.06
CO_2 EF without CKD factor	0.507	0.508	0.501	0.504	0.501	0.503	0.451	0.451	0.451	0.451	0.451	0.451	0.451	0.451	0.451	0.451	0.400	0.503
CO_2 EF with CKD factor	0.548	0.530	0.537	0.544	0.541	0.543	0.486	0.485	0.486	0.477	0.478	0.488	0.481	0.487	0.477	0.454	0.403	0.508

For year 1996 – 2005 average CaO content data of years 1995 and 2006 were used in emissions recalculation since data for average CaO content in produced clinker for years 1996–2003 were not available in facility. Also answer from facility that average CaO content of years where data is available could be used was received.

As it can be seen in Table 4.2.2 the plant specific data resulted in a higher CKD ratio (26.25%) in 1990, while the CKD in 2006 is much lower (0.87%). In addition to the changes to the CKD ratio, the lime content in clinker had decreased considerably from 64.6% (1990) to 50.95% (2006). The EF (without the CKD) changed from 0.51 to 0.4 representing 21% decrease from 1990 – 2006. 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.

Table 4.2.2 CKD correction factor in 1990 – 2007

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Produced clinker (Gg)	668.5	617.6	278.0	30.8	150.0	175.7	198.0	201.7	195.7	263.0	167.2	203.2	221.0	241.1	260.0	265.4	330.6	338.3
Produced cement kiln dust (CKD) (Gg)	175.5	27.0	20.0	5.0	15.0	15.0	15.0	15.0	15.0	15.0	10.0	18.2	14.6	19.1	15.0	1.5	2.9	3.35
CKD / clinker ratio (%)	26.25	4.37	7.19	16.26	10	8.54	7.57	7.44	7.67	5.70	5.98	8.94	6.61	7.9	5.77	0.58	0.87	0.99
Corrected CKD / clinker ratio (%)	8.0	4.4	7.2	8.0	8.0	8.0	7.6	7.4	7.7	5.7	6.0	8.0	6.6	7.9	5.8	0.6	0.9	0.99
CKD correction factor	1.08	1.04	1.07	1.08	1.08	1.08	1.08	1.07	1.08	1.06	1.06	1.08	1.07	1.08	1.06	1.01	1.01	1.01

<u>CO_2 Emission factor for Lime Production (IPCC GPG 2000 Tier 2 method)</u>

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 % and average content of CO_2 in lime is 16.99 %.

<u>Estimation of CO_2 emission from Lime production</u>

Content of dolomite (dry) is 94.76 % or 947.6 $_{\text{kg dolomite}}$

947.6 $_{kg\ dolomite}$ contains:

491.14 $_{kg\ CaCO3}$ (51.86 %)
386.62 $_{kg\ MgCO3}$ (40.80 %)
55.72 $_{kg\ SiO2;\ Fe2O3;\ Al2O3}$ (5.88 %)
14.12 $_{kg\ Others}$ (1.49 %)

947.6 $_{kg\ dolomite}$ complete decomposes and pullulates:

491.14 $_{kg\ CaCO3}$ × 0.440 (emission factor) = 216.10 $_{kg\ CO2}$
386.62 $_{kg\ MgCO3}$ × 0.522 (emission factor) = 201.82 $_{kg\ CO2}$.

Oxides capture:

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

Lime is made (theoretical):

275.04 $_{kg\ CaO}$ + 184.80 $_{kg\ MgO}$ + 69.84 $_{kg\ ballast}$ = 529.69 $_{kg\ lime}$

CO_2 content in lime is 16.99 % (practical):

529.69 $_{kg\ lime}$ – 83.01%

Lime is made (practical):

638.09 $_{kg\ lime\ +\ CO2}$ – 100 %

CO_2 content in lime is:

638.09 $_{kg\ lime\ +\ CO2}$ – 529.69 $_{kg\ lime}$ = 108.41 $_{kg\ CO2}$

CO_2 emissions (1 tonne complete decomposition) pullulate:

216.10 $_{kg\ CO2}$ + 201.82 $_{kg\ CO2}$ – 184.80 $_{kg\ MgO}$ = 309.51 $_{kg\ CO2}$

0.3095 $_{t\ CO2}$ proceed from practical decomposition of 1 tonne of dolomite.

Correction factor for the proportion of hydrated lime for comparability is taken into account. IPCC GPG 2000 provides default correction factor – 0.97.

$$CO_2\ EF_{lime\ production} = 309.51\ _{kg\ CO2} \times 0.97 = 0.3002247\ \text{tonne}\ CO_2\ /\ \text{tonne dolomite}$$

Emission factors of limestone and dolomite use in production of glass and metal are plant specific and reported by facilities within Emission Trading Scheme.

Emission factors used in Mineral Production sub-sector are shown in Table 4.2.3.

Table 4.2.3 CO_2 emission factors for particular raw materials used in Mineral Industry (t CO_2 / t product or raw material)

	1990 – 2007
Limestone (used)	0.44
Dolomite (used)	0.477
Production of lime in Iron and Steel plant	0.785
Soda use	0.415
Fluorspar use	0.0017
Potash use	0.32
Use of clay for production of tiles	0.08

Estimation of CO_2 emission from bricks production

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.

Estimation of CO_2 emission factor in first bricks production – CO_2 emission factors given in Table 4.2.4 are estimated as average for amount of used raw materials – bricks.

1. plant (Table 4.2.4):

- First plant estimate CO_2 emissions based on final production according to volume of one brick, moisture content and percentage of clay in one brick after firing of bricks;
- MgO content in raw material (carbonates) – 4,9% so emission factor is 1,092 t CO_2/t MgO; CaO content in raw materials – 11,6% so emission factor is 0,785 tCO_2/t CaO. Emission factor is estimated by coherence:

$$R\left[tCO_2/t_{izejv}\right] = MgO_R \times \left(S_1/100\right) + CaO_R \times \left(S_2/100\right) = 1{,}092 \times \left(4{,}9/100\right) + 0{,}785 \times \left(11{,}6/100\right) = 0{,}1446$$

where:
R – emission factor of clay tCO_2/ t clay
MgO_R – emission factor of magnesia tCO_2/ t MgO
CaO_R - emission factor of calcium oxide tCO_2/ t CaO
S_1 – content of magnesia in clay (%)
S_2 – content of calcium oxide (%)

- CO_2 emission factor for this plant for time period 1993 – 2005 are taken from Commission Decision 2004/156/EC of 29 January 2004 establishing guidelines for the monitoring and reporting of GHG emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council;
- Since submission 2008, plant specific CO_2 emission factor is used.

2., 3., 4. and 5. plant (Table 4.2.4):

- CO_2 emission factor for this plant for time period 1999 – 2005 are taken from Guidelines established for Emission Trading Scheme where emission factor is estimated with this equation:

$$X_Y\left(CO_3\right)_Z = \left[M_{CO_2}\right] \left\{ Y_X \times \left[M_X\right] + Z \times \left[M_{CO_3}^{-2}\right] \right\}$$

where:
X = alkali earth or alkali metal
Mx = molecular weight of X in (g/mol)
MCO2 = molecular weight of CO_2 = 44 (g/mol)
MCO3- = molecular weight of CO_3^{2-} = 60 (g/mol)
Y = stoichiometric number of X
= 1 (for alkali earth metals)
= 2 (for alkali metals)
Z = stoichiometric number of CO_3^{2-} = 1

- Since submission 2008, emission factors are:
  - $CaCO_3$ – 0,44 and $MgCO_3$ – 0,522;
  - CaO – 0,785 and MgO – 1,092.

Table 4.2.4 CO_2 emission factors of bricks production in 1990 – 2007 (t CO_2 / t product or raw material)

EF / production	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Use of clay for production of bricks																		
1. plant	-	-	-	0.042	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.048	0.145	0.112	0.112
2. plant	-	-	-	-	-	-	-	-	-	0.066	0.066	0.066	0.066	0.066	0.066	0.115	0.108	0.107
3. plant	-	-	-	-	-	-	-	-	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.112	0.112	0.112
4. plant	-	-	-	-	-	-	-	-	-	-	0.051	0.051	0.051	0.051	0.051	0.098	0.064	0.060
5. plant	-	-	-	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.045	0.018	0.020	0.007

The NMVOC emissions from road paving and asphalt roofing are calculated at the LEGMA. The emission factor used was 32%.

Activity data

Activity data were taken from the CSB of Latvia and enterprises. Activity data on production and output by manufacturing companies are freely available until 1999. CSB gives only restricted information on production and output of goods since 1999, the information being classified as confidential. LEGMA has signed an agreement with CSB to get data of total production of products from sectors from what data are confidential. Still as industrial producers are participants in the EU ETS the GHG reports of these enterprises have to be freely available. The GHG reports of EU ETS operators are published on LEGMA home page. The data source of the activity data is industrial producers and the confidentiality rules are no longer in force (Table 4.2.5).

Latvia has simpler situation in activity data of Mineral Products sector because only some or even one facility operates in each sub-category of Mineral Products sector. There is only one facility of cement production, one facility of lime production, two facilities of glass production, five facilities of bricks production and one facility of tiles production. All previously mentioned mineral producers participate in EU ETS and in International ETS. It is possible to obtain more accurate and complete activity data and emission factors from enterprises that are involved in the emission trading system.

Emissions from dolomite and limestone use in glass and metal production are reported in CRF 2.A.3 Limestone and Dolomite use according to recommendations of Expert Review Team. Data of lime production in Iron and Steel facility is reported under CRF 2.A.3 sector because produced lime is used straight in Iron and Steel production process together with raw limestone and dolomite and this produced lime is not a final product of facility. 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.

Table 4.2.5 Activity data CRF 2.A Mineral Products in 1990 – 2007 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Use of dolomite in glass production											2.43	1.81	3.41	2.73	2.14	2.09	NO	NO
Use of limestone in glass production	0.80	0.83	0.87	0.90	3.90	4.34	4.81	1.34	3.00	4.17	5.28	6.39	7.09	6.31	6.56	6.69	4.87	9.86
Use of dolomite in metal production					33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	29.71	30.49	30.40
Use of limestone in Metal Production					14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	14.30	23.42	12.02	9.02
Production of lime (use of limestone) in metal production																17.10	11.76	12.94
Soda Ash Use											2.69	2.53	4.14	3.56	3.01	3.13	0.87	NO
Asphalt Roofing	16.77	5.59	0.86	1.72	5.59	7.31	9.03	16.77	21.07	24.08	20.64	15.48	21.50	22.36	20.64	25.80	31.82	34.40
Road Paving with Asphalt	10.00	3.33	0.51	1.03	3.33	4.36	5.39	10.01	12.57	14.36	12.31	9.23	12.83	13.34	12.31	15.39	18.98	20.52
Other (please specify)	0.00	0.00	0.00	99.79	82.60	112.24	113.49	117.63	147.99	164.43	155.59	166.18	183.81	166.22	171.74	174.24	183.35	186.31
Use of potash in glass production													0.10	0.12	0.09	0.60	NO	NO
Use of fluorspar in glass production				0.02	0.01	0.12	0.12	0.03	0.07	0.11	0.08	0.15	0.16	0.22	0.25	0.27	0.22	0.20
Use of butilacetate in glass fibre production	0.001	0.002	0.001	0.002	0.001	0.002	0.004	0.004	0.004	0.000	0.001	0.001	0.001	0.000	0.001	0.001	NO	NO
Use of clay in bricks production				99.77	82.59	110.08	110.99	114.67	144.84	161.61	152.92	161.97	179.62	161.11	168.18	171.69	181.38	183.86
Use of clay in tiles production						2.03	2.38	2.93	3.07	2.71	2.59	4.07	3.94	4.78	3.23	1.69	1.75	2.24

The activity data to calculate NMVOC emissions from road paving and asphalt roofing are taken from the CSB (Table 4.2.6).

Table 4.2.6 Activity data for road paving with asphalt and asphalt roofing production

Year	Amount of bitumen (Gg)*	57 % for road paving (Gg)	Volatile part (Gg) (45%)	43 % for construction (Gg)
1990	39.00	22.23	10.00	16.77
1995	17.01	9.70	4.36	7.31
1999	56.00	31.92	14.36	24.08
2000	47.99	27.36	12.31	20.64
2001	36.00	20.52	9.23	15.48
2002	50.00	28.50	12.83	21.50
2003	52.01	29.64	13.34	22.36
2004	47.99	27.36	12.31	20.64
2005	60.01	34.21	15.39	25.80
2006	74.00	42.18	18.98	31.82
2007	80.00	45.6	20.52	34.4

4.2.3 Uncertainties and time series consistency

Uncertainties of activity data of cement and lime production as well as raw materials used in glass, metal production is very low because activity data were reported by industrial facilities.

CO_2 emission factors of mineral production are reported by industrial facilities for lime production and bricks and tiles production. CO_2 emissions for cement production are estimated with IPCC GPG Tier2 method by using plant specific data so uncertainty is determined in 2% according to IPCC GPG 2000.

CO_2 emission factors for raw materials used in glass production were taken from IPCC Guidelines or Guidelines established for Emission Trading Scheme and uncertainty was assigned as about 10%.

Uncertainty of activity data for estimations of CO_2 emissions from Asphalt roofing and Road Paving with Asphalt as well as uncertainty of CO_2 emission factor is assumed rather high 70% because default methodology is used in estimations and default percentage for used bitumen is 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.

Indirect GHG emissions from 2.A.6 Road Paving with Asphalt sector, CH_4, N_2O and indirect GHG emission from use of potash, use of fluorspar in glass production, use of clay in bricks and tiles production, as well as all emissions except NMVOC from glass fibre production are reported as "not estimated" due to lack of estimation methodology.

4.2.4 Source-specific QA/QC and verification

All industrial production data used in emission estimation from CRF 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 Environment State Bureau 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 CSP.

All estimations of the emissions done in the LEGMA 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.

4.3 METAL PRODUCTION (CRF 2.C)

4.3.1 Source category description

GHG emissions from metal production contribute 4.16% from total GHG emissions in Industrial Processes sector. 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.

Biggest decrease occurred in time period 1990 – 1991 due to changes in Latvia's national economy (Figure 4.3.1). Decrease of CO_2 emissions in 1990 – 1996 occurred due to decrease of used crude iron in open-hear furnaces due to CO_2 emissions are estimated only from crude iron use excluding used scrap metal part.

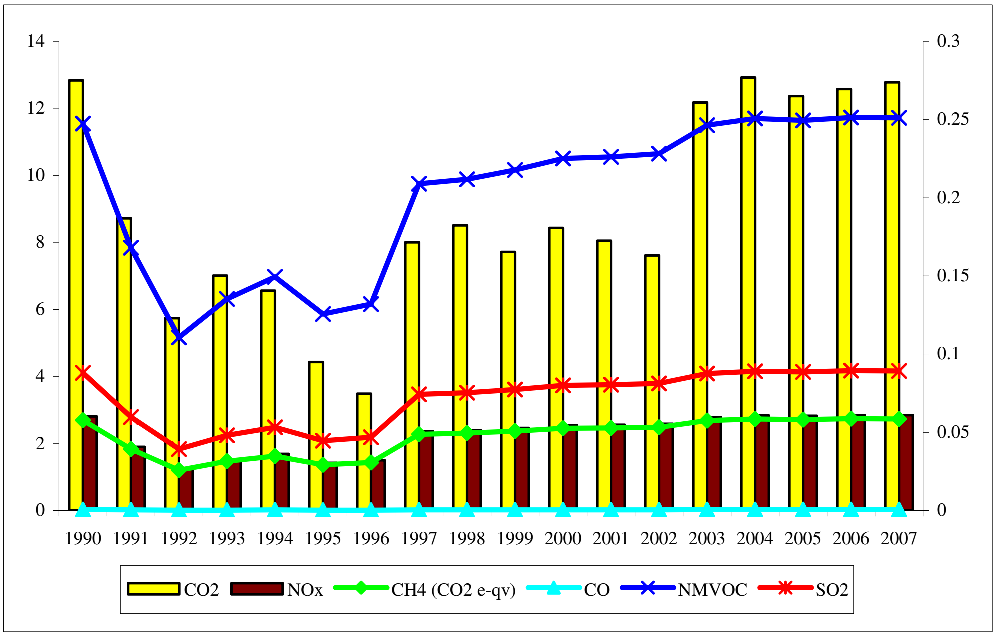


Figure 4.3.1 Direct and indirect GHG emissions from CRF 2.C Metal Production in 1990 – 2007 (Gg)*

* CH_4, CO, NMVOC and SO_2 emissions on the secondary axis

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.

4.3.2 Methodological issues

Methods

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

<u>CO_2 emission estimations from crude steel production</u>

Following equation from IPCC GPG 2000 is used to calculate CO_2 emissions from steel production:

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

According to information reported by steel producer:

- Average carbon content of crude iron using in steel production is 3 – 4%;
- Average carbon content of produced steel is 0.1 – 0.4%.

It is necessary to divide amount of crude steel produced in open-heart furnaces and in electric arc furnaces. Since official statistical information is not available and steel producer plant can't provide relevant information, these amounts are estimated by using amount of raw materials used in open-heart furnaces and electric arc furnaces (used raw materials in different furnaces related to total used raw materials) and the same percentage is related to amount of produced steel. Accordingly amount of steel produced in open-heart furnaces and in electric arc furnaces is divided from total produced crude steel.

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 for decrease of carbon content in final produced crude steel. Carbon content in final steel can't exceed 1% still average carbon content in used pig iron and crude iron is 3.5%.

IPCC GPG 2000 Tier2 method is based on estimation of carbon losses through the production processes when remaining carbon is emitted to air.

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.

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.

Data for CO_2 emission estimations are given in Table 4.3.2 below.

The NMVOC, CO, NO_x and SO_2 emissions from iron and steel production estimates are calculated at the LEGMA based on activity data from the CSB Energy balance and State statistical survey "2–AIR" according to EMEP/CORNAIR methodology and emission factors.

Emission factors

The main sources for emission factors are:

- IPCC 1996;
- IPCC GPG 2000;
- EMEP/CORINAIR Guidebook.

Emission factors of methane and indirect GHG emissions were taken from IPCC 1996 (Table 4.3.1).

Table 4.3.1 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.

In previous submission emission factors from IPCC Guidelines concerning methodology for estimations of emissions from general Iron and Steel production processes without division in technology specific methodology were used.

Activity data

Activity data were taken from the CSB of Latvia and enterprises. Activity data on production and output by manufacturing companies are freely available until 1999. CSB gives only restricted information on production and output of goods since 1999, the information being classified as confidential. LEGMA has signed an agreement with CSB to get data of total production of products from sectors from what data are confidential. Still as industrial producers are participants in the EU ETS the GHG reports of these enterprises have to be freely available. The GHG reports of EU ETS operators are published on LEGMA home page. The data source of the activity data is industrial producers and the confidentiality rules are no longer in force.

Latvia has simpler situation in activity data of CRF 2.C Metal Production because there is only one steel producer and it participates in EU ETS and in International ETS. It is possible to obtain more accurate and complete activity data and emission factors from enterprise that is are involved in the emission trading system.

Table 4.3.2 Activity data for estimation of CO_2 emissions from steel production (Gg)*

	crude steel production	mass of steel produced in OHF (%)	mass of steel produced in OHF	used scrap metal in open heart furnaces	crude iron used in open heart furnaces	crude iron/scrap metal ratio	amount of crude steel from crude iron	mass of steel produced in EAF (%)	mass of steel produced in EAF	EF for electric arc furnaces (t/t)	carbon content in crude iron (%)	carbon content in crude steel (%)	conversion factor
1990	**550000**	98.741	**543074.4**	537227.4	**107732.2**	20.05	**108904.7**	1.26	**6925.6**	0.0015	3.50	0.25	3.67
1991	**373492**	98.741	**368789.0**	364818.4	**73158.4**	20.05	**73954.6**	1.26	**4703.0**	0.0015	3.50	0.25	3.67
1992	**245834**	98.741	**242738.5**	240125.0	**48153.2**	20.05	**48677.2**	1.26	**3095.5**	0.0015	3.50	0.25	3.67
1993	**300393**	98.741	**296610.5**	293417.0	**58840**	20.05	**59480.4**	1.26	**3782.5**	0.0015	3.50	0.25	3.67
1994	**331955**	98.858	**328163.6**	317658.0	**55116**	17.35	**56938.8**	1.14	**3791.4**	0.0015	3.50	0.25	3.67
1995	**279326**	98.719	**275747.1**	285015.0	**37086**	13.01	**35880.1**	1.28	**3578.9**	0.0015	3.50	0.25	3.67
1996	**293167**	98.904	**289954.5**	307261.0	**29099**	9.47	**27460**	1.10	**3212.5**	0.0015	3.50	0.25	3.67
1997	**464529**	99.451	**461977.5**	469205.0	**67039**	14.29	**66006.3**	0.55	**2551.5**	0.0015	3.50	0.25	3.67
1998	**470835**	99.478	**468374.9**	470302.0	**71341**	15.17	**71048.7**	0.52	**2460.1**	0.0015	3.50	0.25	3.67
1999	**483744**	99.541	**481521.4**	490912.0	**64631**	13.17	**63394.7**	0.46	**2222.6**	0.0015	3.50	0.25	3.67
2000	**500292**	99.229	**496434**	503123	**70637**	14.04	**69697.9**	0.77	**3858.1**	0.0015	3.50	0.25	3.67
2001	**502277**	99.207	**498296**	511026	**67352**	13.18	**65674.2**	0.79	**3981.2**	0.0015	3.50	0.25	3.67
2002	**507194**	99.189	**503079**	520425	**63620**	12.22	**61499.5**	0.81	**4114.8**	0.0015	3.50	0.25	3.67
2003	**547346**	99.620	**545265**	524232	**102437**	19.54	**106546.9**	0.38	**2081.4**	0.0015	3.50	0.25	3.67
2004	**556974**	98.922	**550970**	527155	**108762**	20.63	**113675.4**	1.08	**6004.3**	0.0015	3.50	0.25	3.67
2005	**554345**	98.941	**548472**	527950	**104010**	19.70	**108053.1**	1.06	**5872.6**	0.0015	3.50	0.25	3.67
2006	**554546**	98.895	**548419**	531026	**105769**	19.92	**109233.3**	1.10	**6126.9**	0.0015	3.50	0.25	3.67
2007	**558156**	99.760	**556814**	462821.8	**108939**	23.54	**131063.1**	0.24	**1342.0**	0.0015	3.50	0.25	3.67

4.3.3 Uncertainties and time series consistency

Uncertainty of activity data of iron and steel industry is very low and assumed 2%. 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. Also statistical data were used in emission estimations and statistical frame mistake 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.

4.3.4 Source-specific QA/QC and verification

Steel production data used in emission estimation from CRF 2.C Metal 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. Steel producer certify that all additional information for CO_2 emission estimation is correct.

All estimations of the emissions done in the LEGMA 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.

4.3.5 Source-specific recalculations

Total previously mistaken amount of produced steel was corrected for the year 2006. For submission 2009 the amount of produced steel used to calculate CH_4 and indirect GHG emissions is for 17.5% lower than for submission 2008. Therefore CH_4 and indirect GHG emissions for submission 2009 are for 17.5% lower than reported for submission 2008.

4.4 OTHER PRODUCTION (CRF 2.D)

4.4.1 Source category description

Other Production sub-sector includes indirect emissions from:

- Pulp and Paper production;
- Food and Drink production.

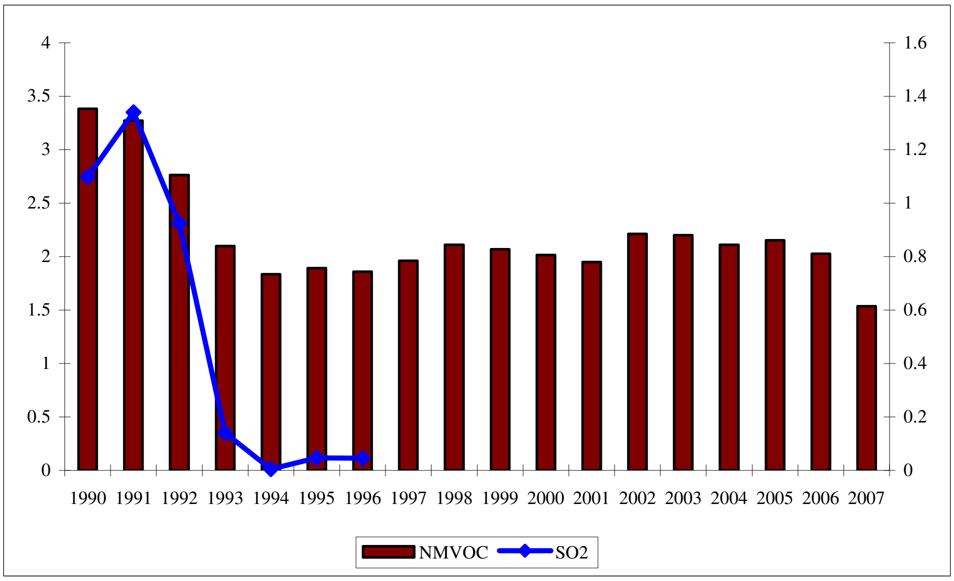


Figure 4.4.1 Total emissions from CRF 2.D Other Production in 1990 – 2007 (Gg)

Biggest fluctuations occurred in time period 1991 – 1993 due to changes in economical situation in country (Figure 4.4.1). 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 24.2% in 2006-2007 that is explained with decrease of produced spirits by 35.5%. Amount of produced cakes, biscuits and breakfast cereals decreased by 31.25% as well as closure of sugar production. Activity data of other CRF 2.D.2 Food and Drink categories increased in 2006-2007. Total amount of production in CRF 2.D.2 Food and Drink sector increased by 1.8%.

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.

4.4.2 Methodological issues

Methods

Calculation of all emissions from processes is done with Excel databases developed by experts from LEGMA. 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 LEGMA. Methodology of IPCC 1996 was used in estimations.

Emission factors

The NMVOC emission factors (Table 4.4.1) are taken from the IPCC 1996 with exception of NMVOC emission factor for spirits production. For submission 2009, NMVOC emissions factor from EMEP/CORINAIR that corresponds to other spirits was used. Central Statistical Bureau provided aggregated statistical data where it can be seen that 95.5% of all spirits produced in Latvia is produced from grains (sheer alcohol or spirits) and no brandy and whiskey is produced in Latvia. That's why previously used emission factor as for Spirits (unspecified sort) 15 kg/hl (alcohol) was changed to emission factor as for Other Spirits 0.4 kg/hl (alcohol).

Table 4.4.1 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
Meet, 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 4.4.2). LEGMA has signed an agreement with CSB to get data of total production of products from sectors where data are confidential.

Still for the 2007 data for the category – wine production, was classified as confidential and not available for the LEGMA. That's why for this category 2006 year's data was used also for year 2007.

Table 4.4.2 Activity data of CRF 2.D Other Production sector

	1. Pulp and Paper	**2. Food and Drink**	**Wine**	**Beer**	**Spirits**	**Met, 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	**1212.28**	19.9	87.4	324.5	569.3	31.0	54.8	314.0	200.0
1991	44.7	**1239.88**	197.5	1295.3	330.0	490.4	35.0	39.2	293.0	200.0
1992	30.8	**912.50**	179.8	858.9	259.3	281.6	39.0	22.1	240.0	200.0
1993	4.7	**703.70**	87.7	545.9	217.4	154.0	26.0	15.8	177.4	245.4
1994	0.2	**578.29**	134.2	637.9	314.8	95.6	15.8	22.7	161.5	174.0
1995	1.5	**611.65**	159.2	652.8	341.5	82.8	29.3	24.4	145.4	214.4
1996	1.5	**619.02**	154.7	644.9	379.6	100.5	31.2	30.6	137.1	201.7
1997	NO	**668.39**	114.7	714.8	456.4	129.1	41.2	35.9	132.1	201.5
1998	NO	**653.00**	99.6	721.0	417.4	110.9	64.9	28.2	124.8	200.4
1999	NO	**675.64**	C	953.2	C	166.9	C	32.7	121.5	144.5
2000	NO	**722.04**	C	945.1	C	197.3	C	38.6	121.1	173.8
2001	NO	**769.63**	C	996.6	C	244.6	C	39.3	123.1	184.9
2002	NO	**855.57**	C	1199.2	C	262.9	C	42.6	122.6	201.3
2003	NO	**862.97**	C	1336.6	C	264.4	C	37.3	124.0	201.4
2004	NO	**871.37**	C	1313.1	C	262.5	C	49.6	119.3	211.8
2005	NO	**876.09**	C	1288.0	C	243.8	C	41.8	114.3	238.1
2006	NO	**926.37**	C	1383.0	C	288.4	C	45.0	106.8	244.2
2007	NO	**1002.59**	C	1414.3	C	286.0	NO	30.9	116.6	336.8

4.4.3 Uncertainties and time series consistency

Uncertainty of activity data was assumed as ±2% because statistical data from CSB were used. SO_2 and NMVOC emission factors were assigned as 10% 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.

4.4.4 Source-specific QA/QC and verification

Activity data for the sector is taken from the Central Statistical Bureau. CSB has the internal QA/QC procedures based on mathematical model and analysis to avoid logic mistakes. CSB now is working on the development of the total QA/QC system. CSB is the ISO standard organization.

All estimations of the emissions done in the LEGMA 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.

4.4.5 Source-specific recalculations

NMVOC emissions from 2.D.2 Food and Drink sector were changed due to changes of used emission factor for estimation of emission from spirits production. For submission 2009 NMVOC emissions factor from EMEP/CORINAIR corresponding other spirits was used.

CSP provided aggregated statistical data where it can be seen that 95.5% of all spirits produced in Latvia is produced from grains (sheer alcohol or spirits) and no brandy and whiskey is produced in Latvia. That's why previously used emission factor as for Spirits (unspecified sort) 15 kg/hl (alcohol) was changed to emission factor as for Other Spirits 0.4 kg/hl(alcohol).

4.5 CONSUMPTION OF HALOCARBONS AND SF_6 (CRF 2.F)

4.5.1 Source category description

Latvia has ratified *Convention for the Protection of the Ozone Layer* (Vienna, 1985) and its *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 [16].

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.

Continuing project started for submission 2005 enterprises not using F – gases as they responded to LEGMA during interrogatory were excluded from list of total F – gases consumers. Questionnaire was sent to 120 enterprises operate with F – gases and response were extremely low about 28%. So experts from LEGMA had to find other ways to collect necessary data.

Latvia has accepted *Regulation of the European Parliament and of the Council on certain fluorinated greenhouse gases*. Ministry has accepted *Regulations of ozone depleting substances and fluorinated greenhouse gases that is freezing agents* with whom producers, importers, exporters and operators need to account for F – gases for previous year till next year 1 February. For submission 2007 these data are available for LEGMA to estimate actual emissions of F – gases. For the submission 2007 not all enterprises operated with f-gases reported necessary data since new rule of legislation weren't posted to all enterprises so not all of them knew their new obligations.

Only 8 enterprises reported their operations with f-gases. All necessary data for year 2005 were obtained from the biggest importers of f-gases. For submission 2009 more than 250 operators reported data of their operation with f-gases.

The calculation of emissions was carried out for that F – gases, namely: SF_6, HFC –134 a, HC – 23, HFC – 125, HFC – 143 a, HFC – 152 and HFC-227 ea. The mostly used gas is HFC-134a (used in mobile air conditioners). It is possible, that emissions from stationary industrial refrigeration potentially might be greater, but not enough activity data and research about F – gases used in this sector are available during inventory.

HFCs emissions from consumption of f-gases are a key source category in 2007 with respect to Trend Assessment without LULUCF sector with 1%.

The emissions of F-gases are linearly increasing since 1995 – 0.54 (CO_2 eq. Gg) in 1995 to 60.04 (CO_2 eq. Gg) in 2007 (Table 4.5.1 – Table 4.5.9, Figure 4.5.1). The reasons for this increase are related to the growth of activity data (for example, more new cars with MAC) and replacement of freons with F-gases, as well as adoption of new technologies.

Table 4.5.1 Actual emissions of SF_6 (kg)

Source	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
2.F.8	10.51	12.02	21.26	29.69	40.89	53.35	82.71	141.50	184.66	224.67	315.07	298.07	364.10
GWP (CO_2 eq Gg)	0.251	0.287	0.508	0.710	0.977	1.275	1.977	3.382	4.413	5.370	7.530	7.124	8.702

Table 4.5.2 Actual emissions of HFC – 23

Source	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
2.IIA.F.1.3	0.0083	0.002	0.0042	0.0149	NO	0.0008	0.0008	0.0017	0.01	NO	NO	NO	NO
GWP (CO_2 eq Gg)	**0.0971**	**0.023**	**0.0491**	**0.1743**	**NO**	**0.0094**	**0.0094**	**0.0199**	**0.117**	**NO**	**NO**	**NO**	**NO**

Table 4.5.3 Actual emissions of HFC – 32

Source	2004	2005	2006	2007
2.IIA.F.1.2	0.0401	0.0016	0.1299	0.2159
GWP (CO_2 eq Gg)	**0.0261**	**0.0010**	**0.0844**	**0.1403**

Table 4.5.4 Actual emissions of HFC – 125

Source	2004	2005	2006	2007
2.IIA.F.1.2	0.0518	0.0095	1.1020	1.4269
2.IIA.F.1.3	0.0028	NO	0.0272	NO
Total emissions (t)	0.0546	0.0095	1.1292	1.4269
GWP (CO_2 eq Gg)	**0.1530**	**0.0266**	**3.1618**	**3.9953**

Table 4.5.5 Actual emissions of HFC – 143a

Source	2004	2005	2006	2007
2.IIA.F.1.2	0.0072	0.0091	1.130371	1.48845
GWP (CO_2 eq Gg)	**0.0274**	**0.0346**	**4.2954**	**5.6561**

Table 4.5.6 Actual emissions of HFC – 227ea

Source	2001	2002	2003	2004	2005	2006	2007
2.F.3	0.0122	0.0122	0.0304	0.0616	0.0397	0.0739	NO
GWP (CO_2 eq Gg)	**0.0353**	**0.0353**	**0.0882**	**0.1786**	**0.1150**	**0.2143**	**NO**

Table 4.5.7 Actual emissions of HFC – 152a

Source	2006	2007
2.IIA.F.1.2	0.0026	NO
GWP (CO_2 eq Gg)	**0.00036**	**NO**

Table 4.5.8 Actual emissions of HFC – 134a

Source	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
2.IIA.F.1.1	0.065	0.090	0.102	0.114	0.138	0.162	0.186	0.222	0.269	0.329	0.379	0.421	0.461
2.IIA.F.1.2				0.010	0.019	0.030	0.073	0.098	0.137	0.199	0.218	2.347	2.153
2.IIA.F.1.3					0.003	0.008	0.024	0.022	0.026	0.038	0.047	0.045	NO
2.IIA.F.1.6	0.029	0.721	1.411	2.514	3.809	4.814	5.663	6.727	7.980	10.851	14.862	20.576	27.178
2.F.4				0.240	0.734	0.995	1.134	1.171	1.205	1.381	1.593	1.746	2.124
2.F.9	0.050	0.045	0.040	0.048	0.037	0.035	0.039	0.031	0.029	0.037	0.043	0.040	0.046
Total emissions (t)	0.145	0.856	1.553	2.926	4.739	6.044	7.118	8.271	9.646	12.834	17.142	25.176	31.961
GWP (CO_2 e-qv Gg)	**0.188**	**1.113**	**2.019**	**3.804**	**6.161**	**7.858**	**9.253**	**10.753**	**12.540**	**16.685**	**22.285**	**32.729**	**41.549**

Table 4.5.9 Total emissions of HFCs (CO_2 e-qv Gg)

Source	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
2.F.1:	**0.2197**	**1.0783**	**2.0165**	**3.6039**	**5.1590**	**6.5275**	**7.7377**	**9.2095**	**11.0528**	**15.0476**	**20.2210**	**37.9489**	**48.5206**
2.IIA.F.1.1	0.0847	0.1174	0.1329	0.1482	0.1794	0.2109	0.2414	0.2880	0.3501	0.4273	0.4933	0.5479	0.5988
2.IIA.F.1.2				0.0134	0.0250	0.0389	0.0943	0.1279	0.1781	0.4566	0.3459	10.5171	12.5907
2.IIA.F.1.3	0.0971	0.0234	0.0491	0.1743	0.0033	0.0191	0.0407	0.0480	0.1504	0.0573	0.0607	0.1348	NO
2.IIA.F.1.6	0.0378	0.9375	1.8345	3.2680	4.9513	6.2587	7.3613	8.7456	10.3742	14.1063	19.3211	26.7491	35.3312
2.F.3							0.0353	0.0353	0.0882	0.1786	0.1150	0.2143	NO
2.F.4				0.3121	0.9541	1.2939	1.4739	1.5225	1.5662	1.7958	2.0705	2.2704	2.7606
2.F.9	0.0654	0.0585	0.0516	0.0619	0.0475	0.0454	0.0508	0.0405	0.0380	0.0478	0.0554	0.0518	0.0595
total HFCs (CO2 e-qv Gg)	**0.2851**	**1.1368**	**2.0681**	**3.9779**	**6.1606**	**7.8669**	**9.2978**	**10.8078**	**12.7453**	**17.0698**	**22.4618**	**40.4854**	**51.3408**

As it can be seen in Figure 4.5.1 all f-gases emissions have increasing tendency. Emissions from other sectors are rather stable or decreasing. 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. It is assumed that f-gases consumption in practice has decreased in last years due to decrease of HFCs gases use in Commercial and Transport refrigerators as well as in medicine inhalators and fire extinguishers. 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. There are no emissions from halocarbons and SF_6 from metal production / Production of halocarbons and SF_6 in Latvia.

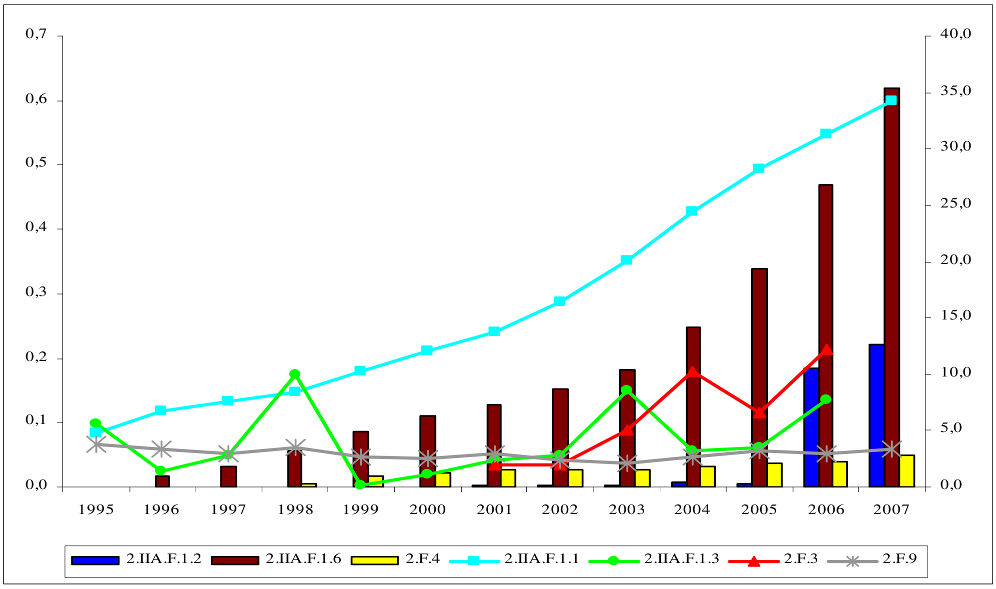


Figure 4.5.1 HFCs emissions from 2.F Consumption of Halocarbons and SF_6 sector in 1990 – 2007 (GWP Gg CO_2 e-qv.)

* sectors 2.IIA.F.1.1, 2.IIA.F.1.3, 2.F.3 and 2.F.9 on the secondary axis

4.5.2 Methodological issues

Methods

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

SF_6 emission from electrical equipment

There is one enterprise where huge amount of SF_6 is used in commutation and control installations. Since 1992, it consumes small amount of SF_6 in electrical equipment, but since 1995 used amount radical increase.

Tier3a equation given in IPCC 1996:

$$E_{total} = \sum E_r + \sum E_i + \sum E_l + \sum E_{liq}$$

where
E_{total} – total emissions
E_r – emission from production
ΣE_i – emission from installation
ΣE_l – emission from usage
ΣE_{liq} – emission from liquidation of installation

Since installations are not produced in Latvia and installations are eliminated because installations are used only since 1992 and only percentage leakage is known Tier2b was chosen to estimate SF_6 emissions:

$$E_t = 2\%\ from E_{total} + 95\%\ from E_{liq}$$

where:
Et – emission (tonnes / year)
E_{total} – total emissions from total amount of SF6 used in installations considering that total amount is sum of new equipment installed in year and working equipment
E_{likv} – emissions from equipment that operates more that 30 years

Since E_{liq} is 0 it was assumed that emission factor is 2% or 0.02 to estimate emissions from consumption and installation of SF_6.

Emissions from Metered Dose Inhalers

Emissions are possible to estimate only from gases usage in medicine. Amount of inhalers contained HFC – 134a were clarified. It was presumed that 100 % of HFC – 134a from medicine inhalers used mainly by asthma patient is emitted. Only amount of HFC – 134a in inhalers were used in estimations of actual emissions from Metered Dose Inhalers.

Emissions from Stationary Refrigeration

Equation from IPCC 1996 methodologies and emission factors:

$$E_{total} = It \times Gs + Itj \times Ge + (It - d) \times Gu$$

where:
E_{total} – total emissions;
It – amount of new installations in year;
Gs – amount of gas in new installations;
Itj – installations stock
Ge – emissions of gas from working installations;
It-d – density of filling of installations;
Gu – amount of gas used in filling.

Mobile and Stationary Air Conditioning

IPCC 1996 offer 2 ways of estimation: bottom–up and top–down. It was assumed to use top – down method due to lack of precise information about imported, produced and filled mobile air conditioners and consumed amount of gas.

According top–down method amount of gas is estimated using coefficients of methodology and total statistical data of amount of cars or stationary air conditioning installations.

Emissions were estimated by top–down method by equation:

$$E_{total} = E_i \times 0{,}3 + E_l \times 0{,}5 + E_{liq} \times E8\%$$

where:
E_{total} – total emissions;
E*i* – emissions from amount of gas in market in year, emission is 30 %;
E*l* – emissions from filling, emission 0.5 %;
E*liq* – emission from liquidation of installation,
E8% – emissions from 8% of cars.

Fire extinguishers

The equation for portable fire extinguishers should be used to estimate amount of HFCs:

$$Et = 5\% \, from E_{total}$$

where:
Et – emission (tonnes / year)
E_{total} – total emissions in furniture.

Emissions from shoes production

Danish methodology was used to estimate emissions from shoes production [15]:

$$E_{total} = E_r + E_l + E_{liq}$$

where:
E_{total} – total emissions;
E_r – emission from production of shoes
E_l – emission from usage of shoes
E*liq* – emission from liquidation of shoes (E*liq* – 0)

Emission factors

Emission factors of estimation of actual F – gases emissions were taken from IPCC 1996 as well as research and assumptions of Danish experts (Table 4.5.10).

Table 4.5.10 Emission factors of F – gases

Source	Implied emission factors		
	Product	Product life	Disposal loss
	(% per annum)		
Domestic Refrigeration			
HFC-134a		1.00	
Commercial Refrigeration			
HFC-134a	3.50	3.00	5.30
HFC-32	3.50	3.00	5.30
HFC-125	3.50	3.00	5.30
HFC-143a	3.50	3.00	5.30
Transport Refrigeration			

Source	Implied emission factors		
	Product	Product life	Disposal loss
	(% per annum)		
Domestic Refrigeration			
HFC-23		3.00	5.30
HFC-134a		3.00	5.30
HFC-125	3.50	3.00	5.30
Stationary Air Conditioning			
HFC-134a	3.50	3.00	5.30
Mobile Air Conditioning			
HFC-134a	0.50	30.00	8.00
Fire Extinguishers			
HFC-227ea		5.00	
Electric Equipment			
SF6	2.00	2.00	
Production of shoes			
HFC-134a	15.00	1.50	

Activity data

Information from completed questionnaires and data from CSB and The Customs Service of Latvia were also summarized as well as data from Division of Chemicals Register within LEGMA. Enterprises operated with f-gases reports their operations within rules of national legislation to LEGMA Chemicals Register. Data of imported and exported f-gases from Register were used to estimate F – gases potential emissions.

4.5.3 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 because only one facility used this gas and reported it to LEGMA. Estimation of emissions also is quite precise. Uncertainty of activity data for SF_6 from electrical equipment is assumed as ±2%, but emission factor 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.

4.5.4 Source-specific QA/QC and verification

All estimations of the emissions done in the LEGMA 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.

4.5.5 Source-specific recalculations

The statistical information of population of Latvia as well as amount of cars with MAC was updated.

4.6 POTENTIAL EMISSIONS OF HALOCARBONS AND SF_6 (CRF 2.F)

4.6.1 Source category description

Potential emissions are calculated only for 2004 – 2007 due to lack of statistical information regarding import and export of F – gases (Figure 4.6.1). Data for estimations are obtained from Division of Chemicals Registry of LEGMA where enterprises have to report data of F – gases with whom enterprises operated in current year.

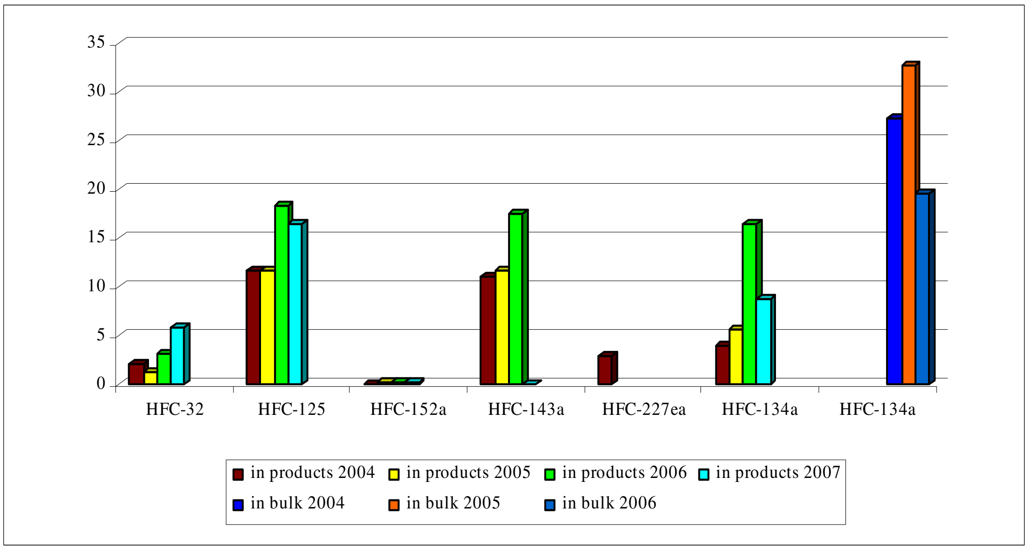


Figure 4.6.1 Total potential emissions of F-gases in 2004 – 2007 (tonnes)

4.6.2 Methodological issues

Methods

It was assumed that 100% of imported amount of gas in current year could emit in air, so imported amount of gas is potential emissions of that gas.

Activity data

According to percentage amount of chemicals in imported freezing agents' amount of chemicals were estimated and reported as potential emissions.

Table 4.6.1 Imported amounts of chemicals or chemical products 2004 – 2006 (tonnes)

Chemicals, products	2004	2005	2006
R 410a	1.5	-	1.36
R 407c	6.1	5.9	10.5
R 404a	19.8	21.9	33.8
R 507	1.5	0.7	-
R 134a	27.3	32.6	19.5
SUVA MP 39	0.5	1.2	
SUVA HP 80	-	0.1	0.27
SUVA HP 81	-	0.4	
Tecfoam SP-27-B5/365/245	2.9	-	2.5
ISCEON 49 (R 413 a)	-	0.5	1.3
FIXER MEGAPRO 65	-	-	15.7
R 422a			0.22

Table 4.6.2 Imported amounts of chemicals or chemical products in 2007 (tonnes)

Chemicals, products	2007
HFC-32	5.94
HFC-125	16.45
HFC-134a	7.14
	0.027-0.639
	0.111-2.654
HFC-152a	0.01-0.215
	0.02-0.394

Table 4.6.3 Percentage amounts of chemicals in imported products 2004 – 2006

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%

4.6.3 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 activity data.

4.6.4 Source-specific QA/QC and verification

The QA/QC procedures are the same as for actual f-gases estimations (see Chapter 4.5.4).

5. SOLVENT AND OTHER PRODUCT USE (CRF 3)

5.1 OVERVIEW OF SECTOR

Solvent and Other Product Use sector emissions contribute only about 0.5% of the total anthropogenic greenhouse gas emissions in Latvia.

This sector contains CO_2 and N_2O and NMVOC emissions.

In the Solvent and Other Product Use sector main attention is being paid to the calculation of NMVOC emissions from the use of paints and lacquers, degreasing and dry cleaning, as well as printing, glues, and household solvents.

Solvent and Other Product Use generate 27% from all NMVOC emissions (Figure 5.1).

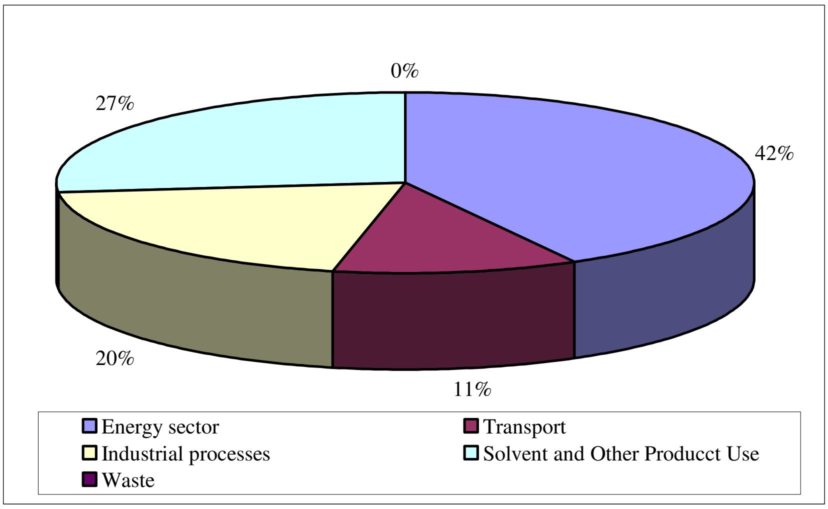


Figure 5.1 NMVOC emissions distribution in main sectors for 2007

Emissions in the Solvent and Other Product Use sector are linked with the economic situation of the country. Decrease of emissions occurred between 1993 and 1995, when industry was going through a crisis (Figure 5.2).

Economy has been growing and total paint use has grown from 10.32 to 21.55 thousand liters from 1996 – 2006 therefore GHG emissions in the solvent and other product use sector increased (32.7%). Emissions from paint application decreased in 2007. The reason is that is coming in force first period of determinate solvent concentrations into paint products, what is written, in Latvian legislation. Therefore national emission factor is lower and emissions decrease.

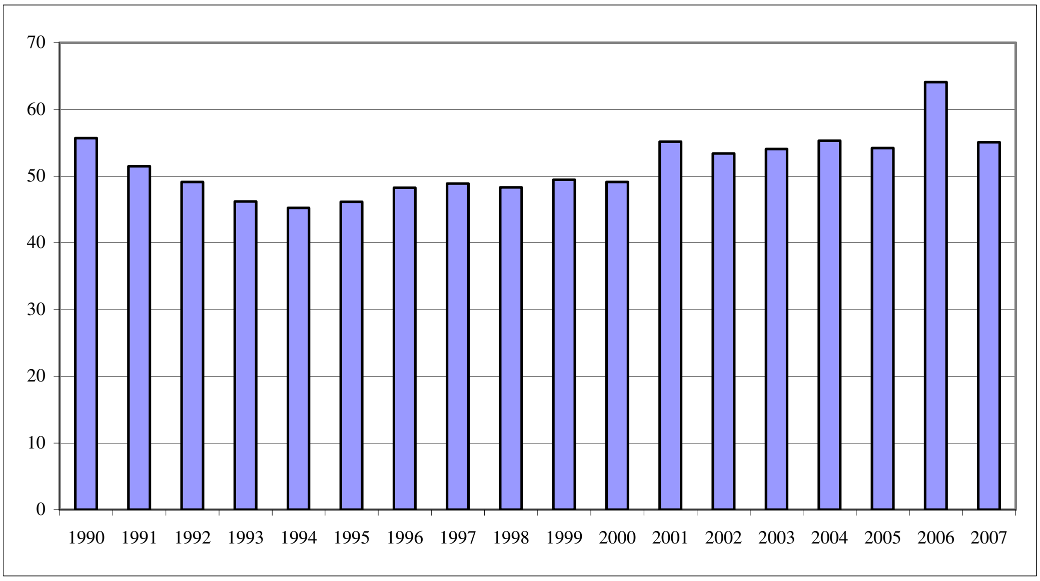


Figure 5.2 Total emissions from Solvent and Other Product Use (Gg CO2 eq.)

The NMVOC emissions from productions of pharmaceuticals are included under Chemical Products, Manufacture and Processing for 1997-2007. The NMVOC emissions are based on emission data from the enterprises and collected by REB and LEGMA.

5.2 SOLVENT AND OTHER PRODUCT USE

5.2.1 Source category description

The most important source in this sector is paint application and it has tendency to increase due to increased paint demand (Figure 5.3). The number of inhabitants has decreased since 1990 [20], and consequently NMVOC emissions for degreasing and dry cleaning and other decreased also.

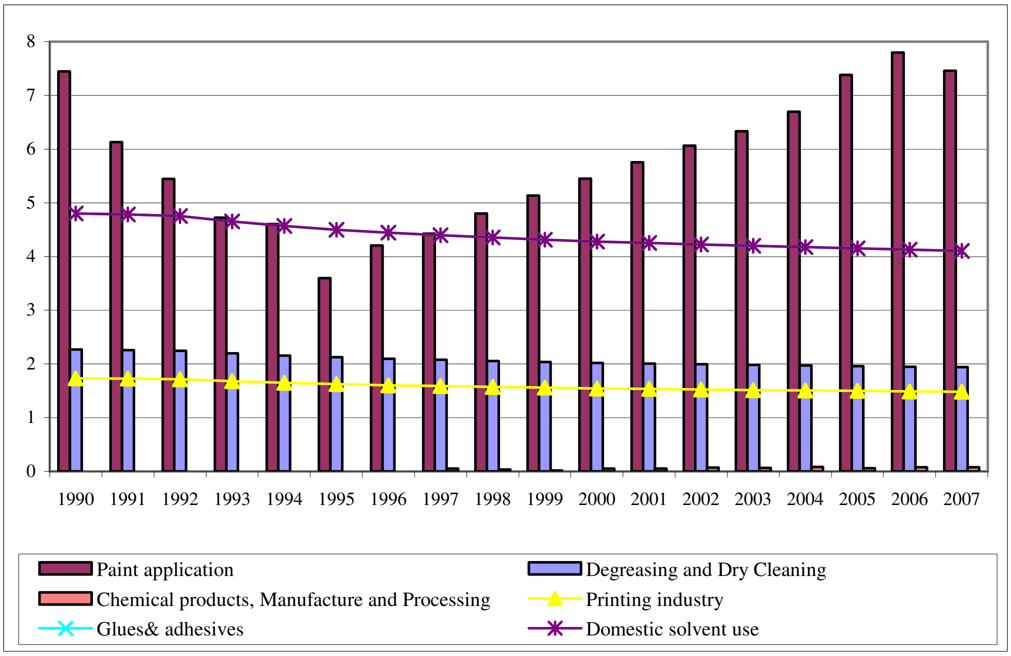


Figure 5.3 NMVOC emissions 1990-2007 (Gg)

The data for the use of N_2O in anaesthesia are available since 1995. The activity data are taken from enterprises and the emission factor is assumed to be 1.00 taking into account that all gas is emitted into air.

Starting from 2007 data is taken from SAM since 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. N_2O emissions from anaesthesia are negligible and contribute only about 0.3% from total N_2O emissions (Figure 5.4).

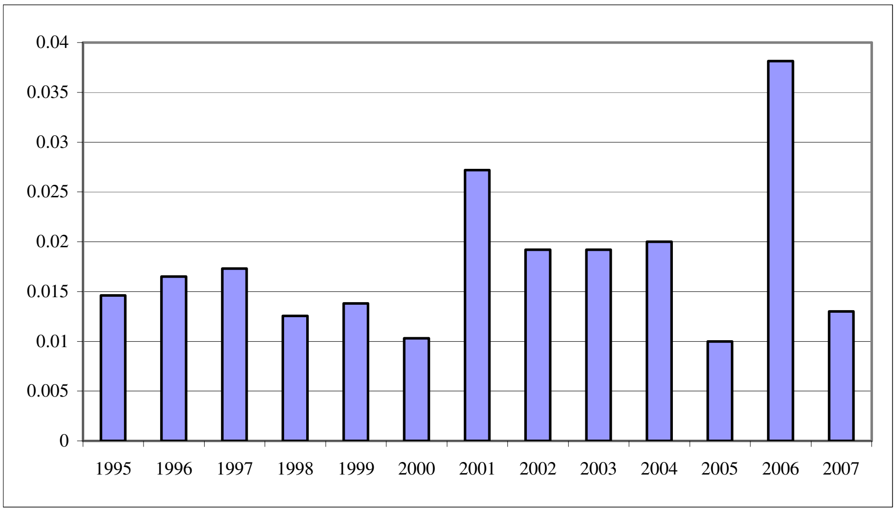


Figure 5.4 N_2O emissions 1995 – 2007 (Gg)

CO_2 emissions were estimated based on EMEP/CORINAIR methodology that allows multiplying NMVOC emissions to carbon content conversion factor.

Methodology for estimation of CO_2 emissions is given in section 5.2.2. Emissions are shown in Figure 5.5 and CRF Table 3.

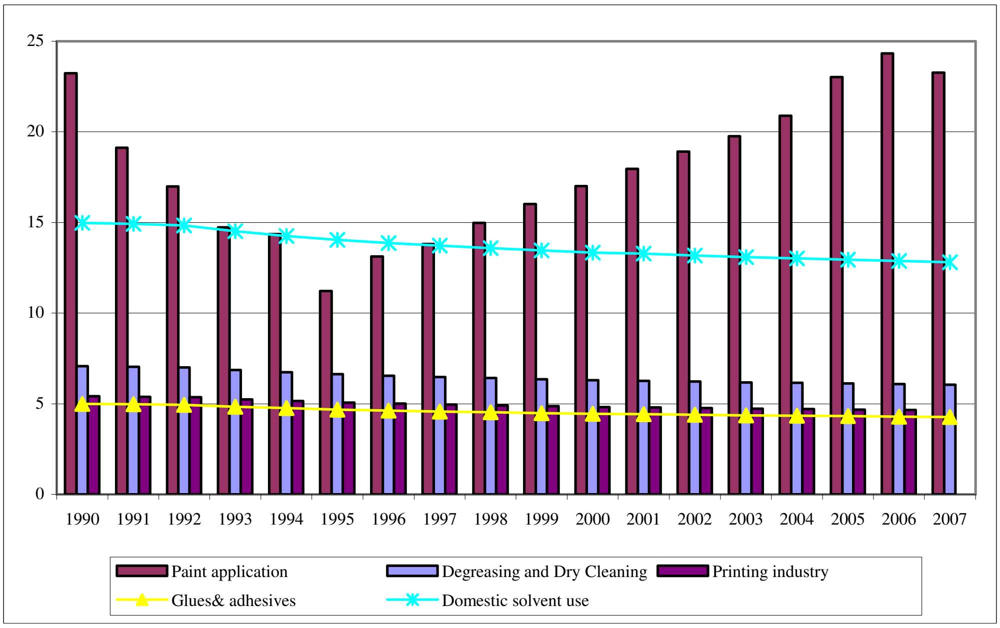


Figure 5.5 CO_2 emissions 1990-2007 (Gg)

5.2.2 Methodological issues

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. In this IPCC sector only emissions from actual use are calculated.

CO_2 emissions were estimated based on EMEP/CORINAIR methodology, the following equation being applied:

$$CO_2 \text{ emissions} = 0.85 \times (44/12) \times \text{emissions of NMVOC}$$

where 0.85 is carbon content conversion factor

EMEP/CORINAIR methodology provides two approaches to calculate NMVOC emissions – simple methodology and detailed methodology. In the simpler methodology NMVOC emissions from solvent use is calculated based on per capita data for the source category. To get the emissions for a source category one has to select a per capita factor and multiply it by the number of inhabitants of the country. In case of the detailed method one needs to gather very detailed information on main solvents used, contributing more than 90% of the total NMVOC emissions. It is allowed to combine simpler method with the detailed one if more precise data in some sub-sectors are available.

The IPCC/OECD has not suggested the methodology to estimate emissions of NMVOC therefore EMEP/CORINAIR methodology the simpler approach was used.

NMVOC emissions/per year = D x I,

where
D – per capita factor, kg/cap/year;
I – number of inhabitants

In Latvia NMVOC emissions for the Paint Application sub-sector was calculated, making use of activity data available from expert made judgement 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. Emission factors used for paint application calculations are shown in Table 5.1. Starting from 2007 is coming in force a first period of determinate solvent concentrations into paint products. Therefore in 2007 is changing national emission factors.

Table 5.1 Emission factors for paint application

Paint type	Emission factor, t/t
Paint on water base*	0.2
Paint on water base**	0.15
Paint on solvent base*	0.5
Paint on solvent base**	0.4

* Emission factor from 1990 – 2007 first six months
** Emission factor starting from middle of 2007

NMVOC emissions from other sub-sectors like Industrial Degreasing; Graphic Arts, Printing, Glues & Adhesives and Domestic Solvent Use were calculated, using simpler method as described above. Workbook provides per capita emission factors for all sub-sectors if there are no locally available data and emission factors to apply detailed methodology. Emission factors used for other sub-sectors calculations are shown in Table 5.2.

Table 5.2 Emission factors*

Sectors	Emission factor, kg/cap/year
Industrial Degreasing	0.85
Graphic Arts, Printing	0.65
Glues & Adhesives	0.6
Domestic Solvent Use	1.8

*Data from the Emission Inventory Guidebook B600-5

The emissions from Chemical products, Manufacture and Processing come from State statistical survey "2-air" on production of pharmaceutical formulations and perfumery products.

5.2.3 Uncertainties and time series consistency

The uncertainty of the statistical data (the number of inhabitants) was assumed to be negligible (2%) compared to the other uncertainties. Activity data and emission factor for paint application were taken from expert research; we assumed that uncertainty for these activity data and emission factors is 50%.

An important data source for N_2O used for anaesthesia is report from enterprises, which import and/or realise this gas. It is assumed that uncertainty is negligible (2%).

5.2.4 Source-specific QA/QC and verification

Expert reviewer checked and filled in QC form for each category according to LEGMA internal QA/QC program.

5.2.5 Source-specific recalculations

For submission 2009, following recalculations were made:

1. Under category 3A for 2005 -2006 CO_2 and NMVOC emissions was corrected because of previously mistaken activity data input;
2. Under categories 3B, 3D5 subcategories printing industry, glue manufacturing and domestic solvent use for 2006 CO_2 and NMVOC emissions were corrected because of previously mistaken activity data input.

6. AGRICULTURE (CRF 4)

6.1 OVERVIEW OF SECTOR

Agriculture is one of the most important economic sectors. It is the biggest user of agricultural land as well as the factor determining the quality of the rural landscape and environment. The development of the sector accelerates year-by-year, yet the contribution of agriculture to the gross domestic product is decreasing against the background of more rapidly growing value added of other sectors. Looking at the overall sectoral development, it has to be noted that, as in the previous years, the value added of the sector has increased, although employment in agriculture is on a decline as a result of increasingly more modern technologies being introduced. The year 2007 was very favorable for crop farming. Particularly grain producers were very successful: record high grain yield was harvested and the prices on grain grew exceptionally under the impact of the global price hike resulting from shortage of grain. Dairy farming also experienced a price rise, supported by the favorable situation on the global markets of dairy products. Yet with the prices on fodder grain going up, the situation became critical in pig-breeding. A positive development is the growing competitiveness of the agricultural holdings as suggested also by the shift in the composition of the holdings: the number of small farms is decreasing, whereas that of large farms with distinct specialization is increasing. Last years have also witnessed considerable shrinking of unused areas of agricultural land.

Latvia's gross domestic product at current prices amounted to 13957410 thousand lats in 2007, which corresponds to 6134 lats per capita. In comparison with 2006, the GDP has grown by 10.3%, mainly on account of an increase in the contribution by types of activity, like financial intermediation (22.5%), construction (14.4%) and trade (12.7%).

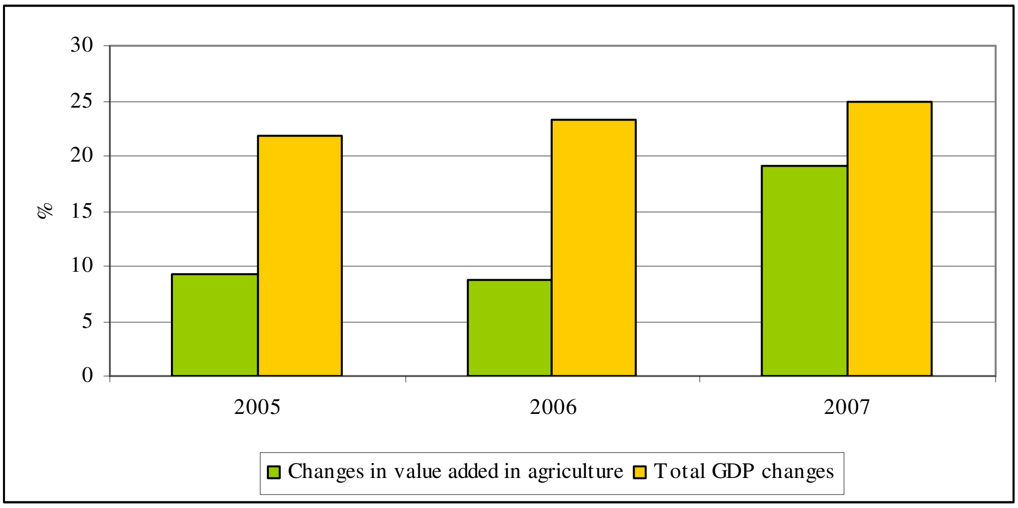


Figure 6.1 Percentage change of GDP and value added in 2005–2007 (Source: CSB)

In 2007 in Latvia there were 113.4 thousand economically active agriculture farms, which managed agriculture land of the total area of 1775.8 thousand hectares. Comparing with 2005 there were 133 thousand farms with 1705.2 ha utilized agriculture area. That's mean in two years number of farms decreased for 19.6 thousand or 14.7%. On average, one farm had 25.5 ha land, including 15.7 ha the utilized agricultural land [1].

Comparing the structure of agricultural farms in 2007 and 2005 it can be noticed that the proportion of small farms has decreased – in the farm group with the size of agricultural land up to 1 ha for 3,9%, but in the farm group with agricultural land size from 2 to 4,9 ha – for 5,4%. At the same time a trend can be observed that there is increase of the number of farms, which manage larger areas of agricultural land number of farms with the agricultural land size that exceeds 50 ha has increased for ~ 660 or1.2%).

Comparing data from the survey of Rural Farm Structure Survey in 2007 and data from 2005, area of utilized agricultural land increased by 70.6 thousand ha or 4%, we have seen increase of arable lands and also meadows and pasture. There were important decrease of unutilized agriculture land – by 65 thousands ha or 29.5 ha.

Common agricultural policy (hereinafter referred to as – CAP) includes not only issues concerning manufacturing of products, but also environment issues and those of the welfare of rural population.

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.

Rise isn't cultivated in Latvia and savannas don't exist. Field Burning of Agricultural Residues is taking place in Latvia on small scale, therefore emissions weren't calculated and notation key "NA" is used. Emissions from previous grass burning are included under LULUCF sub sector Grassland.

In 2007, the Agriculture sector contributes 17% from total national emissions. Total GHG emissions from agriculture have declined approximately 65% over the period of 1990 – 2007 (Figure 6.2). Fluctuation of emissions has observed in the time series (Table 6.1).

The general reason for this is economical crisis during 1991-1995, when significantly were decreased amount of livestock in farms as well as use of nitrogen fertilisers.

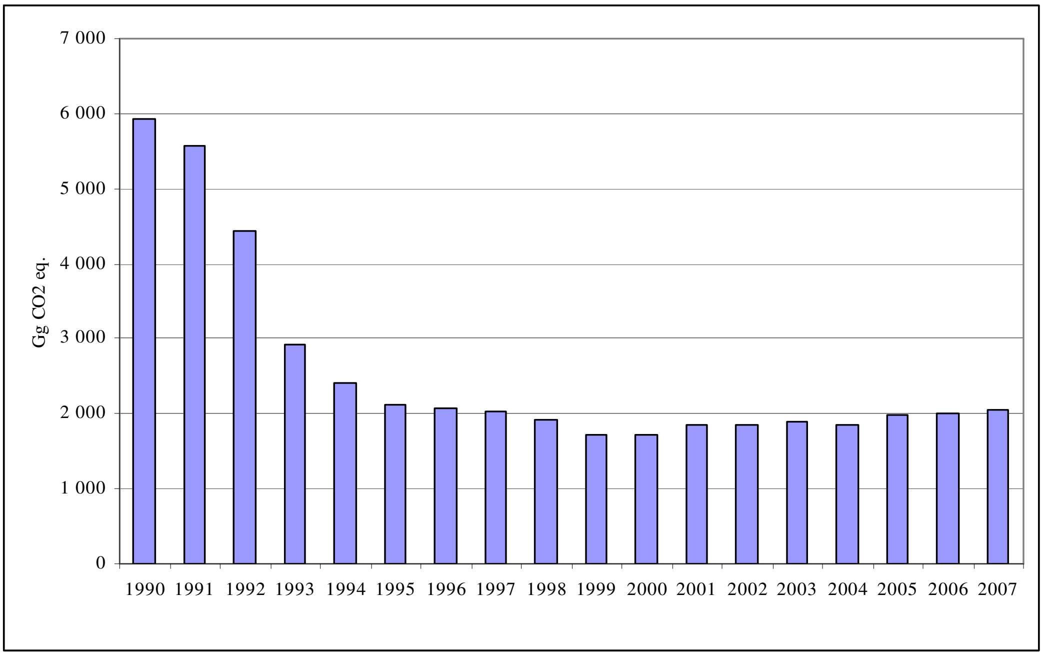


Figure 6.2 Trend in agricultural emissions in 1990 – 2007 (Gg CO_2 eq.)

The proportion of manure managed in different manure systems affects N_2O emissions from Manure Management. N_2O emissions from Agricultural Soils are influenced by different points - use of synthetic fertilizers annually, changes of animal numbers between years**,** fluctuation of sown area and area of cultivated organic soils.

Table 6.1 Agricultural greenhouse gas emissions by source and gas in 1990 – 2007

	CH_4 (Gg)			**N_2O (Gg)**		
	Total	Enteric Fermentation	Manure management	Total	Manure management	Agricultural Soils
1990	111.27	97.96	13.31	11.59	1.78	9.81
1991	107.11	94.64	12.47	10.74	1.71	9.03
1992	88.77	79.27	9.5	8.27	1.37	6.90
1993	54.6	48.88	5.72	5.71	0.85	4.86
1994	45.79	40.61	5.17	4.7	0.73	3.97
1995	44.63	39.31	5.32	3.80	0.7	3.09
1996	41.79	37.02	4.77	3.89	0.67	3.22
1997	39.19	34.72	4.47	3.92	0.63	3.29
1998	35.86	31.67	4.19	3.74	0.58	3.16
1999	31.35	27.52	3.83	3.41	0.51	2.90
2000	30.6	26.88	3.73	3.46	0.5	2.96
2001	32.07	28.08	3.99	3.81	0.53	3.28
2002	32.31	28.2	4.11	3.78	0.54	3.25
2003	31.21	27.2	4.01	3.98	0.52	3.46
2004	30.7	26.75	3.95	3.91	0.51	3.40
2005	31.47	27.5	3.97	4.26	0.52	3.74
2006	30.86	26.9	3.92	4.36	0.51	3.85
2007	32.21	28.2	4.01	4.46	0.53	3.93

6.2 ENTERIC FERMENTATION (CRF 4.A)

6.2.1 Source category description

The emission sources cover domestic livestock. Latvia reports emissions from cattle (including dairy cows), swine, horses, goats and sheep. Emissions from poultry have not been estimated.

In 2007, methane emissions from Enteric Fermentation of domestic livestock comprised 29% of total agricultural emission, expressed in CO_2 equivalents. CH_4 emissions were 28.2 Gg and decreased 71% since 1990 due to decreasing number of cattle (Figure 6.3).

CH_4 emissions from Enteric Fermentation are key source for 2007 accordingly level and trend assessment (including LULUCF) and contribute 1% and 3% respectively.

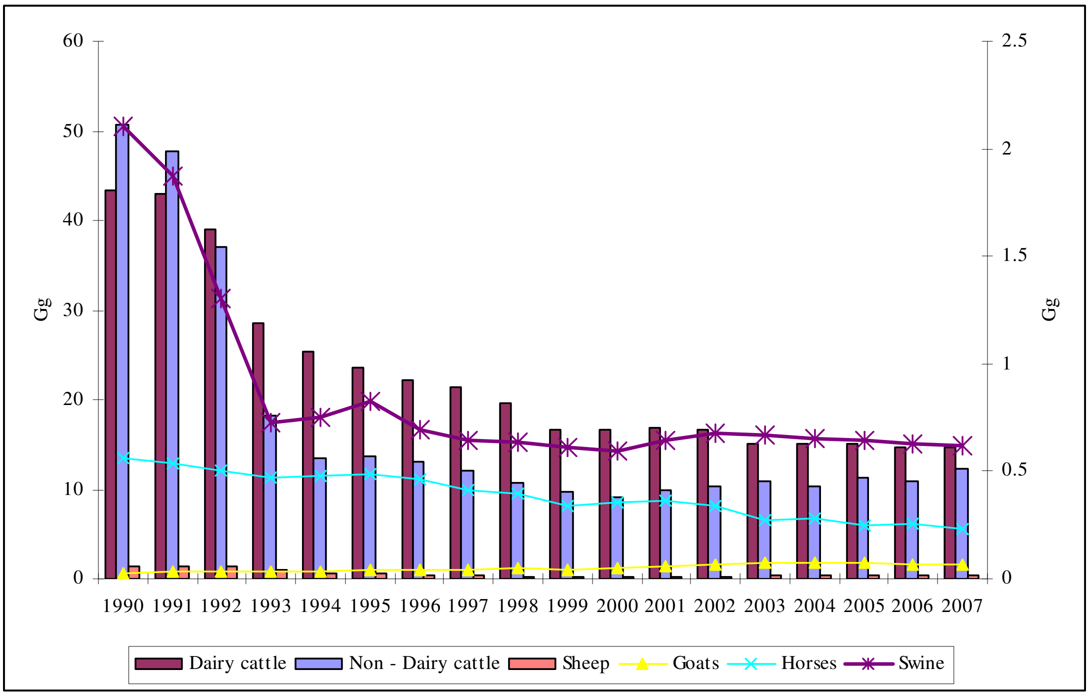


Figure 6.3 Methane emissions from Enteric Fermentation in 1990 – 2007 (Gg)

6.2.2 Methodological issues

Methods

Calculation of emissions is based on methods described in the IPCC 1996 and IPCC GPG 2000. CH_4 emissions from Enteric Fermentation have been estimated using the Tier 1 methodology. In Tier 1 method, total emissions have been calculated by multiplying the number of the animals in each category with the IPCC default emission factor of each animal category. The total emission is the sum of emissions from each category. For emission calculation was used IPCC Tool and then data was put in the CRF Reporter.

Emission factors and other parameters

To calculate CH_4 emissions from Enteric Fermentation the default emission factors were used from IPCC 1996 (Table 6.2).

Table 6.2 CH_4 emission factors from Enteric Fermentation

Types of animals	EF (kg/head/year)
Dairy cattle	81
Other cattle	56
Sheep	8
Goats	5
Horses	18
Swine	1.5

Activity data

The number of cattle, sheep, horses, swine and goats were obtained from the Statistical yearbooks of Latvia (Table 6.3) [2].

Table 6.3 Number of livestock for 1990 -2007 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	312	239	86	7	27	501	3700
1995	292	245	72	9	27	553	4198
1996	275	234	56	8	26	460	3791
1997	263	214	41	9	23	430	3551
1998	242	192	29	11	22	421	3209
1999	206	172	27	8	19	405	3237
2000	204	162	29	10	20	394	3105
2001	209	176	29	12	20	429	3621
2002	205	183	32	13	19	453	3882
2003	186	193	39	15	15	444	4003
2004	186	185	39	15	16	436	4050
2005	185	200	42	15	14	428	4092
2006	182	195	41	14	14	417	4488
2007	180	219	54	13	13	414	4757

The source of data on the number of livestock in state farms and statutory companies are statistical surveys while sample surveys are used to collect information from peasant farms, household plots and private subsidiary farms. The survey was first launched in 1995 and since then it is conducted twice a year. The sample for 2006 covers 15.0 thsd farms selected by economic size and specialisation [2].

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%;
- For emission calculation was used Tier1 method and default emission factors therefore selected average value 40% from 30-50% (Source: IPCC GPG 2000).

6.2.4 Source-specific QA/QC and verification

Expert reviewer checked and filled in QC form for each category according to internal QA/QC program.

6.3 MANURE MANAGEMENT (CRF 4.B)

6.3.1 Source category description

The emission sources cover management of manure from domestic livestock. Latvia reports CH_4 and N_2O emissions from cattle (including dairy cows), swine, horses, goats, sheep and poultry.

Total emissions from Manure Management of domestic livestock consisted approximately 12% of total agricultural emissions (expressed in CO_2 equivalents) in 2007. Methane emissions from Manure Management were 4.01 Gg. CH_4 emissions from Manure Management have decreased 70% during the time period 1990 - 2007 (Figure 6.4).

According trend assessment N_2O emissions from Manure Management is a key source and contributes 1%.

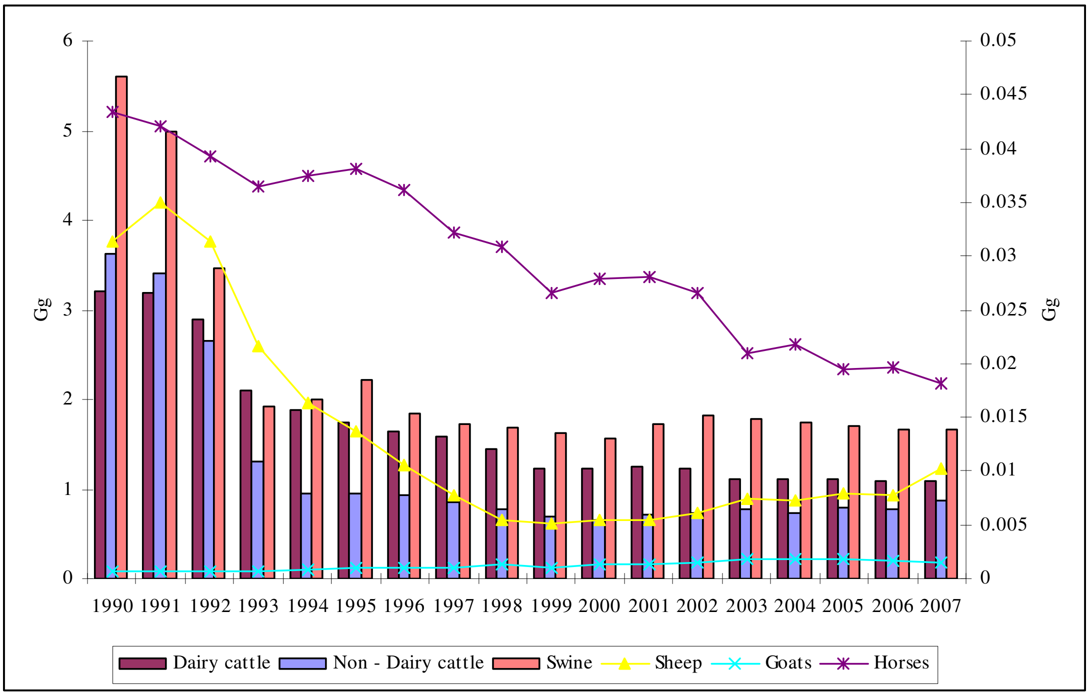


Figure 6.4 CH_4 emissions from Manure Management in 1990–2007 by livestock type

In 2007, nitrous oxide emissions from Manure Management were 0.53 Gg. It is observed, that emissions from Manure Management have decreased 70% from 1990 to 2007 (Figure 6.5).

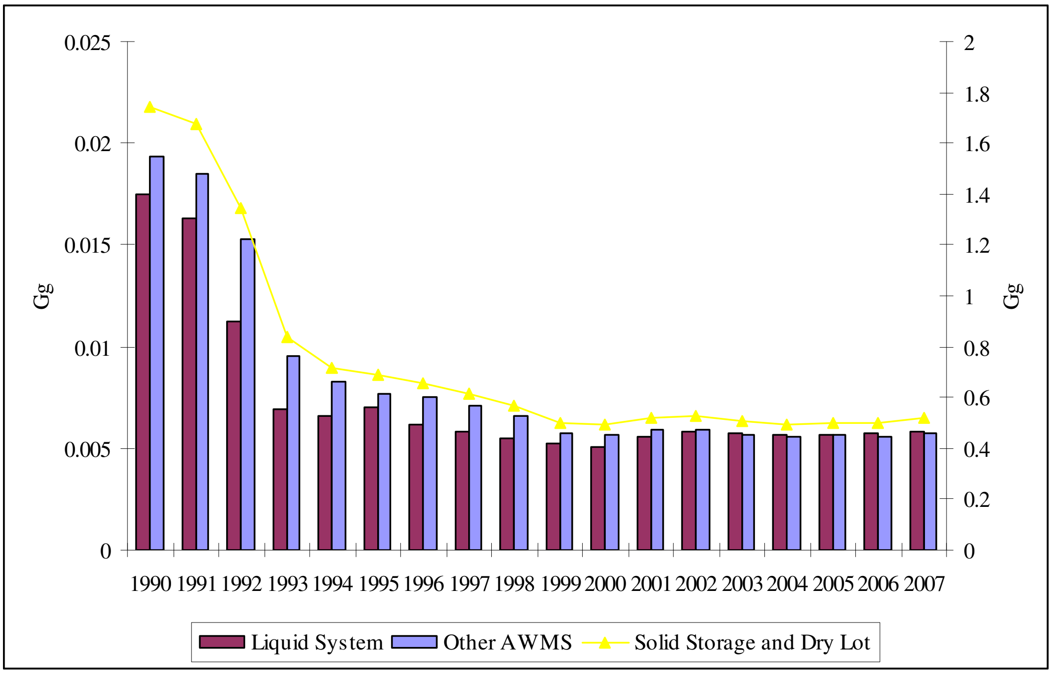


Figure 6.5 Nitrous oxide emissions from Manure Management in 1990 – 2007 by manure management system (Gg)

The fluctuations in emissions (Figure 6.3. and Figure 6.4) are related changes in animal numbers and changes in the distribution of manure management systems.

6.3.2 Methodological issues

Methods

The IPCC 1996 Tier 1 approach was applied to evaluate emissions from Manure Management.

Methane emissions from Manure Management are calculated multiplying the number of the animals in each category with the emission factor for each category.

Nitrous oxide emissions from Manure Management have been calculated by using IPCC methodology and local expert assumptions. The amount of nitrogen excreted annually per animal has been divided between different manure management systems and multiplied with a specific emission factor (IPCC default value) for each manure management system. Manure management systems reported in the inventory are liquid system, daily spread, solid storage and dry lot, pasture range and paddock and other. N excretion during the year per each animal and the distribution of manure management systems are national calculated values (for some livestock type's N excretion are the same as in the IPCC default).

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

Emission factors and other parameters

To calculate CH4 emissions from Manure Management were used IPCC default emission factors (Table 6.4). Emission factors as for *cool* climate region were chosen because annual temperature in Latvia is 6.0 ºC (reference period 1971-2000).

Table 6.4 CH_4 emission factors from manure Management

Types of animals	EF (kg/head/year)
Dairy cattle	6
Other cattle	4
Sheep	0.19
Goats	0.12
Horses	1.4
Swine	4
Poultry	0.078

Calculation of nitrous oxide emissions from Manure Management is also based on the IPCC default emission factors (Table 6.5).

Table 6.5 IPCC default emission factors for N_2O from Manure Management

Manure management system	Emission factor (kg N2O – N/kg)
Liquid system	0.001
Solid storage and dry lot	0.02
Other	0.005

Activity data

Animal numbers were obtained from CSB (Table 6.3) and directly, statistical bulletins for each year. The distribution of different manure management systems received from Research made by LSIAE (2005) is shown in the Table 6.6; 6.7 and 6.8 [8, 11, 21].

Table 6.6 Distribution of different manure management systems for 1990-2003

	Liquid system, %	Solid storage and dry lot, %	Pasture range and paddock, %	other, %
Dairy cattle	3.5	53.5	40	3
Non - Dairy cattle	2.1	50.69	45.21	2
Sheep		57.5	42.5	
Goats		57.5	42.5	
Horses		49.3	50.7	
Swine	46	51		3
Poultry	39	61		

Table 6.7 Distribution of different manure management systems for 2004-2005

	Liquid system, %	Solid storage and dry lot, %	Pasture range and paddock, %	other, %
Dairy cattle	3.5	52.5	41	3
Non - Dairy cattle	2.1	49.32	46.58	2
Sheep		56.16	43.84	
Goats		56.16	43.84	
Horses		47.95	52.05	
Swine	46	51		3
Poultry	39	61		

Table 6.8 Distribution of different manure management systems for 2006 - 2007

	Liquid system, %	Solid storage and dry lot, %	Pasture range and paddock, %	other, %
Dairy cattle	3.6	52.4	41	3
Non - Dairy cattle	2.1	49.32	46.58	2
Sheep		56.16	43.84	
Goats		56.16	43.84	
Horses		47.95	52.05	
Swine	46	51		3
Poultry	37	63		

Data about annual N excretion per animal (Table 6.9) obtained from Research made by LSIAE (2005) [8, 21]. National expert made an account, based on a research, in which livestock manure amount and nitrogen amount was analysed over a long time period as well as different available information (Annex 3).

Table 6.9 Average N excretions per head of animal [8]

Types of animals	**N, kg/year (CS)**
Other cattle	50
Dairy cattle	71
Sheep	6
Swine	10
Horse	46
Poultry	0.6

For goats the same N emission factor was used as for sheep and it was 6 N, kg/year.

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

The QA/QC procedures are the same for whole agricultural sector (see Chapter 3.2.4).

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. 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.

Accordingly level and trend assessment (including LULUCF) of key source for 2007 direct N_2O emissions from agricultural soils consist 2% and 2% respectively, but indirect N_2O emissions from agricultural soils consist 1% and 2%. N_2O emissions from Pasture Range and Paddock Manure are key source according to Trend assessment (including LULUCF) - 1%.

N_2O emissions from Agricultural Soils contribute 59 % of total agricultural emissions (expressed in CO_2 equivalents) in 2007. Nitrous oxide emissions from Agricultural Soils were 3.93Gg in 2007.

Emissions have decreased and fluctuated over the period 1990 – 2007 (Figure 6.6). It is due to decreased animal numbers that affected the amount of nitrogen excreted annually to soil. In the latest years can observed that emissions have increased. The main reason is increasing use of synthetic fertilizers.

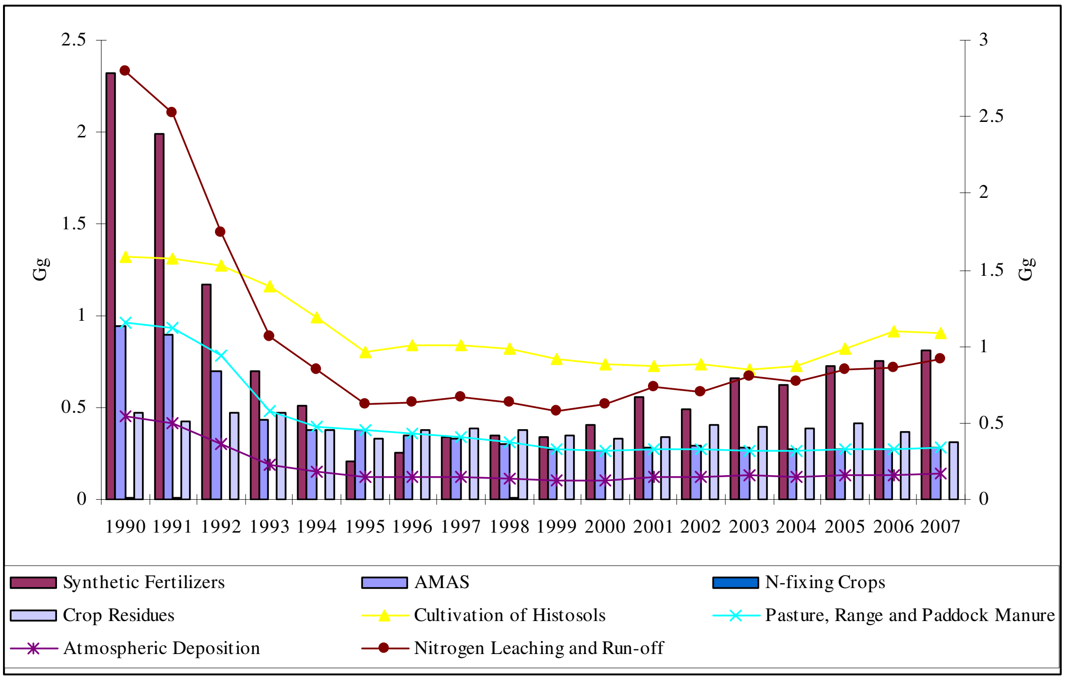


Figure 6.6 Direct and indirect N_2O emissions from Agricultural Soils by source category

6.4.2 Methodological issues

Methods

Nitrogen inputs to soils from all sources were calculated using IPCC Tier 1a. Direct N_2O emissions from agricultural soils are estimated as follows (GPG, 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 Tier 1a (GPG, Equation 4.22):

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

F_{SN}	Annual amount of synthetic fertilizer nitrogen applied to soils
N_{FERT}	Annual amount of nitrogen in synthetic fertilizers applied to soils (thsd.t) – see Table 6.14
$Frac_{GASF}$	Fraction of nitrogen lost through gaseous emissions of NH_3 and NOx - 0.1kg (IPCC 1996, Table 4-19)

Nitrogen input through application of animal manure

For emission calculation is used equation from IPCC 1996:

$$F_{AW} = (Nex * 1\text{-}(Frac_{Fuel} + Frac_{GRAZ} + Frac_{GASM}))$$

Nex	Amount of nitrogen excreted by the livestock, see Table 6.9
$Frac_{Fuel}$	Such activities not occurred
$Frac_{GRAZ}$	Fraction of livestock nitrogen excreted and deposited onto soil during grazing
$Frac_{GASM}$	Fraction of livestock nitrogen excretion that volatilises as NH3 and NOx – 0.2 kg (IPCC 1996, Table 4-19)

N fixed by Crops (F_{BN})

The method applied for calculation of emissions is IPCC Tier 1a (GPG, Equation 4.25):

$$F_{BN} = 2*Crop_{BF}*Frac_{NCRBF}$$

$Crop_{BF}$	Seed yield of pulses, Table 6.15
$Frac_{NCRBF}$	Fraction of nitrogen in N-fixing crop (crop kg N/kg of dry biomass) , GPG Table – 4.16

Nitrogen input from crop residues

The method applied for calculation of emissions is IPCC Tier 1a (GPG, Equation 4.28):

$$F_{CR} = 2*(Crop_o * Frac_{NCRO} + Crop_{BF} * Frac_{NCRBF}) * (1 – Frac_R) * (1- Frac_{BURN})$$

$Crop_o$	Production of all other (non-N fixing) crops in country, Table 6.15
$Frac_{NCRO}$	Fraction of nitrogen in non-N fixing crop - 0.015 kg N/kg of dry biomass (IPCC 1996; Table 4-19)
$Frac_{NCRBF}$	Fraction of nitrogen in N-fixing crop (crop kg N/kg of dry biomass) , GPG Table – 4.16
$Frac_R$	Fraction of crop residue that is removed from the field as crop – 0.45 kg N/kg crop – N biomass (IPCC 1996; Table 4-19)
$Frac_{BURN}$	In Latvia such activities not occurred

Area of cultivated organic soils (histosols- F_{OS})

The IPCC 2000 defines F_{OS} as the area of organic soils cultivated annually. During the In country review (May of 2007) ERT recommended that for calculation of Histosols consistent data source is necessary, therefore:

- sown area, which is collected by CSB and has consistent time series is used instead of previously used area of arable land;
- area of permanent crops was extrapolated for 1990 – 1995 by CSB.

For assessing approximate area of Histosols were used materials from Ministry of Agriculture, Central Statistical Bureau, scientists publications. Detailed information about assessing area of Histosols is in the Annex 3.

Some information from research is described below:

The biggest part of Histosols consists in the fallow land and it reflects to the area, which isn't used for agriculture. Since 1990-ties proportion of Histosols isn't changed, because practically wasn't actions for new area drainage. It is observed that increased agricultural area which isn't used for agricultural actions. As well as number of farm animals essentially decreased and therefore decreased area of cultivated meadows and pastures.

Proportion of cultivated meadows and pastures in the Histosols for period 1990 -2007 is shown in the Table 6.10. An assumption was made using CSB surveys.

Table 6.10 Proportion of cultivated meadows and pastures in the histosols for period 1990-2007

Years	%
1990 - 2002	18.6
2003	15.8
2004	13
2005-2006	17.2
2007	15.8

According to national research Histosols is calculated as 7% from cultivated agricultural area (Annex 3). From national expert, who was prepared previously mentioned research, was received answer that it is possible to use sown area instead of arable land for Histosols calculation. Received answers from CSB and national expert were documented in separate folder developed by national inventory compiler. Reassessed areas of approximate cultivated Histosols are shown in the Table 6.11.

Table 6.11 Assessed area of Histosols 1990 – 2007 [12]

	Sown area*, thsd, ha	Permanent crops*, thsd.ha	Meadows and pastures*, thsd.ha	0f which cultivated	Cultivated area, thsd. ha	**Histosols, 7% from cultivated area, thsd.ha**
1990	1627	11.4	844.2	*157.02*	1795.43	**125.680**
1991	1621	11.6	843.4	*156.87*	1789.48	**125.26**
1992	1572	8.4	825.1	*153.47*	1733.85	**121.37**
1993	1426	8.4	803.4	*149.43*	1583.82	**110.87**
1994	1195	8.6	803.4	*149.43*	1353.04	**94.71**
1995	930	10.6	800.5	*148.89*	1089.47	**76.26**
1996	986	16.2	798.1	*148.45*	1150.65	**80.55**
1997	1003	15.1	677.9	*126.09*	1144.19	**80.09**
1998	983	12.1	677.9	*126.09*	1121.19	**78.48**
1999	912	11.7	617.7	*114.89*	1038.59	**72.70**
2000	881	11.5	605.7	*112.66*	1005.16	**70.36**
2001	870	12.1	611.3	*113.70*	995.80	**69.71**
2002	878	12.2	610.3	*113.52*	1003.72	**70.26**
2003	851	12.0	613.1	*96.87*	959.87	**67.19**
2004	899	12.4	620.9	*80.72*	992.12	**69.45**
2005	1000	12.8	628.9	*108.171*	1120.97	**78.47**
2006	1123	13.2	636.8	*109.530*	1245.73	**87.20**
2007	1126	10	641	*101.278*	1237.28	**86.61**

* Data source: CSB [20]

To calculate indirect emissions from Atmospheric Deposition (NH_3 and NOx) and Leaching were used calculation steps according to IPCC Workbook.

Emission factors and other parameters

IPCC default emission factors, national values and other parameters have been used. Emission factors and other parameters are presented in Table 6.12 and 6.13.

Table 6.12 N_2O emission factors for emissions calculation from agricultural soils*

Categories	**Emission factors**
Synthetic fertilizers	1.25%
AWAS	1.25%
N-fixing Crops	1.25%
Crop residue	1.25%
Organic soils	8 kg N_2O – N/ha
Atmospheric deposition	1% of N deposition
N-leaching and run-off	2.5% of N leaching

* IPCC default values used

Table 6.13 Dry matter fraction and nitrogen content of crops included in inventory

	FracDM*	Frac NCRBF*
Wheat	0.81	0.0028
Barley	0.81	0.0043
Oats	0.92	0.007
Rye	0.9	0.0048
Rape	0.75	0.015
Potatoes	0.75	0.011
Sugar beet	0.77	0.015
Vegetable	0.8	0.015
Peas and beans	0.87	0.0142

* IPCC default

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 6.3)), use of N synthetic fertilizers (Table 6.14) and productions of crops (Table 6.15). Other data sources are LSIAE [8] (distribution of different manure management systems are shown in the Table 6.6, 6.7 and 6.8 and researches made by local experts (area of cultivated organic soils) [12; 18].

Table 6.14 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	41
2006	43
2007	46

Table 6.15 Productions of crops (thsd.t)

Year	Wheat and oth.	Barley	Oats	Rye	Rape	Potatoes	Sugar beet	Vegetables	Pulses
1990	402.5	697	176.1	323.6	3.8	1016.1	439.1	169.4	22.7
1991	190.2	761.9	177.2	145.8	0.9	944	377.9	209.2	20.7
1992	332.4	426.3	60	295	1.4	1167.4	462.6	250.8	8.6
1993	338.3	445.8	73.7	340.7	2.5	1271.7	298	284.8	4.3
1994	199.4	476.8	88.9	113.4	1.8	1044.9	228.2	233.2	4.5
1995	260.5	284	73.2	71.3	0.9	863.7	250	223.7	4.7
1996	374.9	371.5	101.4	112.9	1.3	1081.9	257.8	179.5	7.8
1997	424.6	359.8	116.5	133.5	0.5	946.2	387.5	162.5	8.3
1998	428.8	321.7	103.6	104.8	1.6	694.1	597	119.6	11.3
1999	396	232.6	66.1	88.7	11.7	795.5	451.5	130.1	3.6
2000	472.2	261.1	79.6	110.7	10	747.1	407.7	105.8	3.9
2001	507.3	231.1	82.4	107.2	13	615.3	491.2	159.3	4
2002	584.9	262.4	79.7	101.5	32.7	768.4	622.3	148.2	4.2
2003	519.9	246.6	78.3	87.6	37.4	739	532.4	217.5	5
2004	571.8	283.5	107.4	96.8	103.6	628.4	505.6	180.8	4.5
2005	739.3	365.8	122	87.2	145.7	658.2	519.9	172.2	3.5
2006	643.3	307	91.6	116.8	120.6	550.9	473.9	174.4	1.4
2007	874	351	130	181	197	642	11	156	2.6

The nitrogen excreted per animal is the same used for calculating nitrous oxide emissions from Manure Management (Table 6.9).

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

The QA/QC procedures are the same for whole agricultural sector (see Chapter 3.2.4).

6.5 FIELD BURNING OF AGRICULTURAL RESIDUES (CRF 4.F)

Field Burning of Agricultural Residues is taking place in Latvia on small scale and according to latest information from Ministry of Agriculture is negligible for the whole time series and it is decided to use notation key – NA.

6.6 RECALCULATIONS

There aren't any changes in activity data, methodology and emission factors for Agriculture sector except the notation key for Field Burning of Agricultural Residues (CRF 4.F) was changed from NE to NA. Previously planned improvements regarding elaboration of national emission factors, for example, CH_4 emission factor from Enteric Fermentation wasn't done due to lack of financial resources.

6.7 PLANNED IMPROVEMENTS

It is planned to elaborate detailed methodology for category Enteric Fermentation.

7. LAND USE, LAND-USE CHANGE AND FORESTRY (CRF 5)

7.1 OVERVIEW OF SECTOR

This category comprises CO_2 emissions and removals arising from Land Use, Land Use Change and Forestry (LULUCF). LULUCF sector in GHG balance is very important in Latvia due to the fact, that the country is rich with forests. According to data provided by National statistical forest inventory (NFI) total area of Forest land remaining forest land in 2007 was 3257 th.ha (50% of total land area are Latvia). Besides, 134 th.ha are Land converted to forest land, generally, because of natural afforestation during last decades. About 89 th.ha of those areas registered as 1 year old forest stand, which usually means, that these areas have changing status – between Forest land and Grassland, depending from intensity of management. As soon as land owner cut down grass together with young trees, for instance, to fulfil requirements for well managed agricultural lands, the land moves to the Grassland category. If land owner omit cutting of grass, natural afforestation with root and stump shoots takes place and at the end of the year a sample plot, depending from height of shoots (less or more than 1.5 m), moves to Land converted to forest land category or remains in Grassland category. In the 1990-2007 reporting period all Forest land areas were recalculated according to NFI data using historical recalculation method approved in 2007 (reporting period 1990-2006, 3rd annex of annual report). It should be also mentioned that significant share of Forest land (forest infrastructure, mares and wetlands), which didn't fit to the forest definition in this report are moved to other categories. Category Other land was introduced in this report to separate Forest land, which doesn't fit into other subcategories.

In submission 2009, Latvia reports carbon stock changes and GHG emissions from Forest Land, Wetland, Cropland, Grassland and Other land using the new CRF tables. In the Forest Land category removals and emissions associated with living biomass and dead organic mater (dead wood) are calculated. Calculations were done by Latvian State Forest Research Institute "Silava" (LSFRI Silava) with support of Ministry of Agriculture of Republic of Latvia (MoA). CO_2 removals and emissions of Forest land, Cropland and Grassland category are reported as emissions from organic soils (Cropland, Grassland, Forest land), liming of agricultural soils (Cropland), controlled burning (Forest land, Grassland) and wildfires (Forest land).

Removals and emissions of GHG from forest fires in LULUCF sector are recalculated from 1990 using data provided by NFI. The last values are calculated combining information about area of wildfires estimated by State forest service (SFS) and measured volumes of damaged wood in the NFI database. This submission includes removals from Wetlands, Settlements and Other lands, where sequestrated carbon is calculated using the NFI data.

N_2O emissions from drainage of soils are not reported due to lack of the activity data.

Land areas and land categories used in Latvian Inventory

In data submission 2009 National division of land categories corresponds to IPCC GPG-LULUCF, 2003. Initial source of information about area of Forest land and Land converted to forest come from the NFI. Initial source of information about Grassland, Cropland and Wetland is State land service (SLS), but the information about Wetland and Grassland is updated according to measurements of NFI sample plots – woodlands, which corresponds to definition of forests are moved to Forest land or Land converted to forest and areas, which don't fit to this definition are moved to other categories, generally – to Wetland or Settlements. Category Other land was introduced to separate Forest land, which doesn't fit into other categories.

According to National legislation forest is an ecosystem in all stages of its development, dominated by trees the height of which at the particular location may rich at least 7 meters and the present or potential projection of crown of which is at least 20 % of area occupied by the forest stand. According to definition used in this report 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.

The following aren't regarded as forest:

- area separate from forest, covered by trees, the size of which does not exceed 0.1 ha;
- rows of trees of artificial or natural origin, the width of which is less than 20 m;
- orchards, parks, cemeteries and forest tree seed orchards.

For reporting according to IPCC GPG-LULUCF, 2003 Forest Land is divided in tree categories: Unmanaged forest land, Forest land remaining forest land and Land converted to forest land.

Cropland includes arable land and orchards, as well as areas marked as cropland in the National land inventory, but covered by woody vegetation, which doesn't fit to definition of Forest land.

Grassland includes meadows and pastures, as well as abandoned managed land and bushland, which doesn't fit to forest definition.

Change of dynamics of Forest Land, Cropland and Grassland area is shown in Figure 7.1.1.

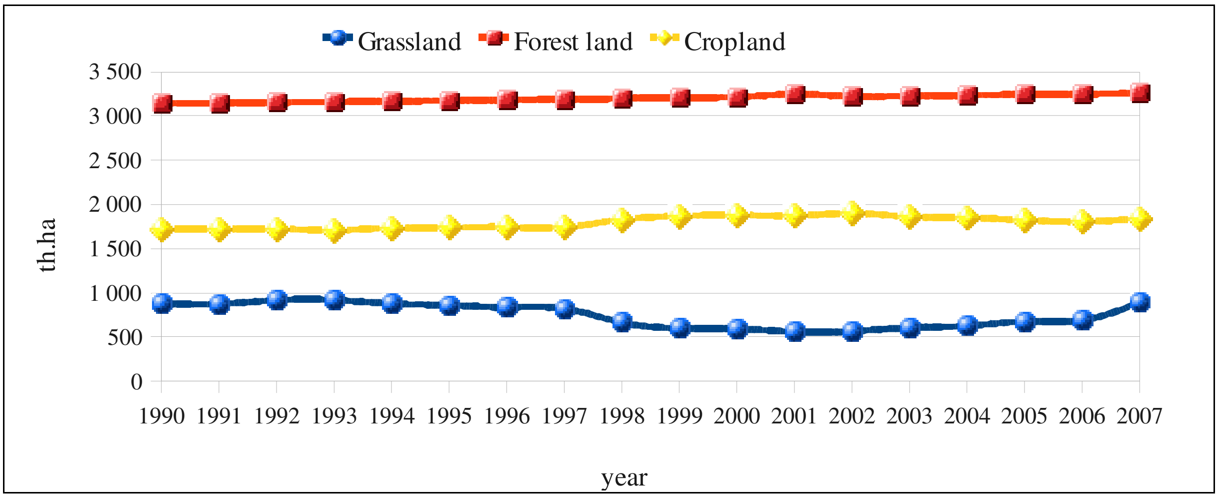


Figure 7.1.1 Dynamics of Forest land, Cropland and Grassland (th.ha)

In 2007, the LULUCF sector in Latvia is a sink because total sector emissions are significantly smaller as removals due to accumulation of carbon in living biomass in Forest land (Table 7.1.1). Net emissions of CO_2 from the Wetland in 2007 were -47.2 Gg and from Settlements -393.3 Gg. In 2007 category Other lands was introduced to separate emissions from other lands covered with woody vegetation. Total emissions from the Other land in 2007 were -18.09 Gg. This category was recalculated down to 1990, using data provided by the NFI. A significant role of methodology, especially more detailed calculation of increment of forest biomass also should be taken in account, when compare the data provided in earlier and this report.

Table 7.1.1 Total CO_2 emissions and removals from LULUCF sector in 1990-2007

Year	Forest land	Cropland	Grassland	Wetland	Settlements	Other lands	Total
1990	-21660.4	405.8	-4.8	-28.1	-146.7	-5.1	**-21439.3**
1991	-23017.0	404.4	-6.2	-28.5	-163.7	-5.1	**-22816.1**
1992	-24113.7	392.3	-9.2	-28.1	-179.5	-5.1	**-23943.4**
1993	-24185.7	356.3	-11.9	-28.1	-183.6	-5.1	**-24058.1**
1994	-24054.3	196.2	-12.9	-28.5	-194.5	-5.6	**-24099.7**
1995	-24072.0	153.7	-13.5	-28.1	-199.2	-5.6	**-24164.6**
1996	-25076.0	161.5	-14.4	-28.5	-203.9	-5.6	**-25166.9**
1997	-23683.4	162.1	-20.7	-28.7	-210.5	-5.6	**-23786.7**
1998	-23304.4	159.6	-20.6	-29.4	-213.1	-5.6	**-23413.5**
1999	-23334.1	148.3	-21.5	-29.4	-214.4	-5.6	**-23456.6**
2000	-24326.7	145.7	-24.7	-29.4	-216.2	-5.6	**-24457.0**
2001	-29876.2	139.8	-23.8	-29.5	-216.9	-5.6	**-30012.3**
2002	-25715.4	155.2	-11.6	-29.4	-216.5	-5.6	**-25823.4**
2003	-26131.0	160.1	-7.7	-29.5	-216.6	-5.6	**-26230.2**
2004	-27978.1	145.1	-22.4	-29.5	-216.8	-5.6	**-28107.3**
2005	-28163.8	161.7	-29.0	-29.5	-216.9	-5.6	**-28283.0**
2006	-32530.7	181.3	13.8	-29.5	-216.9	-5.6	**-32587.6**
2007	-31730.6	209.4	-39.2	-47.2	-393.3	-18.1	**-32018.9**

The total GHG emissions from LULUCF sector are shown in the Figure 7.1.2. Significant increase of removals in 2001 is associated with reduced harvesting volume.

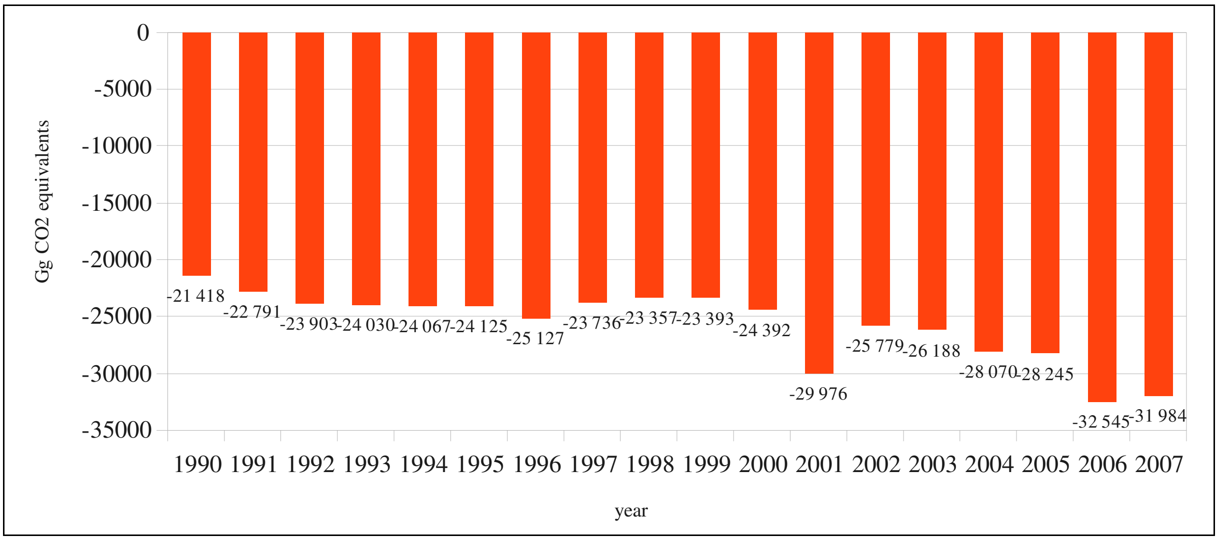


Figure 7.1.2 Total GHG removals from LULUCF (Gg CO_2 eqv)[1]

If compare to CO_2 removals in 1990 and the last decade, in 2007 they increased significantly, which is associated with changes in land use structure and increase of biomass increment in Forest land. Net yearly removals of CO_2 in 2007 in LULUCF sector increased by 50% in a compare to situation in 1990.

1 negative figures – GHG removals.

7.2 FOREST LAND (CRF 5.A)

Forest Land is divided in tree categories: Unmanaged Forest Land, Forest Land Remaining Forest Land and Land converted to Forest Land. Unmanaged forests are strict protected nature reserves and strict protected zones in national parks. This land area is 14.6 th.ha. Land converted to Forest Land is included under Grassland converted to Forest Land. Forest land is general key source by the level and trend assessment for 2007 with 72 and 30%, respectively.

7.2.1 Forest Land remaining Forest Land (CRF 5 A 1)

7.2.1.1 Source category description

In Forest land remaining forest land changes in carbon stock are estimated in 4 pools (above-ground biomass, below-ground biomass, dead wood and soil carbon in some extend[2]) on forest areas, which have been forest for at least the past 20 years. Activity data for biomass increment in this category is taken from the NFI. One of pools – litter – is not estimated at all because of lack of activity data. But it would be possible to estimate this pool as well as to calculate carbon and nitrogen removals within 3-4 years, if repeated measurements of carbon and nitrogen concentration would be done in sample plots, investigated within the scope of Forest Focus demonstration project Biosoil. The first ring of measurements demonstrated, that uncertainty might be less than 20% using 95 sample plots, but more sample plots are necessary in certain forest types not covered under the Biosoil.

Forest sector covers carbon uptake, which is associated with annual growth increment, calculated from average annual growth rate and carbon release from the commercial harvest. Emissions from the Forest land involves also controlled burning of slash and wildfires. Removals in the Forest land in the period from 1990 to 2006 were completely recalculated in this report according to radial increment of trees in the NFI sample plots. Detailed methodology of calculation attached to the last year report (reporting period 1990-2006, 3rd annex). Result of recalculation – net emissions are shown in Figure 7.2.1.

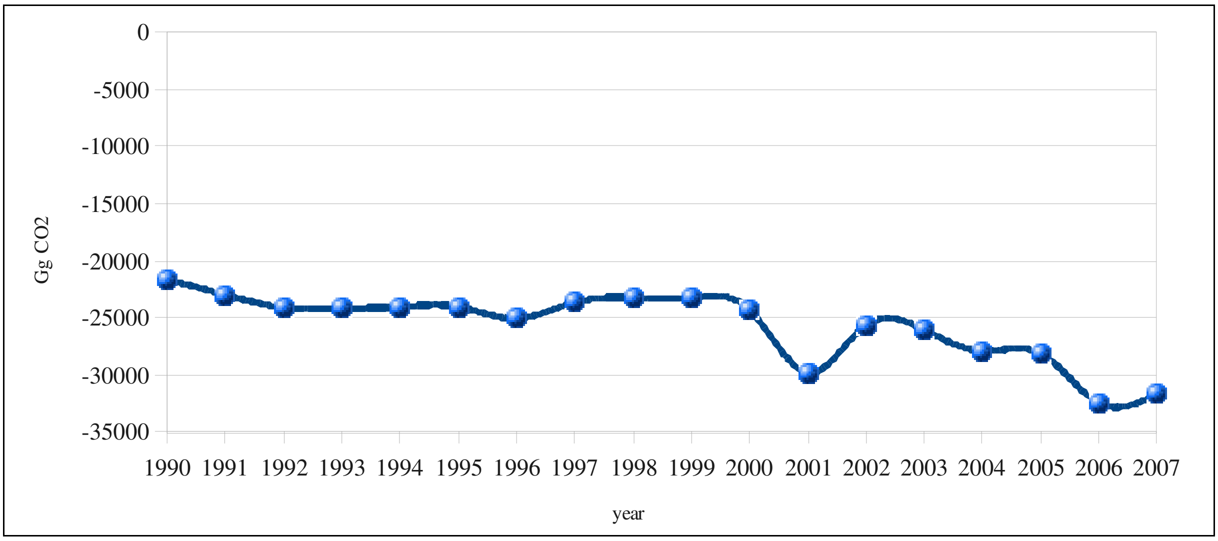


Figure 7.2.1 Net emissions & removals – Forest land remaining forest land (Gg of CO_2)

2 Emissions from drained organic soils.

7.2.1.2 Methodological issues

Methods

Changes in carbon stock and GHG emissions are estimated according to IPCC GPG-LULUCF, 2003. Tier 1 and 2 are used. Method 1 (Default method), which requires the biomass carbon loss to be subtracted from the biomass carbon increment for the reporting year. The following equation is used for change in carbon stock in living biomass:

$$\Delta C_{FF_{LB}} = (\Delta C_{FF_G} - \Delta C_{FF_L}) \; where:$$

$\Delta C_{FF_{LB}}$ – annual change in carbon stocks in living biomass (includes above and belowground biomass) in forest remaining forest land, $t\,C\,yr^{-1}$;

ΔC_{FF_G} – annual increase in carbon stocks due to biomass growth, tonnes $C\,yr^{-1}$;

ΔC_{FF_L} – annual decrease in carbon stock due to biomass loss, tones $C\,yr^{-1}$.

CO_2 removals and emissions from burning on-site in the forest were calculated according IPCC GPG-LULUCF, 2003. The method is described in details in Chapter 7.8.

After finalization of second round of NFI it will be possible to switch to second method which is based on difference in biomass stock in certain time frame (5 years). This method doesn't provide information about a current year, but it's much more precise, because of simpler calculation and smaller uncertainties Results will not change significantly in a compare to method introduced in 2009, because in both cases average values obtained within 5 years period are used. Switching to one year period (use of data of 1/5 of all sample plots) would increase significantly uncertainties

Calculation of changes of stock of dead wood in forest land was done by combination of data provided by NFI and UNECE[3] (UNECE, 2006). Regression equation was elaborated to calculate changes according to these data (Figure 7.2.2). This is temporary solution, which demonstrates trend, but more detailed results will be possible to obtain after finalization of second round of NFI. Yearly increment of stem volume from 1990 to 2007 in Forest land is shown in Figure 7.2.3.

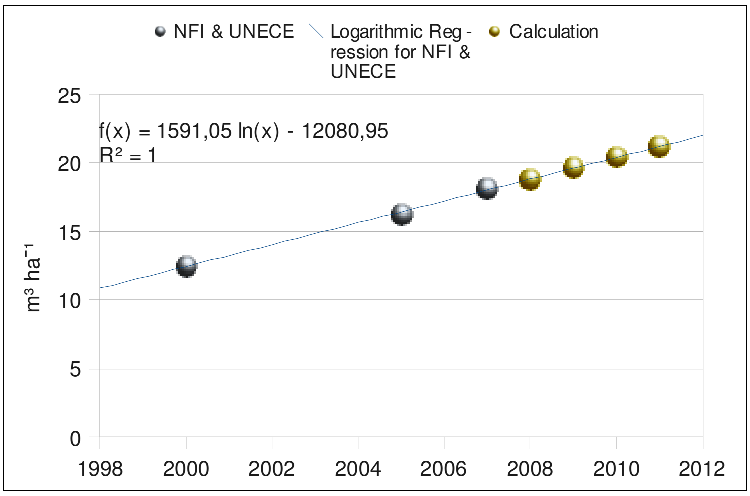


Figure 7.2.2 Regression equation for calculations of dead wood in forest land

3 The United Nations Economic Commission for Europe

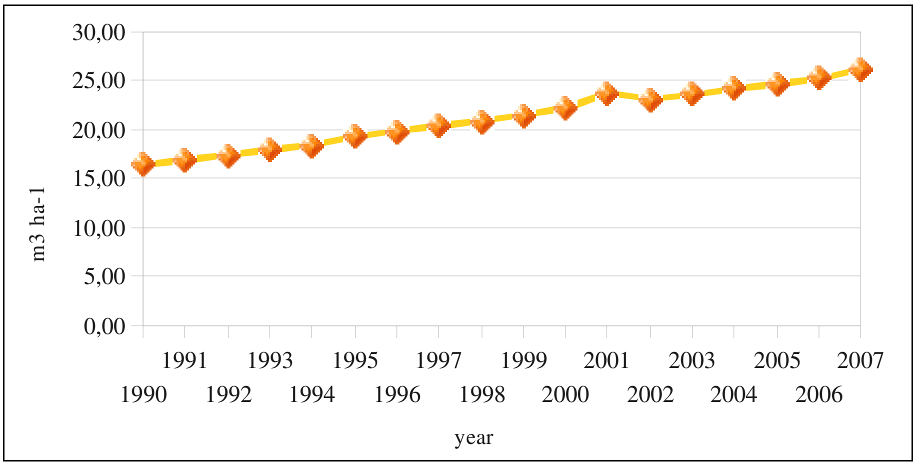


Figure 7.2.3 Yearly increment of stem volume in Forest land

Emission factors and other parameters

Assumptions that have been made for calculation are shown in Table 7.2.1.

Table 7.2.1 Factors and parameters used for calculations of change in carbon stock in living biomass

Basic wood density	0.5 ($t_{d.m.}$ 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 $t_{d.m.}^{-1}$)

Activity data

Activity data are used from NFI and State Forest Service (SFS). The data are shown in the Table 7.2.2 and Table 7.2.3. Forest area in last decades is significantly different in a compare to previous reports, because it's now recalculated according to the data obtained from the NFI sample plots. These still aren't final figures due to the fact, that the NFI doesn't provide historical data about forest stands, which are now younger than 20 years. Manual or automated remote sensing analysis of satellite images from early nineteen's is necessary to estimate actual area and dynamics of forest land. This work is planned for second half of 2009.

The SFS harvesting data are reliable and provides more detailed information about commercial felling, then the NFI can do, because of rather small number of sample plots in clear-cuts or thinned stands and complicated recalculation from stump diameter to a harvested volume. Only after completion of second round of NFI measurements, when actual amount of harvested biomass in certain plots will be available these data will be used to calculate harvested timber within the scope of the emission reporting.

Table 7.2.2 Area of Forest Land, thsd.ha

	Land converted to forest land	Forest land remaining forest land	Unmanaged forestland	Total forest area
1990	10.4	3142.4	13.7	3166.5
1991	12.5	3147.5	13.7	3173.7
1992	13.6	3154.4	13.7	3181.7
1993	16.2	3158.2	13.7	3188.1
1994	17.4	3166.0	13.7	3197.1
1995	20.2	3171.6	13.7	3205.5
1996	23.0	3181.4	13.7	3218.1
1997	29.5	3189.5	13.7	3232.6
1998	31.2	3197.6	13.7	3242.5
1999	33.4	3206.1	13.7	3253.1
2000	38.1	3213.8	13.7	3265.6
2001	44.5	3246.2	13.7	3304.4
2002	44.4	3221.6	13.7	3279.7
2003	44.4	3227.6	13.7	3285.7
2004	44.4	3233.2	13.7	3291.2
2005	44.5	3243.9	13.7	3302.1
2006	44.5	3246.2	14.6	3305.3
2007	134.0	3257.2	14.6	3405.8

Table 7.2.3 Timber harvesting volume (mill.m^3)

Year	Volume (mill.m^3)
1990	5
1991	4.4
1992	4
1993	4.8
1994	5.7
1995	6.9
1996	6.8
1997	8.9
1998	10
1999	10.8
2000	11
2001	10.5
2002	11.3
2003	11.7
2004	10.8
2005	11.3
2006	9.8
2007	10.1

7.2.1.3 Uncertainties and time series consistency

Uncertainty for CO_2 removals is 8.4%, but for CO_2 emissions calculation – 10%. Here and in further chapters uncertainties, where possible, are calculated from standard deviation of input data

7.2.2 Land Use Changes to and from Forest Land (CRF 5A2 and 5B2.1, 5C, 5D2.1, 5E2.1, 5F2.1)

Forest area is increasing due to natural afforestation of abandoned agricultural areas, generally belonging to the category Grassland. Afforestation is also favoured by soil type of abandoned lands, climatic conditions and reduced human activities.

7.2.2.1 Source category description

Land Use Change to Forest Land changes in carbon stock is estimated in 2 pools (above-ground biomass, below-ground biomass) on forest areas, which is younger than 20 years. Organic material losses in drained soils aren't included in calculation, because area of afforested organic soils is insignificant and uncertainty of calculations is much higher, than result of calculations of emissions.

This sector covers carbon uptake associated with annual growth increment, which is calculated relating with average annual growth rate per category. No carbon release from the commercial harvest is estimated for this category because it is not allowed in this age. Result of recalculation – net emissions are shown in Figure 7.2.4.

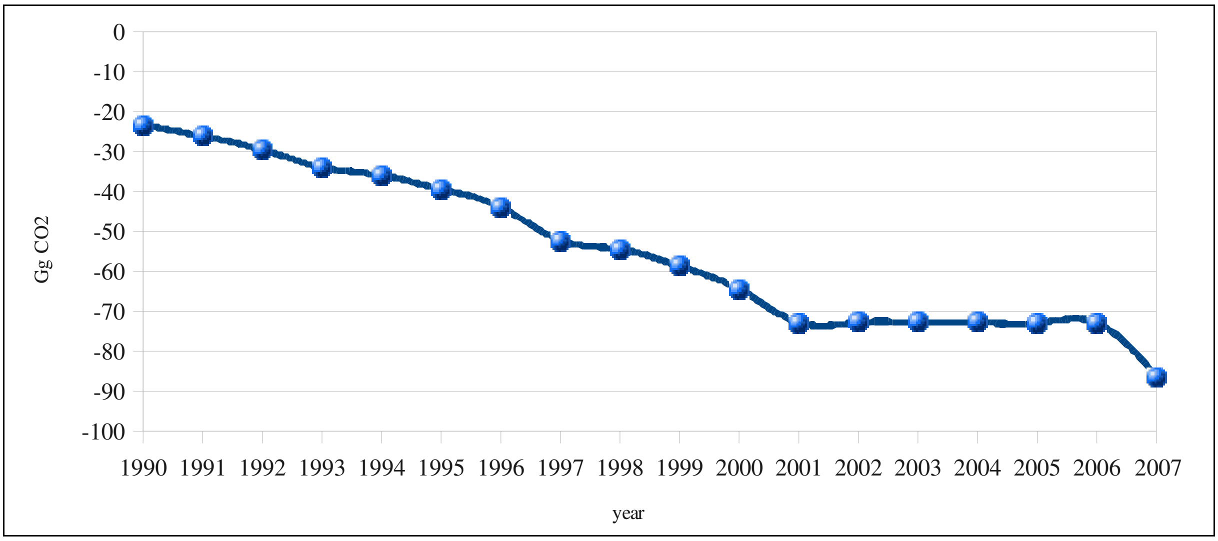


Figure 7.2.4 Net emissions & removals – Land converted to forest land (Gg of CO_2)

7.2.2.2 Methodological issues

Methods

Default method (IPCC GPG-LULUCF, 2003) which requires the biomass carbon loss to be subtracted from the biomass carbon increment for the reporting year is used. All calculations were done in the same manner as in case with Forest land remaining forest land.

Yearly increment of biomass was calculated specifically for these areas according to forest types, therefore it differs from the average increment in Forest land remaining forest land.

Yearly increment of stem volume from 1990 to 2007 in the Land converted to forest land is shown in Figure 7.2.5.

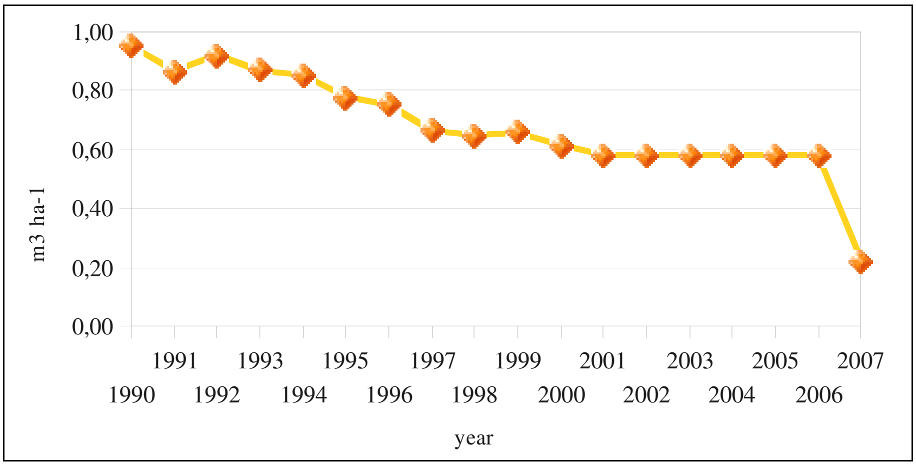


Figure 7.2.5 Yearly increment of stem volume in the Land converted to forest land

Emission factors and other parameters

Assumptions that have been made for calculation are shown in Table 7.2.1 (identical to the ones in category Forest land remaining forest land).

Activity data

Activity data were provided by NFI. Sample plots growing on non-forest land and fitting to the forest definition, but younger than 20 years, were separated from others. In time period between 1990 and 2006 area of this category reduced due to recalculation of increment – as soon as the stand became less than 1 year old, it was moved to Grassland category.

7.2.2.3 Uncertainties and time series consistency

Uncertainty for CO_2 removals is 11.9%.

7.3 CROPLAND (5 B)

7.3.1 Source category description

CO_2 removals from single trees and groups of trees located on lands marked as a cropland in the State land inventory, which where measured within the scope of the first round of NFI, are allocated under category Cropland. The emissions of CO_2 from cropland in 2007 were 209.4 Gg. Removals from croplands were recalculated according to data provided by NFI from 1990 to 2006. CO_2 emissions are released from agricultural soils using different management practices and liming of agricultural soils. In submission of 2007 emissions from organic soils are included (- 78.82 Gg of C in total). CO_2 emissions associated with liming of agricultural lands in 2007 were 4.71 Gg of CO_2. Result of recalculation – net emissions are shown in Figure 7.3.1.

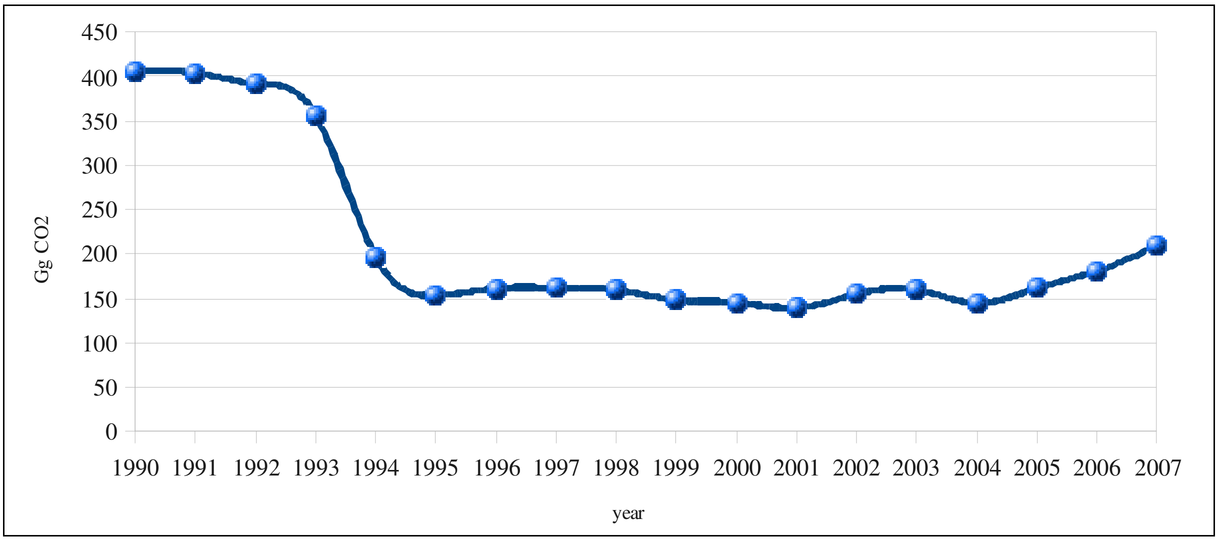


Figure 7.3.1 Net emissions & removals – Cropland (Gg of CO_2)

7.3.2 Methodological issues

Methods

CO_2 removals and emissions from croplands were calculated according to IPCC GPG-LULUCF, 2003 using methodology utilized in calculation of emissions and removals on Forest lands.

Emissions from organic soils are calculated using equation 3.3.5 IPCC GPG-LULUCF, 2003:

$$DELTAC_{cc\,Organic} = \sum C * (A * EF)_c \quad where$$

$DELTAC_{cc\,Organic} - CO_2\, emissions emissions\ from\ cultivated\ organic\ soils in\ cropland\ remaining\ cropland,\ tonnes\, C\, yr^{-1}$
$A - land\ area,\ ha$
$EF - emission\ factor,\ tonnes C\ ha^{-1}\, yr^{-1}$

The amount of carbon released is converted to CO_2 by multiplying with 44/12

CO_2 emissions from liming have been calculated using IPCC GPG-LULUCF, 2003. In inventory was included data about limestone ($CaCO_3$). Carbon is converted to CO_2 by multiplying with 44/12.

Emission factors and other parameters

For CO_2 emission calculation regarding organic soils and agricultural lime application were used default emissions factors and rate (Table 7.3.1) from IPCC GPG-LULUCF, 2003. Average calculated above-ground woody biomass increment per year was used to estimate removals from Croplands. All calculations of increment and total biomass in this and other categories were done within NFI database using specially designed spreadsheet model.

Table 7.3.1 Fractions and emission factors

Annual loss rate for Upland crops (Mg/ha/yr)	1.0
C conversion factor for Limestone $Ca(CO_3)$	0.12
Annual emission factor for cultivated organic soils	1 tonnes C ha $^{-1}$ yr $^{-1}$

Activity data

Activity data regarding total cropland area were obtained from State Land Service and information from MoA. Activity data about wooden vegetation on croplands, including orchards, were obtained from NFI. For CO_2 emission calculation of CSB data about sown area was used according to UNFCCC ERT recommendations (Table 7.3.2). Area of orchards wasn't used any more due to switching to data provided by the NFI, where all woody vegetation is summarized together.

Table 7.3.2 Areas of Cropland, th.ha

	Cropland area	Sown area	Area of organic soils	Area covered by woody vegetation
1990	1723	1627	113.9	0.6
1991	1723	1621	113.5	0.6
1992	1724	1572	110.0	0.6
1993	1710	1426	99.8	0.6
1994	1735	1195	83.7	0.9
1995	1740	930	65.1	0.9
1996	1744	986	69.0	0.9
1997	1743	1003	70.2	0.9
1998	1830	983	68.8	0.9
1999	1870	912	63.8	0.9
2000	1880.12	881	61.7	0.9
2001	1873.64	870	60.9	0.9
2002	1900.05	878	61.5	0.9
2003	1861.29	851	59.6	0.9
2004	1850.03	899	62.9	0.9
2005	1822.63	1000	70.0	0.9
2006	1807.43	1123	78.6	0.9
2007	1188.10	1126	78.8	1.0

Activity data about limestone was obtained from CSB (Table 7.3.3). The used lime very fluctuated as it is shown in the Table 7.3. The fluctuation could be related due to farms submitted information to CSB.

Table 7.3.3 Limes used per ha of area treated (t/ha)

90-95	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
3.5	3.1	1.2	1.9	2	3.3	6.1	10.2	13.9	2.9	3.5	1.5	3.4

The development of the area estimate for organic soils for period 1990 – 2007 is described in Chapter 6 Agriculture.

Cropland area was estimated using data provided by CSB, taking in account changes the area of croplands in compare to the previous years.

Due to the fact, that sample plots of the NFI covers all of the country area, including croplands and orchards, it is possible to calculate increment of woody biomass using these data.

Standard variables and equations provided in IPCC GPG-LULUCF, 2003 were used in calculations. Weighted average wood density according to the Table 3A.1.9-1 Basic wood densities of stem wood (tonnes dry matter m^{-3} fresh volume) for boreal and temperate species was calculated from the data provided by NFI to estimate biomass and default factor (1.3) from Table 3A.1.10 Default values of biomass expansion factors (BEFS) were used in connection with growing stock of biomass to recalculate above-ground biomass. Default factor (0.32) from Table 3A.1.8 Average underground to aboveground biomass ratio (root-shoot ratio, R) in natural regeneration by a broad category (tonnes dry matter tonne dry $matter^{-1}$) was used to calculate root biomass.

7.3.3 Uncertainties and time series consistency

Uncertainty of increment of growing stock of woody biomass on croplands in 2007 is 74.2 %, and it should be taken in account in evaluation of these data. In the previous years, after recalculation, uncertainty varies from 108 to 121%. Additional work has to be done to estimate allometric biomass functions for big single trees and small groups of trees, which are a common source of biomass on croplands.

7.4 GRASSLAND (CRF 5.C)

7.4.1 Source category description

This source category includes CO_2 removals and emissions from Grassland remaining grassland.

CO_2 removals from bush land and abandoned managed land overgrowing by woody vegetation corresponding to forest definition are moved from this category to the Forest land remaining forest land (average age of vegetation is more than 20 years) and Forest land converted to forest land (average age of woody vegetation is less than 20 years). Therefore this category includes only removals corresponding to single trees and groups of trees which doesn't fit to definition of forest land, as well as CO_2 emissions from cultivated organic soils and emissions from burning of last year's grass. Taking in account, that the NFI doesn't provide historical data about land use and a rather significant area of Grassland converted to Forest land can return to the previous state and vice versa within one or two years, because of cutting of grass, small trees and bushes, it is possible, that certain area of Grassland has uncertain status. Actual area of those "dynamic" Grasslands will be clear after completion of second round of the NFI. The fluctuations of definitions of land use don't have impact on calculation of removals, because actual increment data are used to obtain results.

Total emissions from category Grassland remaining grassland in 2007 were -39.2 Gg of CO_2. Results of recalculation – net emissions are shown in Figure 7.4.1. Significant increase of emissions in 2006 is associated with warm and dry weather and lot of wildfires as a result. Area of wildfires in this year was about 10 more than in the previous year (Table 7.4.2).

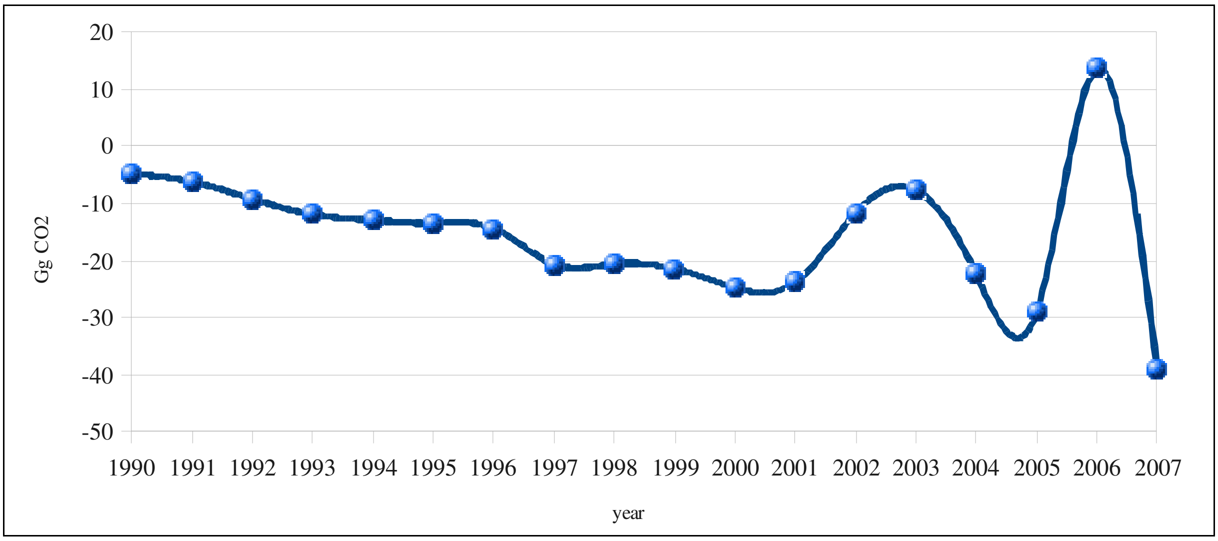


Figure 7.4.1 Net emissions & removals – Grassland (Gg of CO_2)

7.4.2 Methodological issues

Methods

For CO_2 removals calculation IPCC GPG-LULUCF, 2003 was used. CO_2 emissions regarding cultivated organic soils and burning were determined according to IPCC GPG LULUCF, 2003, too.

Actual increment of biomass on grasslands estimated within the scope of NFI was taken as a source for the calculations of emissions and removals.

Emission factors and other parameters

Average increment, 1.83 m^3 ha^{-1} yearly, and corresponding area of grasslands covered by woody vegetation (20.68 th.ha) were used to calculate carbon removals on grasslands. The trend of aboveground biomass increment on grasslands in previous years calculated according to radial increment of trees in NFI sample plots is shown in Figure 7.4.2.

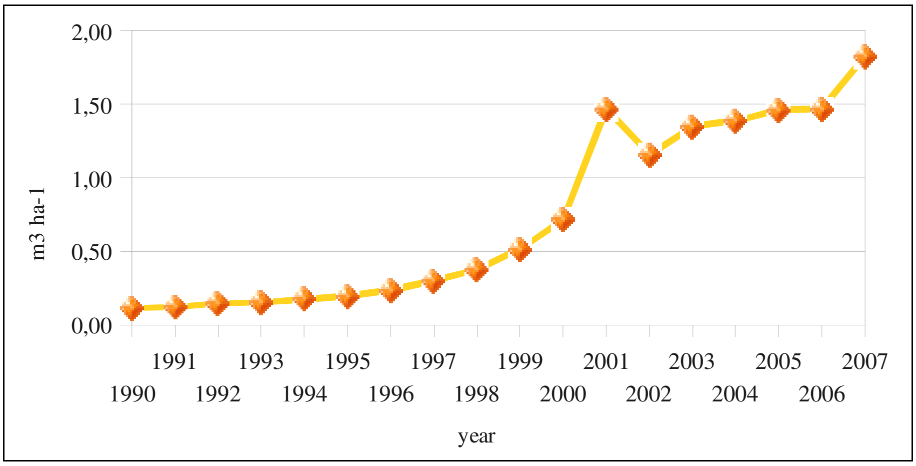


Figure 7.4.2 Average aboveground biomass increment in grasslands, m^3 ha^{-1} $year^{-1}$

Biomass conversion factors for recalculation to CO_2 were taken to IPCC GPG-LULUCF, 2003 according to methodology utilized in calculation of emissions and removals on Forest lands.
For organic soils the default emission factor for grassland (0.25 t C ha^{-1} yr^{-1}) was used, IPCC GPG-LULUCF, 2003, Table 3.4.6.

Emission factors for calculation of emissions related to burning of last year's grass (g kg^{-1} of dry matter combusted) are shown in the Table 7.4.1.

Table 7.4.1 Default emission factors for emission calculation related burning of last year's grass[4]

CO_2	1498
CO	59
CH_4	2
NO_x	4
N_2O	0.1

Mass of available fuel is used as 2100 kg d.m. ha^{-1}according to IPCC GPG-LULUCF, 2003. Fraction of the biomass combusted, dimensionless is used 0.5 according to IPCC GPG-LULUCF, 2003.

Activity data

Activity data regarding bush land and abandoned area were obtained from State Land Service and information from MA.

Area of burning of last year's grass from SFRS (Table 7.4.2) and data are available started from 1993.

[4]IPCC GPG-LULUCF, 2003

Table 7.4.2 Area of last years grass

Year	Area, ha
1993	21
1994	98
1995	526
1996	1224
1997	576
1998	1255
1999	2685
2000	2262
2001	4800
2002	11547
2003	14335
2004	6717
2005	2089
2006	25806
2007	4048

7.4.3 Uncertainties and time series consistency

Uncertainty of increment of woody biomass on Grassland is 55.66%. As well as in case with Cropland, allometric biomass functions should be elaborated to increase precision of obtained data.

7.5 WETLANDS (CRF 5 D)

7.5.1 Source category description

Total area of wetlands was taken from CSB, then area of wetlands fitting to the forest definition was subtracted and moved to Forest lands. Residual area of wetlands is 320.8 th.ha.

Source data for estimation of increment of biomass were taken from NFI by filtering those wetlands covered by woody vegetation, which doesn't fit to forest definition.

Total emissions/removals from category Wetland remaining wetland in 2007 were -47.2 Gg of CO_2.

Results of recalculation – net emissions are shown in Figure 7.5.1.

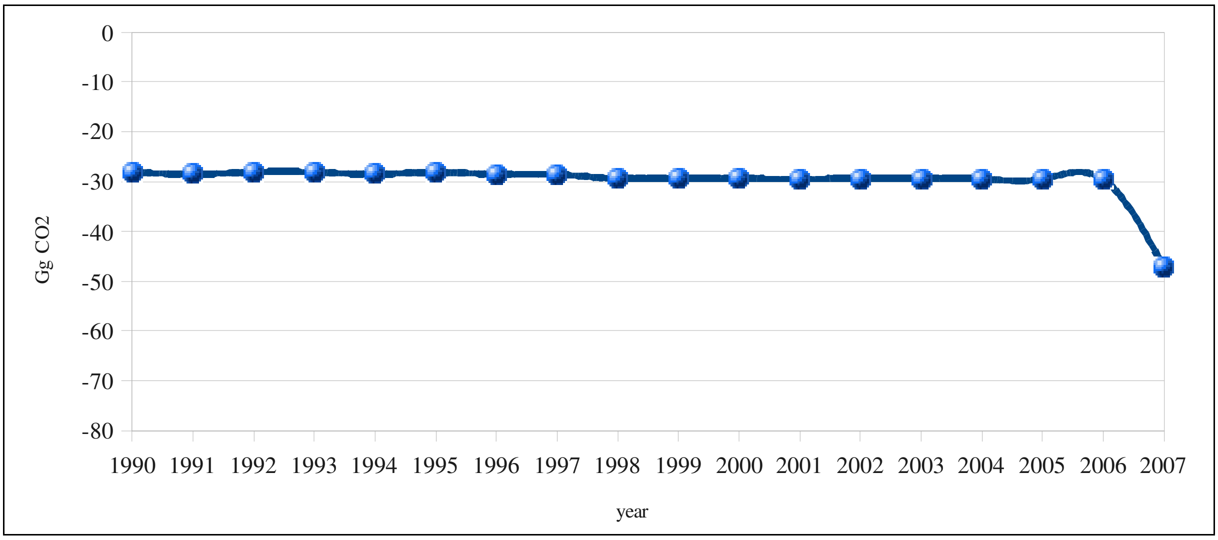


Figure 7.5.1 Net emissions & removals – Wetlands (Gg of CO_2)

7.5.2 Methodological issues

Methods

For CO_2 removals calculation IPCC GPG-LULUCF, 2003 was used. Actual increment of biomass on wetlands estimated within the scope of NFI was taken as a source for the calculations of emissions and removals.

Emission factors and other parameters

Average increment, 0.19 m^3 ha^{-1} yearly (in 2007), and corresponding area of wetlands covered by woody vegetation (162.68 th.ha) were used to calculate carbon removals on wetlands.

Biomass conversion factors for recalculation to CO_2 were taken to IPCC GPG-LULUCF, 2003 according to methodology utilized in calculation of emissions and removals on Forest lands (Chapter Forest Land (CRF 5A)).

Activity data

Remaining area of wetlands, which doesn't fit to forest land definition, is 320.8 th.ha (Table 7.5.1).

Table 7.5.1 Area of wetlands

Year	Total area, th.ha	Area covered by woody vegetation, th.ha
1990	570.0	157.9
1991	570.0	158.5
1992	497.0	159.0
1993	482.4	159.0
1994	467.8	159.0
1995	453.2	159.0
1996	438.6	159.6
1997	424.0	160.4
1998	456.0	161.5
1999	466.0	161.5
2000	484.2	162.1
2001	483.0	168.9
2002	485.8	163.8
2003	485.3	164.9
2004	480.8	165.5
2005	486.7	165.5
2006	486.1	168.9
2007	320.8	162.7

7.5.3 Uncertainties and time series consistency

Average uncertainty of increment of woody biomass on wetlands in 2007 is 29.47%. As well as in case with Grassland and Cropland, allometric biomass functions should be elaborated to increase precision of obtained data.

7.6 SETTLEMENTS (CRF 5E)

7.6.1 Source category description

This land-use category includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other land-use categories. Settlements include all classes of urban tree formations (trees grown along streets, in public and private gardens, and in different kinds of parks, provided such trees are functionally or administratively associated to cities, villages, etc.). The focus of estimation is on change in carbon stocks in living biomass.

Area of settlements initially was taken from CSB, but in contrast to previous reporting periods – forest infrastructure is moved to settlements, increasing total area and removals in this category.

Total emissions from category Settlements remaining settlements in 2007 were -393.25 Gg of CO_2.

Results of recalculation – net emissions are shown in Figure 7.6.1.

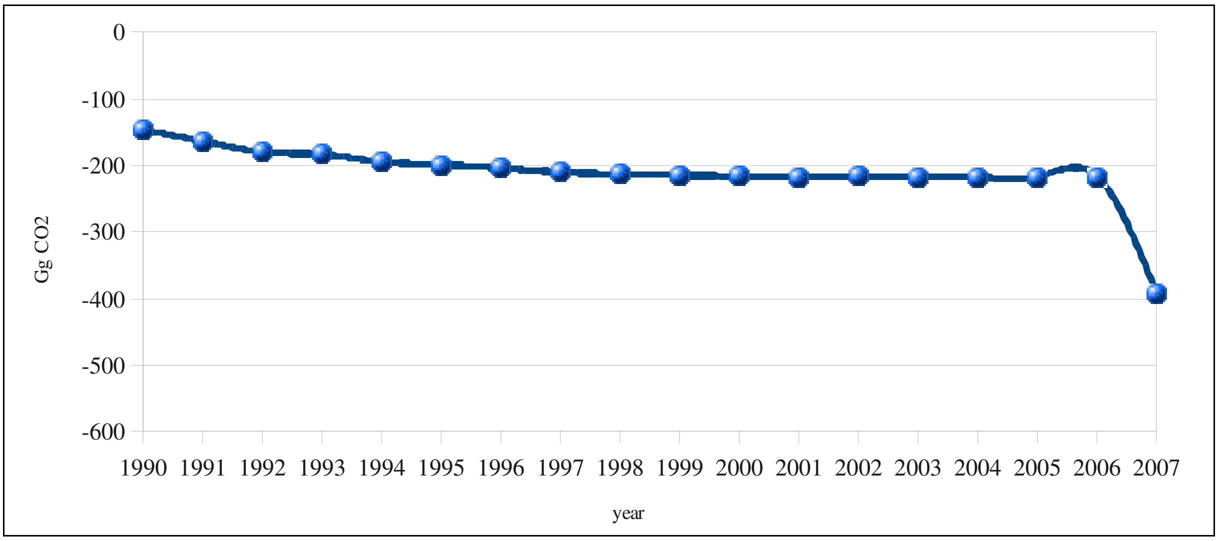


Figure 7.6.1 Net emissions & removals – Settlements (Gg of CO_2)

7.6.2 Methodological issues

Methods

For CO_2 removals calculation IPCC GPG-LULUCF, 2003 was used. Actual increment of biomass on settlements estimated within the scope of NFI was taken as a source for the calculations of emissions and removals.

Standard methodology described under Chapter 7.2.1.2 is used to recalculate increment of biomass to CO_2 removals.

Emission factors and other parameters

Average increment, 1.74 m^3 ha^{-1} yearly (in 2007), and corresponding area of settlements covered by woody vegetation (143.5 th.ha) were used to calculate carbon removals on settlements. The trend of aboveground biomass increment on Settlements in previous years calculated according to radial increment of trees in NFI sample plots is shown in Figure 7.6.2.

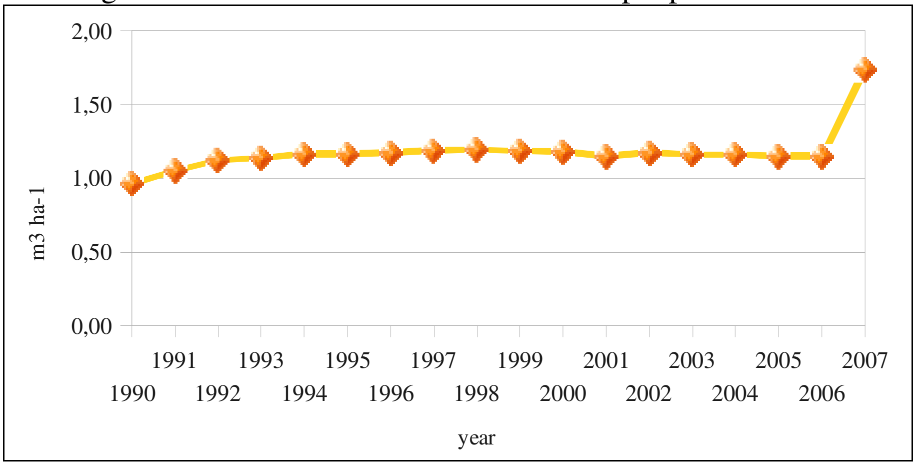


Figure 7.6.2 Average aboveground biomass increment in Settlements, m^3 ha^{-1} $year^{-1}$

Biomass conversion factors for recalculation to CO_2 were taken to IPCC GPG-LULUCF, 2003 according to methodology for the calculation of emissions and removals on Forest lands.

Activity data

Area of settlements, including forest infrastructure, according to CSB and NFI data in 2007 was 245.3 th.ha (Table 7.6.1).

Table 7.6.1 Area of settlements

Year	Area, th.ha
1990	143.0
1991	143.0
1992	165.7
1993	188.3
1994	211.0
1995	233.7
1996	256.3
1997	279.0
1998	310.0
1999	316.0
2000	285.5
2001	294.5
2002	282.4
2003	277.0
2004	268.0
2005	228.4
2006	227.6
2007	245.3

7.6.3 Uncertainties and time series consistency

Uncertainty of increment of woody biomass on Settlements in 2007 was 24.76%. As well as in case with the Cropland, Grassland and Wetland allometric biomass functions should be elaborated to increase precision of obtained data.

7.7 OTHER LANDS (CRF 5F)

7.7.1 Source category description

This land-use category includes generally forest land, which doesn't fit into other land-use categories, like glades, sand dunes and moorlands. The focus of estimation is on change of carbon stocks in living woody biomass.

Area of other lands is taken from NFI. Like in case of other land use categories increment of biomass is recalculated from 2007 to 1990, using information about radial increment from NFI.

Total emissions from category Other lands in 2007 is -18.09 Gg of CO_2.

Results of recalculation – net emissions are shown in Figure 7.7.1.

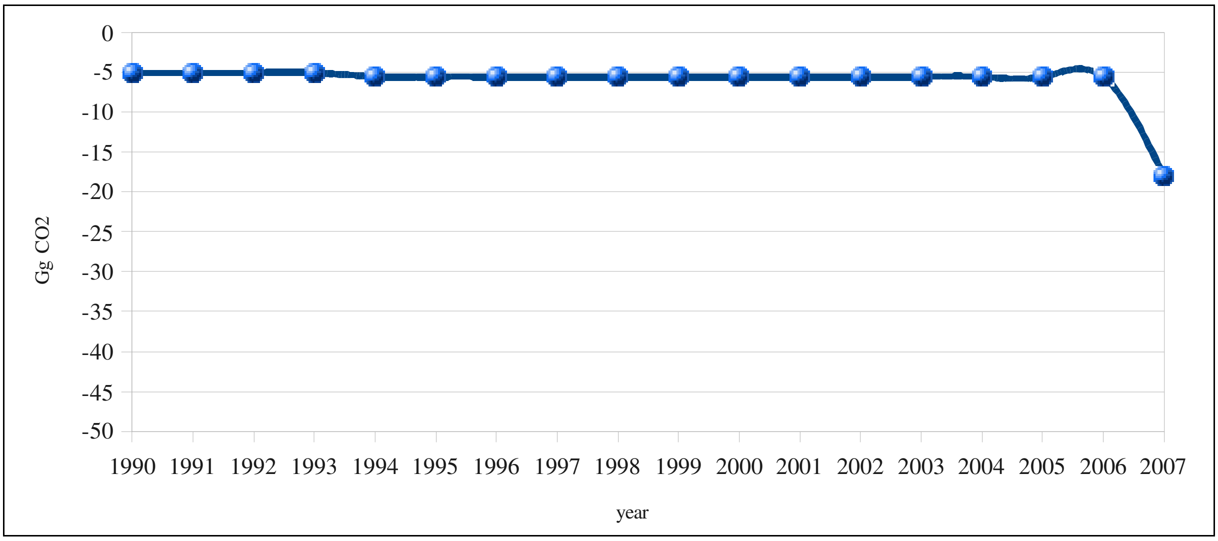


Figure 7.7.1 Net emissions & removals – Settlements (Gg of CO_2)

7.7.2 Methodological issues

Methods

For CO_2 removals calculation IPCC GPG-LULUCF, 2003 is used. Actual increment of biomass on the Other land estimated within the scope of NFI is taken as a source for the calculations of removals.

Standard methodology described under Chapter Forest Land (CRF 5.A) is used to recalculate increment of biomass to CO_2 removals.

Emission factors and other parameters

Average increment, 0.37 m^3 ha^{-1} yearly (in 2007), and corresponding area of Other land covered by woody vegetation (31.54 th.ha) is used to calculate carbon removals on Other land. The trend of aboveground biomass increment on Other land in previous years calculated according to radial increment of trees in NFI sample plots is shown in Figure 7.7.2. Large increment in the Other land in 2007 is associated with one-year-old stands, which weren't taken in account in calculation in previous years due to methodological issues – all one-year-old stands are excluded from this category and moved to other land use categories during the backward increment calculation.

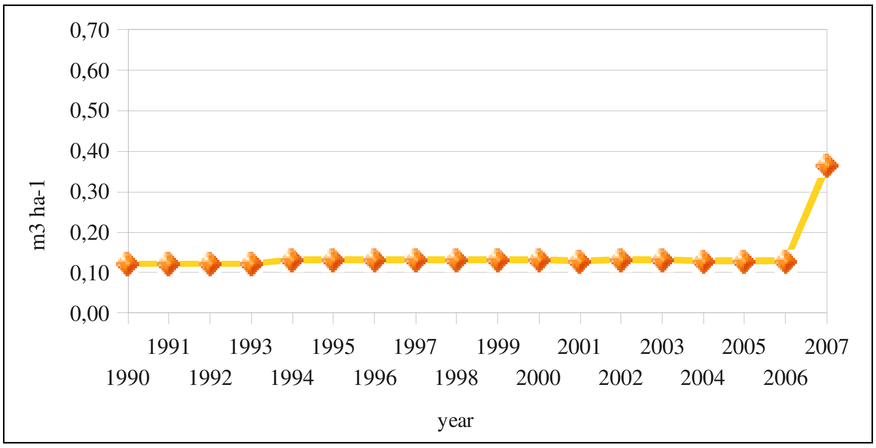


Figure 7.7.2 Average aboveground biomass increment in Other land, m^3 ha^{-1} $year^{-1}$

Biomass conversion factors for recalculation to CO_2 are taken to IPCC GPG-LULUCF, 2003 according to methodology utilized in calculation of emissions and removals on Forest lands (Chapter Forest land (CRF 5A)).

Activity data

Area of Other land according to the NFI data in 2007 is 31.5 th.ha (Table 7.7.1).

Table 7.7.1 Area of Other lands

Year	Total area, th.ha
1990	26.5
1991	26.5
1992	26.5
1993	26.5
1994	26.8
1995	26.8
1996	26.8
1997	26.8
1998	26.8
1999	26.8
2000	26.8
2001	27.6
2002	26.8
2003	26.8

Year	Total area, th.ha
2004	27.6
2005	27.6
2006	27.6
2007	31.5

7.7.3 Uncertainties and time series consistency

Uncertainty of increment of woody biomass on Other lands in 2007 is 37.22%.

7.8 BIOMASS BURNING (CRF 5V)

7.8.1 Source category description

Biomass burning occurs in many types of land uses causing emissions of CO_2, CH_4, N_2O, CO, and NO_x. This chapter covers biomass burning on forest lands.

Wildfires of managed forests take place in Latvia, but no evidences of burning of forests for land conversion occur. Another source of emissions related to biomass burning is controlled burning of slash during harvesting of mature forest stands. It is rather uncommon practise, but still in use especially in places, where slash can't be extracted for biofuel production due technical or economical reasons.

Area of wildfires in time period between 1990 and 2007 is provided by the State forest service, amount of burned biomass[5] is calculated accordingly to the data provided by the NFI – area of forests corresponding to sample plots, where fire damages are detected, and volume of damaged trees.

Total amount of burned biomass (both in controlled burning and wildfires) corresponds to 185 thsd.kg d.m. and CO_2 emissions – to 338 Gg of CO_2. Emissions of all GHG are a bit smaller, than last year due to smaller area of wildfires in 2007.

7.8.2 Methodological issues

Methods

Standard methods of calculation provided in IPCC GPG-LULUCF, 2003 were utilized. Emissions from wildfires were calculated using equation 3.2.20 IPCC GPG-LULUCF, 2003:

$$L_{fire} = A * B * C * D * 10^6 \quad where$$

L_{fire} – quantity of GHG released due to fire, tonnes of GHG
A – area burnt, ha
B – mass of 'available' fuel, $kg\,d.m.ha^{-1}$
C – combustion efficiency, dimensionless (Table 3A.1.12)
D – emission factor, $g(kg\,d.m.)^{-1}$

Emissions from controlled burning were calculated using equation 3.2.19 and emission ratios from Table 3A.1.15 IPCC GPG-LULUCF, 2003:

5 Trees damaged by fire.

Estimation of non – CO_2 *emissions from C released:*

$$CH_4\ Emissions = (carbon\ released) * (emission\ ratio) * \frac{16}{12}$$

$$CO\ Emissions = (carbon\ released) * (emission\ ratio) * \frac{28}{12}$$

$$N_2O\ Emissions = (carbon\ released) * (emission\ ratio) * \frac{44}{28}$$

$$NO_x\ Emissions = (carbon\ released) * (emission\ ratio) * \frac{46}{14}$$

Emission factors and other parameters

Weighted average wood density according to the Table 3A.1.9-1 Basic wood densities of stem wood (tonnes dry matter m^{-3} fresh volume) for boreal and temperate species is calculated from the data provided by NFI to estimate biomass and default factor (1.3) from Table 3A.1.10 Default values of biomass expansion factors (BEFS) is used in connection with growing stock biomass were used to recalculate above-ground biomass. Underground biomass is not taken in account in this calculation.

For emission calculation from controlled burning of slash in forest default emission factors according IPCC GPG are used (Table 7.8.1).

Table 7.8.1 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 slash was assumed as 20.2% from annual cutting volume according national research [9]. The following assumptions have been made for slash calculation, which was burned (State Forest Service):

- Slash on-site burning 50% in period from 1990 to 1999, the rest 50% left to decay;
- In 2000 – slash burning 30% and 70% left to decay.

From the slash burned on-site, 2/3 is actually burned on-site, and 1/3 is gathered by population and used as fuel wood. Assumptions for calculation are shown in Table 7.7.2.

Table 7.8.2 Factors and parameters used for calculations of change in carbon stock in living biomass

Basic wood density	0.5 ($t_{d.m.}\ m^{-3}$)
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 $t_{d.m.}^{-1}$)

For wildfires default factor (for all boreal forest – 0.34) from Table 3A.1.12 Combustion factor values (proportion of prefire biomass consumed) for fires in a range of vegetation types were used to calculate amount of burned biomass. Emission factors for CH_4, CO, N_2O, NO_x and CO_2 are taken from Table 3A.1.16 Emission Factors (g kg^{-1} dry matter combusted) applicable to fuels combusted in various types of vegetation fires (Table 7.8.3).

Table 7.8.3 Emission factor for each GHG (g $kg_{d.m.}^{-1}$)

CO_2	CH_4	CO	N_2O	NO_x
1532	7.1	112	0.11	0.7

Data about wildfires were recalculated from 1990 using data provided by the State forest service about the area of forest fires.

Activity data

Country level estimates of area burnt provides by the State forest service are used. These data might have rather high level of uncertainty due to the fact, that only perimeter of wildfires is measured, but not distribution of damaged areas within the perimeter. Total area of wildfires on forest lands covered by woody vegetation in 2007 was 271 ha.

Controlled burning is not an issue in Latvia any more due to increased use of slash in forest biofuel production. Incineration of slash on-site takes place only in minor cases in small clear-cuts generally in private forests, when collection and transportation of this material is not possible because of climatic conditions or other factors. This means, that the expert judgement based approach utilized until 2007 can't be applied in future. Instead of this it is necessary to extend NFI to mark type of utilization of slash in clear-cuts and thinning operations. Such approach would give indubitable results, which could be validated in relation to amount of burned biomass using information about harvested volume provided by the State forest service.

7.8.3 Uncertainties and time series consistency

Uncertainty of the volume of damaged trees is 26.4%. Uncertainty of burned area is 20-30%.

7.9 SOURCE - SPECIFIC QA/QC AND VERIFICATION

QC procedures were focused on the processing, handling, documenting, archiving, and reporting procedures that are used for all inventory source and sink categories. In cases where estimates for the LULUCF sector were prepared by institutions other than the inventory agency, the inventory agency requested, that Tier 1 QC procedures (IPCC GPG-LULUCF, 2003) are performed.

The most of the calculations within the scope of LULUCF emissions and removals were done by LSFRI Silava on the base of the NFI data, which has own QC system, for instance, 10% of sample plots are measured twice by the QC team. It is important to mention, that even if total are af certain land use types are determined mistakeously, it doesn't affect result of calculations of removals, because increment of biomass is calculated at sample plot level and weighted averages of mean values are used in further calculations. At the same time the NFI has no impact on systematic mistakes possibly cause by default coefficients used in calculations. This mean, that the most of attention in future should be paid to the improvement of allometric biomass equations necessary for recalculation of biomass and carbon stock according to specie distribution. The final check of calculated data presenting emissions and removals includes calculation backwards to get source data (down to level of data provided by NFI and other institutions). Another check has been done independently by MoA and LEGMA. Before publishing data were repeatedly validated by the experts involved in the reporting.

7.10 RECALCULATIONS

Activity data of wildfires on forest lands were completely recalculated according to information of wildfire areas provided by the SFS and information of damaged wood in wildfire areas provided by the NFI. Removals from Forest lands, Cropland, Grassland, Wetland, Settlements ans Other lands are recalculated from 1990 according to radial increment data from the NFI sample plots. Emissions from drained organic forest soils were recalculated as well using the NFI data. Forest definition given in the Annex to Decision 16 /CMP.1 is used for reporting, starting from 2007, as well as during recalculation of emissions and removals from 1990 to 2006.

Emissions from last years grass burning were recalculated according to ERT recommendations (Centralized review 2008). For submission 2009, mass of available fuel is used as 2100 kg d.m. ha^{-1}according to IPCC GPG-LULUCF, 2003 instead of 4100 kg d.m. ha^{-1}according.

7.11 PLANNED IMPROVEMENTS

This reporting period is the first attempt to switch to NFI data in the CRF reporting in Latvia, showing pros and cons of this approach as well as necessary improvements and extensions to existing methodology of NFI. Complete switch to NFI data will be possible only after finalization of the second round of measurements in all sample plots.

The area of Forest land and initial balance of area of other Land use categories will be recalculated according to the NFI sample plots using remote sensing analysis of satellite images from early 90ths and later years, giving detailed picture of land use dynamics in Latvia.

Forest soil is the most significant storage of carbon. It is planned to integrate soil sampling in limited number of sample plots with following carbon and nitrogen determination into the NFI to estimate dynamics of these elements in soil in 5 years repeated measurement cycle.

8. WASTE (CRF 6)

8.1 OVERVIEW OF SECTOR

Waste management has acquired priory 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 nine 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. Till the end of 2008 - 10 regional waste management plans have been accepted in Cabinet of Ministers, remainder 2 regional plans must be accepted in nearest time.

Main activity data sources for GHG emissions calculations in Waste sector are databases "3-Wastes", "2-Water" [24] and data from CSB [25].

Data on hazardous waste in Latvia have been collected and compiled by LEGMA 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 implemented in the biggest cities in the middle of 1990-ties and on the basis of the assessment 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 in which C acknowledgement is obligation to report on wastes) 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 LEGMA 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. However, for calculation of the emission data about population from CSB were used as activity data.

GHG emissions from Waste sector have been increased since 1990. In 2007, emissions were approximately 0,9% lover than in 1990. In 2007, emissions from the Waste sector were 833,03 Gg CO2 equivalents; it contributes about 6.91 % of total GHG emissions (excluding LULUCF). Total emissions from Waste sector are shown in Figure 8.1.

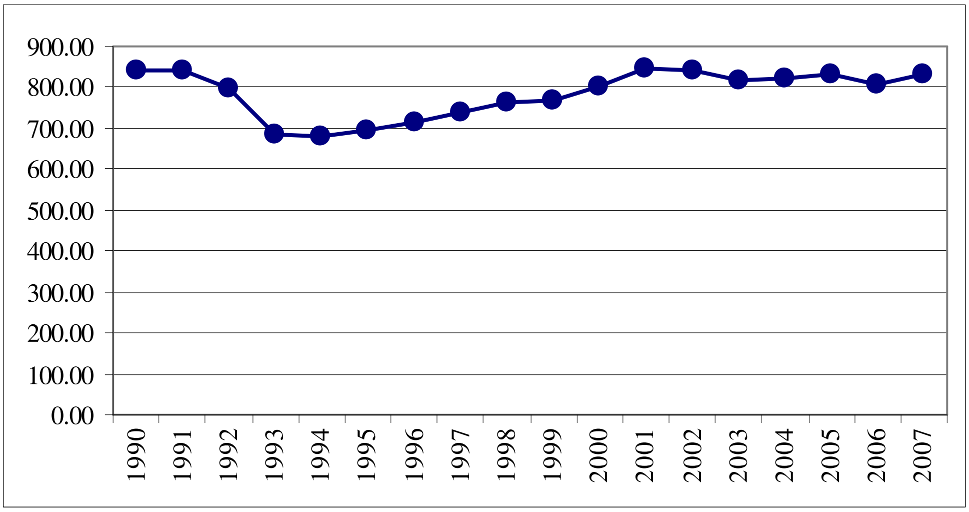


Figure 8.1 Total emissions from Waste sector in CO_2 equivalent (Gg)

In 1993 methane collection from wastewaters was started and emissions from wastewaters decrease. Every year emissions from waste disposal on land increased equable, because First Order Decay (Tier 2) method for calculations is used and methane collection and recovery in landfills is not yet well developed.

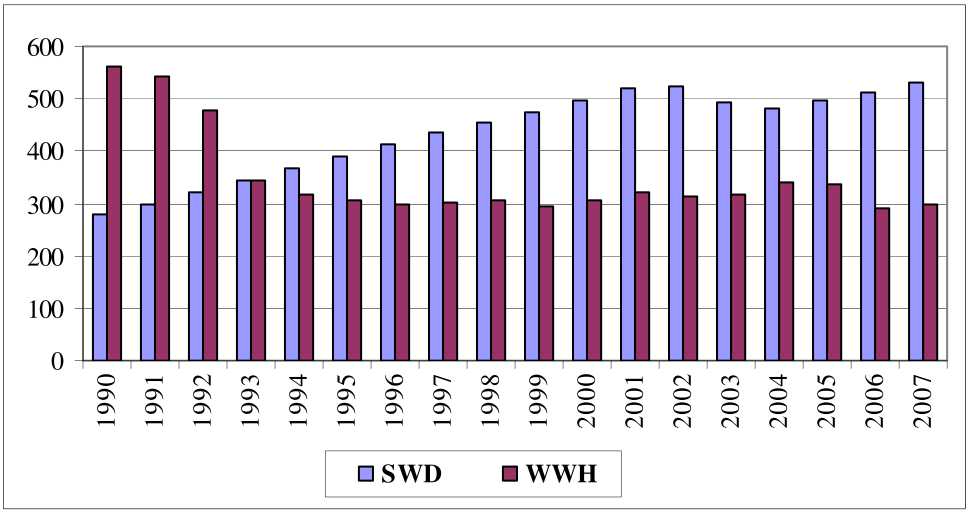


Figure 8.2 Emissions from SWD and WWH sectors in CO_2 equivalent (Gg)

Emissions from Waste Incineration (WI) and Composting (Comp.) in last years, when emissions from these sectors were calculated, are very small in comparison with other sectors (SWD and WWH).

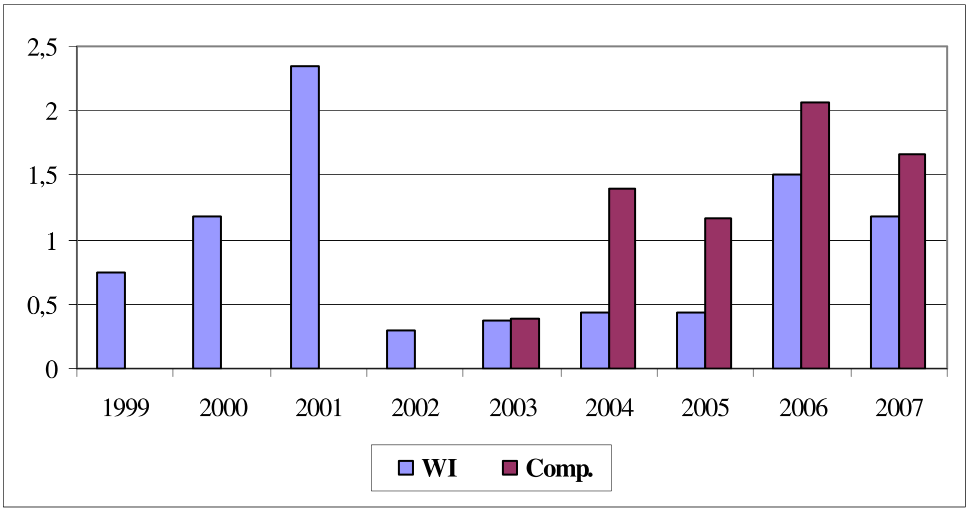


Figure 8.3 Emissions from WI and Comp. sectors in CO_2 equivalent (Gg)

According to the information from LEGMA the total generated amount of waste are shown in Table 8.1.

Table 8.1 Generated wastes in Latvia (Gg)

Year	Municipal (non-hazardous) wastes	Hazardous wastes	Total
2002	821,24	72,26	**893,5**
2003	982,07	25,77	**1007,84**
2004	1136,70	27,49	**1164,19**
2005	1230,62	27,93	**1258,55**
2006	1420,46	45,05	**1465,51**
2007	1386,57	31,56	**1418,13**

To properly evaluate CH_4 emissions from wastewater according to the IPCC 1996 and IPCC GPG 2000, the project *Wastewater Management in Latvia and the Formation of Methane* (2003) was worked out. Equation for calculation is given in section 8.3.2.

N_2O is emitted as the release from sewage purification system and waste incineration. N_2O emissions are estimated only from wastewater treatment plants releases, because N_2O emissions from waste incineration are not possible to estimate without direct measurements. In Latvia that kind of measurements in waste incineration facilities are not done. Incinerated wastes were classified like clinical and hazardous (industrial) wastes. IPCC good practice guidance 1996 and EMEP/CORINAIR methodology do not provide useful factors for N_2O emission calculation.

Data on CO_2 emissions from waste incineration are available only since 1999, for earlier years no information 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

CH_4 emissions from solid waste disposal are a key source. According to level assessment in 2007, when LULUCF not included, CH_4 emissions from solid waste disposal on land contributes about 4% of emissions, when LULUCF is included – 1%. According to trend assessment in 2007, when LULUCF not included, CH_4 emissions from solid waste disposal on land contributes about 7% of emissions, if LULUCF is included – 1%.

To estimate CH_4 emissions with First Order Decay (Tier2) method from landfills, time series for disposed waste amounts till 1970 was developed. Disposed amounts for years 1970 – 1989 were estimated taking into account population and Grand domestic product (GDP). These values were compared with base year (1990) values and time series was developed for disposed amounts. Landfills from 1970 – 1979 are estimated as uncategorised, from 1980 – 1989 landfills estimated as 50% - uncategorised and 50% - managed. Since year 1990 all waste disposal sites are estimated as managed sites, because waste levelling taking place in Latvia's landfills. Some small landfills do not have waste levelling in these years, but waste amount, which are disposed in these landfills, are very small. Disposed amount and landfill type for 1990 – 2000 are expert estimation, which is done according to some waste projects in biggest Latvia's cities. According to information, which is received from Regional environmental boards (REB), number of active waste disposal sites decreased from 558 in 1997 to 84 in 2007. Data about waste disposal on land for 2001 - 2007 are taken from database "3-Wastes". All calculations are done for unsorted wastes, because waste composition is hard to estimate for previous years.

Table 8.2 Estimated Disposed amounts from 1970 – 2000

Year	Population	Disposed waste amount (Gg)	GDP/capita (in Ls by 2000 prices)
1970	**2351903**	342,38	1794
1971	2400000	346,27	1794
1972	2400000	346,27	1794
1973	2400000	346,27	1794
1974	2400000	346,27	1794
1975	2400000	346,27	1794
1976	2400000	346,27	1794
1977	2400000	346,27	1794
1978	2400000	346,27	1794
1979	**2502816**	354,58	1794
1980	2502816	354,58	**1794**
1981	**2514640**	356,05	1800
1982	2550000	363,15	1850
1983	2550000	367,39	1900
1984	2550000	375,87	2000
1985	2550000	382,32	**2076**
1986	**2587716**	395,89	2200
1987	2600000	405,37	2300
1988	2600000	413,85	2400
1989	**2666567**	427,72	2500
1990	**2668140**	**431,5**	**2543**
1991	2600000	458,18	2300
1992	2600000	484,94	2100
1993	2600000	511,66	1900
1994	2600000	538,41	1700
1995	**2500580**	565,1	**1451**
1996	**2469531**	591	1600
1997	**2444912**	581	1700
1998	**2420789**	557	1800
1999	**2399248**	544	1900
2000	**2377383**	600	**1975**

Figures in bold is primary data from National statistics. All other years are estimated according to these figures. Disposed amount are estimated according to GDP and population changes. Population amounts for year 1971 -1978, 1982 – 1985, 1987 – 1988, 1991 – 1994 are round off, because correct figures are not available. GDP data from 1970 – 1979 are taken the same as 1980. 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. When this plan will be realized, data collection about disposed municipal wastes amounts and its composition will become more accurate. Disposed waste amounts in Latvia are shown in Figure 8.4.

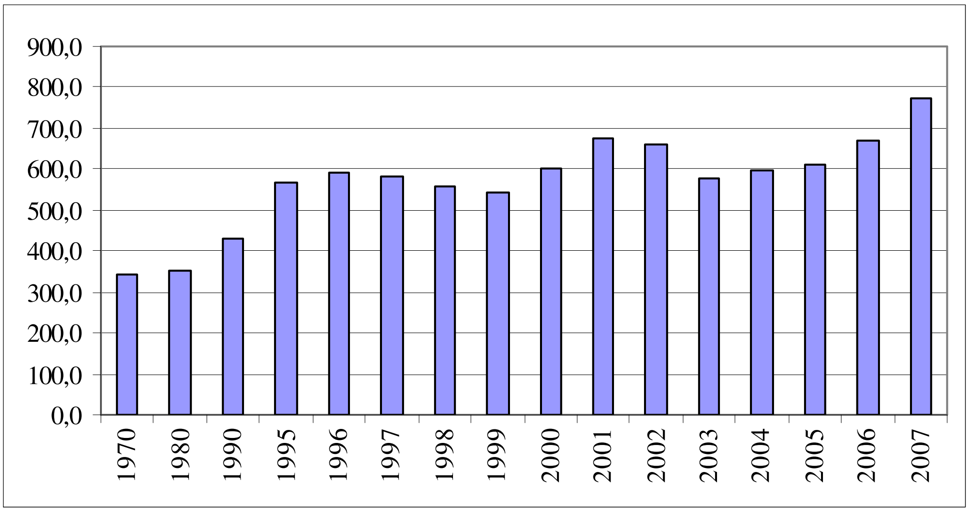


Figure 8.4 Disposed waste amounts in Latvia (Gg)

Since October 2002 CH_4 recovery from landfills are in progress. For 2007 only in two waste facilities (SIA Getlini EKO, SIA Liepajas RAS) CH_4 recovery was realised. 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 total 5,155 Gg of CH_4 was collected and recovered. Recovered methane amount is presented in Figure 8.5.

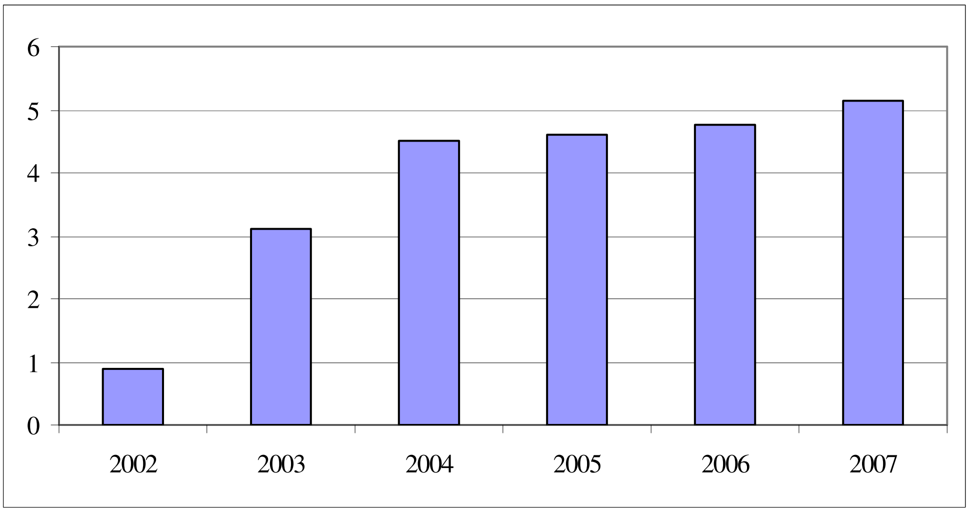


Figure 8.5 Recovered CH_4 from waste landfills (Gg)

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.

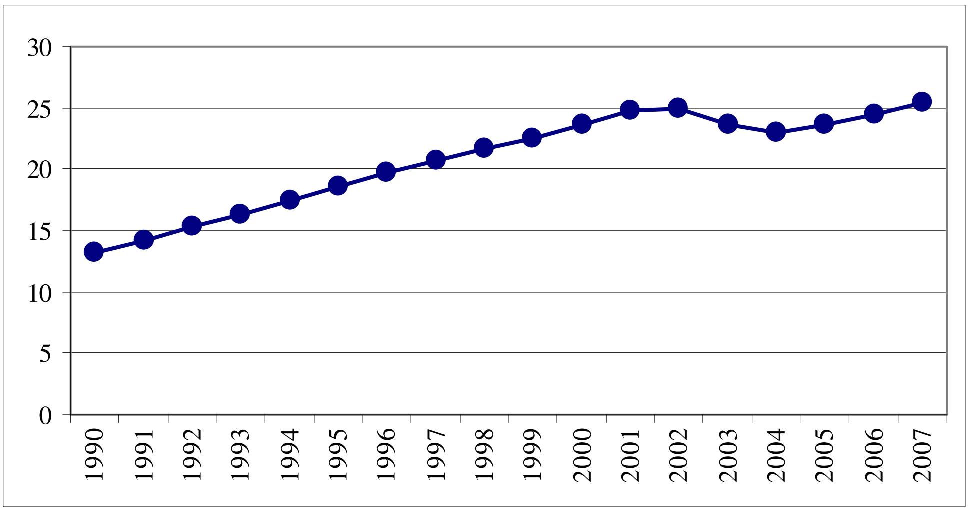


Figure 8.6 CH_4 emissions from waste landfilling (Gg)

8.2.2 Methodological issues

IPCC GPG 2000 (Tier 2) method is used for CH_4 emissions calculation and is based on equations:

$$L_o\ CH_{4\ \text{potential emission}} = MSW_L * MCF * DOC * DOC_F * F * 16/12$$

$$CH_{4\,RE(t)} = \sum_n (L_{o_n} * (e^{-k(t-(x-1)-1)} - e^{-k(t-(x-1))}))$$

$$CH_{4\ \text{year emission (t)}} = [CH_{4\ RE(t)} - R_{(t)}] * (1 - OX)$$

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
Uncategorised – 0,6
DOC *– degradable organic carbon (0,18);*
DOC_F *– fraction of DOC dissimilated (0,6);*
F *– fraction of CH_4 landfill gas (0,5);*
R *– recovered CH_4 (Gg);*
$CH_{4\ RE}$ *– methane real emission;*
k *- methane generation coefficient (1/y) (0,05);*
x *– calculation starting year;*
n *– number of years, when calculations are started;*
t *– inventory year.*

All emissions factors are default factors from IPCC 1996 guidelines, because Latvia hasn't national emission factors.

8.2.3 Uncertainties and times series consistency

Emission factors uncertainty is estimated as 15%. It is calculate from IPPC default uncertainties for many factors, which are used in methane emissions calculations. 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 2001.

8.2.4 Source-specific QA/QC and verification

QA/QC procedure for waste disposing is done according LEGMA internal OA/QC program. Data and calculation checking is done.

8.3 WASTEWATER HANDLING (CRF 6.B)

8.3.1 Description of source categories

LEGMA data show that 210 million m³ of wastewater in 2007 was discharged, from which 137 million m³ were treated by different wastewater treatment plants, ~75% from which were biological plants.

CH_4 emissions from Wastewater Handling are key source contributing 2% according to Level Assessment in 2007 when LULUCF is not included.

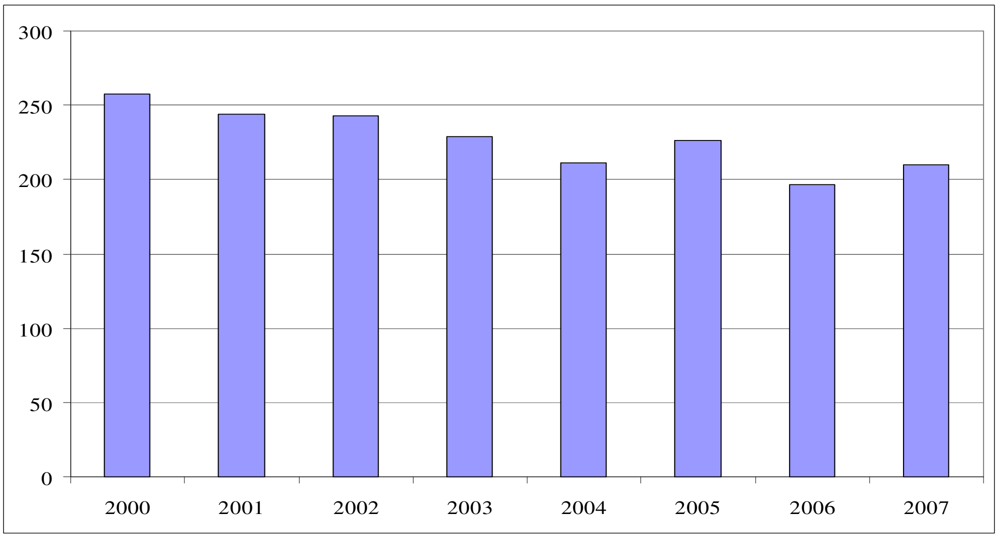


Figure 8.7 Amount of discharged wastewater in last eight years (mio m^3)

In most cases urban wastewaters are treated in aerobe systems in Latvia. However, the accurate breakdown of amount aerobic and anaerobic processes during treatment of municipal waste water is unknown; therefore assumption that all the municipal waste water is treated in anaerobic plants. Such assumption can make the emissions from municipal waste water handling sector overestimated what most likely is so. Only one waste water treatment plant in Latvia (UWWTP "Daugavgriva" in Riga – capital of Latvia) has methane tanks for recovery of methane produced during the treatment process; therefore there is assumption the all methane, generated by population served with waste water collection and treatment service by UWWTP "Daugavgriva", is recovered.

Because of Latvia's climate sludge fields produce negligent amounts of methane (CH_4), therefore calculations of CH_4 emissions from municipal wastewater sludge were not carried out [14].

The handling of urban wastewater is the main source of the CH_4 emissions from Wastewater Handling sector. Emission from food processing industry is much lower, reaching ~9 % (2007) from total CH_4 emission from Wastewater Handling sector.

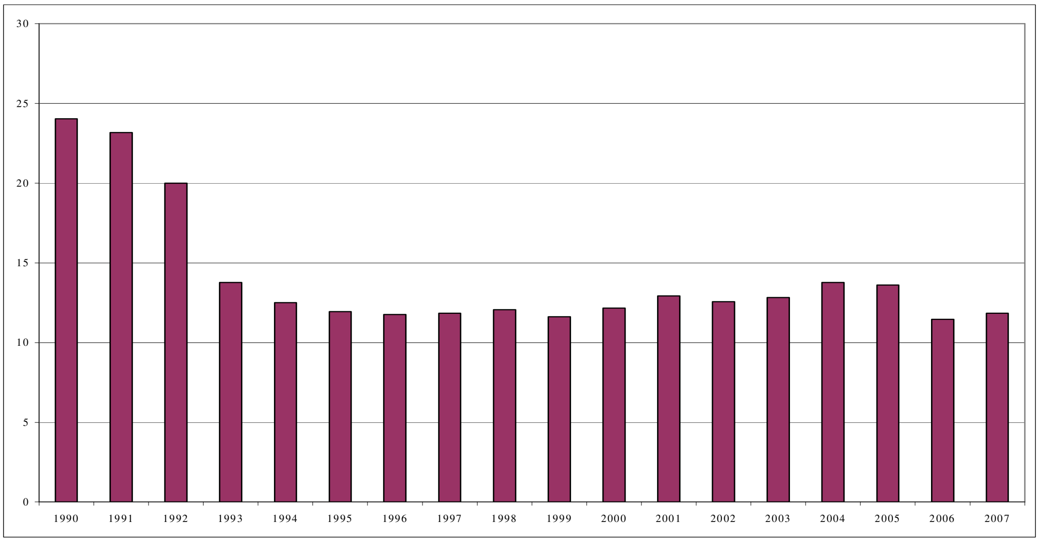


Figure 8.8 Total emissions of methane from wastewater handling, Gg

Amount of methane emissions was recalculated due to following factors:

1. Emissions from urban waste water handling were updated because of number of national population was revised and harmonized between sectors.
2. Emissions from industrial waste water handling were recalculated because mistake was found in previous calculations during the QC/QA procedure.

The calculations regarding industrial wastewater in this report take into account amount of all the wastewater that is produced as result of food industry when ether it is treated in local treatment plants of factory or is transferred to public wastewater treatment plant.

8.3.2 Methodological issues

To calculate CH_4 emissions from wastewater treatment, the control equation offered by IPCC was used:

$$WM = P \times D \times SBF \times EF \times EF \times FTA \times 365 \times 10^{-12}$$

where:
WM – total CH_4 emissions from municipal wastewater in one year, Tg;
P – number of population; P = 2,281 million;
D – organic load (BOD); D = 60 g BOD/person;
SBF – easy degradable part of BOD; SBF = 0,5;
EF – emission factor; EF = 0,6 g CH_4/g BOD;
FTA – anaerobically degradable part of BOD; FTA = 0,8.

$$WM = 2,282 \times 10^{6} \times 60 \times 0,5 \times 0,6 \times 0,8 \times 365 \times 10^{-12} = 0,012\ (Tg)$$

Wastewater from Riga and partly from Jurmala is treated by UWWTP "Daugavgriva", and methane is collected as a biogas as mentioned above. Therefore emissions have to be decreased due to recovery of methane generated from waste water in Riga (with 0,633 mio inhabitants connected to treatment plant [29]), and thus:

$$WM = 0.0120 - 0.633 \times 10^{6} \times 60 \times 0.5 \times 0.6 \times 0.8 \times 365 \times 10^{-12} = 0.0087\ (Tg)$$

Table 8.3.1 Activity data, methane recovered and emission from domestic waste water treatment

Year	Number of national population, th.	Methane recovered, Gg	Emission, Gg CH_4
1990	2667,887	0	14,022
1991	2657,709	0	13,969
1992	2642,355	0	13,888
1993	2584,792	4,483	9,102
1994	2539,812	4,405	8,944
1995	2499,327	4,335	8,801
1996	2468,148	4,281	8,692
1997	2443,414	4,238	8,605
1998	2419,195	4,196	8,519
1999	2397,557	4,159	8,443
2000	2375,339	4,205	8,280
2001	2364,254	3,154	9,273
2002	2345,768	3,154	9,176
2003	2331,480	3,154	9,101
2004	2319,203	3,416	8,773
2005	2306,434	3,348	8,775
2006	2294,590	3,327	8,733
2007	2281,305	3,327	8,663

Emission from industrial wastewater was calculated as:

$$WM = P \times V \times C \times PFM \times 10^{-9}$$

WM – total CH_4 emissions from industrial waste water in one year, Tg;
P – amount of food production produced in one year, t;
V – output of wastewater for each tonne of production produced, m^3/t;
C – organic load in wastewater (COD), kg/m^3;
PFM – emission factor of CH_4, $kgCH_4/kgCOD$; PFM = 0.25.

Amount of food production of all relevant types were taken from national statistics [21].

Following values were assumed in calculation of emissions from industrial wastewater handling:

1. Output of waste water for each tonne of production produced
   a. Processing of milk production – 5 m^3;
   b. Processing of meat production – 16 m^3;
   c. Processing of fish production – 10 m^3.
2. Organic load (COD) in industrial waste water
   a. Processing of milk production – 3000 mg/l;
   b. Processing of meat production – 3000 mg/l;
   c. Processing of fish production – 2000 mg/l.

Emissions from industrial wastewater handling are calculated as follows in table.

Table 8.3.2 Calculation of emission of CH_4 from industrial wastewater handling

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 or kg/m^3	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	240,3	5	1201,5	3	3604,5	0,25	901,1
Meat	148,4	16	2374,4	3	7123,2	0,25	1780,8
Fish	75,2	10	752,0	2	1504,0	0,25	376,0

Also emissions from local anaerobic treatment plants are taken into consideration. The research claims that emissions from such treatment plants are 0,113 Gg/a of CH_4. A small amount of N_2O is emitted during the release from the sewage system. The calculations employ total protein use of 0.075 kg per resident per day, or 27.375 kg per resident per year, and emission factor 0.16 kg N / kg protein [12] that gives emission 0.157 Gg of N_2O (2007). N_2O emission from industrial wastewater handling is negligible – 0.0004 Gg/a.

8.3.3 Uncertainties and times series consistency

The following uncertainties were used for Wastewater Handling sector for activity data and emission factors:

Table 8.3.3 Uncertainties for Wastewater handling sector

Emission	Activity data	Emission factor
CH_4	2%*	10%**
N_2O	2%*	10%**
CO_2	-	-

* 2% - frame uncertainty of CSB;
**10% - default uncertainty from IPCC guidelines.

8.3.4 Source-specific QA/QC and verification

QA/QC procedures are the same for whole Waste sector (see Chapter 8.2.4).

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 LEGMA. 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.

Currently there are no large amounts of waste being incinerated in Latvia without energy recovery. 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*. There are approximate data available on Riga crematorium (see section 8.4.4), and calculations of its emissions are being made in accordance with the CORINAIR methodology. 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 2007 incinerated amount of waste decrease due to hazardous waste incineration facility do not work in full capacity. CO_2 emissions from Waste Incineration are presented in Figure 8.9.

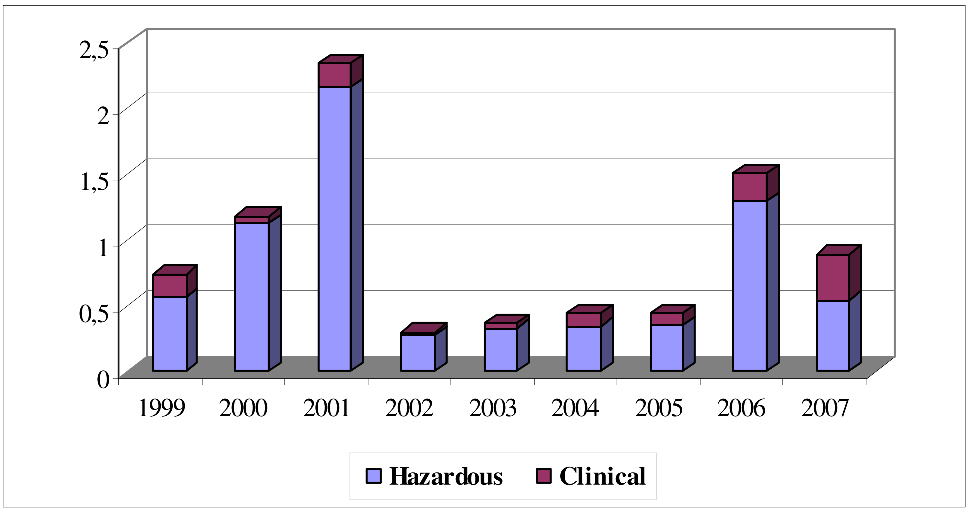


Figure 8.9 CO_2 emissions from Waste Incineration by waste type (Gg)

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 8.3).

Table 8.4 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

It isn't possible to estimate N_2O emissions from Waste Incineration without direct measurements. In Latvia these measurements in Waste Incineration facilities aren't done. Incinerated wastes are defined as clinical and hazardous (industrial) wastes. IPCC GPG 2000 and EMEP/CORINAIR don't provide factors for N_2O emission calculation.

Table 8.5 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

Cremation

In Latvia the only working crematorium, as stated in the project *Inventory of Dioxin and Furan Releases in Latvia* (2002), is crematorium in Riga. The crematorium is being under operation since December 22nd, 1994, on average 1500 to 2000 bodies being incinerated every year. 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. Calculations were based on emission factors given by the EMEP/CORINAIR methodology [28].

Indirect GHG emissions from cremation were calculated by multiplying the number of bodies incinerated with the corresponding emission factor. Only the average number of bodies incinerated in 1995 - 2006 in Riga crematorium is available (assumed to be 1750), therefore emissions are identical for these years:

$$SO_{x\ emissions} = 1750 \times 6{,}364 \times 10^{-2} kg/body = 111{,}37\ kg \Rightarrow 0{,}000111\ Gg$$
$$NO_{x\ emissions} = 1750 \times 4{,}552 \times 10^{-1} kg/body = 796{,}6\ kg \Rightarrow 0{,}000797\ Gg$$
$$CO_{emissions} = 1750 \times 2{,}121 \times 10^{-1} kg/body = 371{,}175\ kg \Rightarrow 0{,}000371\ Gg$$
$$NMVOC_{emissions} = 1750 \times 1{,}30 \times 10^{-2} kg/body = 22{,}75\ kg \Rightarrow 0{,}000022\ Gg$$

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.

8.4.5 Source-specific QA/QC and verification

QA/QC procedures are the same for whole Waste sector (see Chapter 8.2.4).

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. 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.

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.

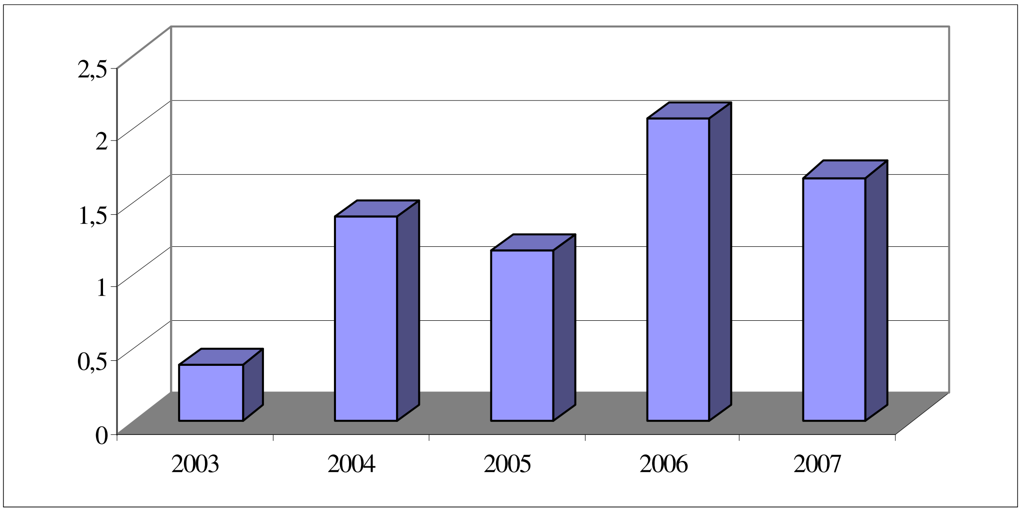


Figure 8.10 Total emissions from waste composting in CO_2 equivalent (Gg)

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. 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 8.6 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

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

QA/QC procedures are the same for whole Waste sector (see Chapter 8.2.4).

9. RECALCULATIONS AND IMPROVEMENTS

The changes in the inventory since the previous submission (Table 9.1) to the UNFCCC (15.04.2008) were done according to:

- recommendations by ERT included in FCCC/IRR/2007/LVA (14 December 2008), FCCC/ARR/2006/LVA (24 April 2008);
- recommendations by ERT during Centralized review (2008);
- corrections of activity data by CSB;
- using of new methodology for LULUCF and ENERGY;
- changes of emission factors for ENERGY and INDUSTRIAL PROCESSES;
- using of COPERT IV for 2004 - 2007 for Road transport.

Table 9.1 Overall impact of recalculations on national emissions

	2006 submission		2007 submission		Difference	
	Total (including LULUCF)	Total (excluding LULUCF)	Total (including LULUCF)	Total (excluding LULUCF)	Total (including LULUCF)	Total (excluding LULUCF)
1990	5 768.447	26 455.789	5 260.88	26 678.91	-9%	0.84%
1991	3 267.662	24 522.539	1 945.77	24 737.09	-40%	0.87%
1992	-1 770.651	19 826.301	-3 937.76	19 965.24	122%	0.70%
1993	-4 855.329	15 938.854	-7 955.20	16 074.98	64%	0.85%
1994	-5 953.458	13 975.509	-10 020.98	14 046.48	68%	0.51%
1995	-5 176.711	12 492.653	-11 553.80	12 571.05	123%	0.63%
1996	-6 324.459	12 561.694	-12 504.95	12 621.94	98%	0.48%
1997	-4 658.245	11 971.780	-11 691.85	12 043.79	151%	0.60%
1998	-4 024.136	11 445.632	-11 835.15	11 521.53	194%	0.66%
1999	-3 977.963	10 666.386	-12 656.75	10 736.07	218%	0.65%
2000	-4 111.942	10 020.716	-14 289.76	10 102.54	248%	0.82%
2001	-4 273.917	10 660.482	-19 236.45	10 739.48	350%	0.74%
2002	-3 437.064	10 667.640	-15 039.39	10 739.98	338%	0.68%
2003	-2 845.314	10 847.011	-15 272.31	10 916.04	437%	0.64%
2004	-3 859.811	10 832.699	-17 125.07	10 944.44	344%	1.03%
2005	-3 324.255	11 130.463	-17 031.37	11 213.20	412%	0.74%
2006	-6 193.917	11 621.446	-20 873.69	11 671.48	237%	0.43%

Detailed description on recalculations and information about planned improvements is described in the sectoral chapters.

For submission 2009 and it is foreseen that for further 2 years, none local researches will be elaborated for improving of inventory related national parameters, especially Agriculture and Energy sectors due to economical situation in country and lack of financial resources.

It is planned to try to introduce the detailed Tiers for key categories according to IPCC Guidelines.

Quality Improvement Plan for GHG inventory is added as Annex 9.

REFERENCES

1. Agriculture and Rural Area of Latvia. Ministry of Agriculture. 2007;

2. Agriculture of Latvia in 2006. Central Statistical Bureau of Latvia, 2008;

3. CSB. Annual Eurostat Energy Questionnaire, 2007.

4. A.Ozols. Datu izvērtēšana un sagatavošana Starptautiskā lietišķo sistēmu analīzesinstitūta sagatavoto Excel tabulu aizpildīšanai Reģionālā gaisa piesārņojuma informācijas un modelēšanas modelī. Rīga. 2005;

5. Forestry sector in Latvia 2006. Latvian Forest Industry Federation, Riga, 2006;

6. Fourth national Communication of the Republic of Latvia under United Convention on Climate Change. Ministry of the Environment. Riga, 2006;

7. Intergovernmental Panel on Climate Change (IPCC). Good Practice Guidance and Uncertainty management in National GHG, 2000;

8. Lauksaimniecības sektora radītās siltumnīcefekta gāzu emisijas. Latvijas Valsts Agrārās ekonomikas institūts. Pētījumu rezultāti (2(16)/2006). Rīga, 2006. (GHG Emissions from Agriculture. Latvian State Institute of Agrarian Economics. Working papers 2(16)/2006);

9. Lipins L. Assessment of wood resources and electivity of wood utilization (Koksnes izejvielu resursu un to izmantošanas efektivitātes novērtējums). 2004;

10. LZA Fizikālās Enerģētikas institūts, "Pētījums par vietējās aviācijas un vietējo iekšzemes ūdensceļu degvielas patēriņu no 1990-2004", Rīga, 2006;

11. Melece L. Kūtsmēslu apsaimniekošanas sistēmu izvērtējums laika posmam no 1990 – 2003. gadam. 2005.(Evaluation of Manure Management Systems for 1990 – 2003. 2005. (Within a Contract LEGMA and expert));

12. Melece L. Pētījums par organisko augšņu (histosols) daudzumu Latvijā 1990-2004. (Research on the amount of organic soils (histosols) in Latvia from 1990 – 2004 according to IPCC Good Practice Guidance and uncertainty management for national greenhouse gas inventories;

13. Metodiskie norādījumi CO_2 emisiju noteikšanai, izstrādāti, ievērojot ANO Vispārējās konvencijas "Par klimata pārmaiņām", Klimata pārmaiņu starpvaldību padomes (IPCC) rekomendācijas un Latvijā pielietotā kurināmā fizikālās īpašības. Riga,2004;

14. Notekūdeņu apsaimniekošana Latvijā un metāna veidošanās. SIA Alabastrs, Rīga 2003;

15. Ozone depleting substances and the greenhouse gases HFCs, PFCs and SF_6. Danish consumption and emissions 2001, DEPA;

16. Potential problems and further Questions from the ERT formulated in the course of the in-country review of Latvia's Initial Report under the Kyoto Protocol and 2006 Inventory Submission. Riga, 26 May 2007;

17. Project report "SF_6, HFC and PFC emission inventory in Latvia 1995-2003", Riga 2004;

18. Raubēna. A. Reassessed emissions regarding FCR. "Zemes dati" in Excel (Received Extrapolated data for permanent crop (1990-1995) from Central Statistical Bureau of Latvia. Riga 24.05. 2007, 17:34);

19. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.1996;

20. Statistical yearbook of Latvia (1990-2007). Central Statistical Bureau of Latvia, 2008;

21. Sudārs R. Slāpekļa izdalīšanās no kūtsmēsliem un kūtsmēslu apsaimniekošanas (savākšanas, uzglabāšanas un utilizācijas) sistēmas un to raksturojums. (Research during the Project „CORINAIR – Institutional strengthening of National Air Emissions Inventories in Latvia", R. Sudārs. Nitrogen Separation).

22. Transport and communication. Collection of statistical data. CSB, Riga 1999-2002;

23. UNFCCC, Report of the Review of the Initial Report of Latvia. 2007

24. http://vdc2.vdc.lv:8998

25. http://www.csb.gov.lv/csp/content/?cat=355

26. http://www.em.gov.lv/em/2nd/?cat=6

27. Intergovernmental Panel on Climate Change, 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

28. EMEP/CORINAIR Emission Inventory Guidebook – 2006.

29. Ministry of Agriculture, ENQUIRY ON MCPFE QUANTITATIVE INDICATORS FOR SFM, NATIONAL DATA REPORTING FORMS, 2006.

30. Ministry of Economics, Economic development of Latvia. Report.Riga.2008.

ANNEX 1 KEY SOURCE ANALYSES

Table 1 Key sources - Level Assessment in 1990 with LULUCF

	IPCC Source Categories	GHG	Base year 1990	LA, %	Cumulative, %
1	Removals from Forest Land	CO2	21660.40	0.44	0.44
2	CO2 Emissions from Stationary Combustion-oil	CO2	7421.58	0.15	0.60
3	CO2 Emissions from Stationary Combustion-gas	CO2	5537.97	0.11	0.71
4	CO2 Emissions from Stationary Combustion-coal	CO2	2840.01	0.06	0.77
5	Mobile Combustion: Road Vehicles	CO2	2313.57	0.05	0.82
6	Emissions from Enteric fermentation in Domestic Livestock's	CH4	2057.23	0.04	0.86
7	Emissions from Agricultural Soils	direct-N2O	1649.86	0.03	0.89
8	Emissions from Nitrogen Used in Agriculture	indirect-N2O	1033.87	0.02	0.91
9	Emissions from Manure Management	N2O	551.63	0.01	0.92
10	Mobile Combustion: Railways	CO2	525.64	0.01	0.93
11	Emissions from Wastewater Handling	CH4	504.78	0.01	0.945
12	Emissions from Cropland	CO2	405.85	0.01	0.953

Table 2 Key sources - Level Assessment in 1990 without LULUCF

	IPCC Source Categories	GHG	Base year 1990	LA, %	Cumulative, %
1	CO2 Emissions from Stationary Combustion-oil	CO2	7421.58	0.28	0.28
2	CO2 Emissions from Stationary Combustion-gas	CO2	5537.97	0.21	0.49
3	CO2 Emissions from Stationary Combustion-coal	CO2	2840.01	0.11	0.59
4	Mobile Combustion: Road Vehicles	CO2	2313.57	0.09	0.68
5	Emissions from Enteric fermentation in Domestic Livestock's	CH4	2057.23	0.08	0.76
6	Emissions from Agricultural Soils	direct-N2O	1649.86	0.06	0.82
7	Emissions from Nitrogen Used in Agriculture	indirect-N2O	1033.87	0.04	0.86
8	Emissions from Manure Management	N2O	551.63	0.02	0.88
9	Mobile Combustion: Railways	CO2	525.64	0.02	0.90
10	Emissions from Wastewater Handling	CH4	504.78	0.02	0.92
11	Emissions from Cement Production	CO2	366.12	0.01	0.93
12	Pasture, Range and Paddock Manure	N2O	358.39	0.01	0.94
13	Emissions from Manure Management	CH4	279.52	0.01	0.95

Table 3 Key sources - Level Assessment in 2007 without LULUCF

	IPCC Source Categories	GHG	2007	LA, %	Cumulative, %
1	Mobile Combustion: Road Vehicles	CO2	3495.215	0.29	0.29
2	CO2 Emissions from Stationary Combustion-gas	CO2	3160.782	0.26	0.55
3	CO2 Emissions from Stationary Combustion-oil	CO2	971.244	0.08	0.63
4	Emissions from Agricultural Soils	direct-N2O	775.399	0.06	0.70
5	Emissions from Enteric fermentation in Domestic Livestock's	CH4	592.116	0.05	0.75
6	Emissions from Solid Waste Disposal Sites	CH4	532.875	0.04	0.79
7	CO2 Emissions from Stationary Combustion-coal	CO2	410.342	0.03	0.82
8	Emissions from Nitrogen Used in Agriculture	indirect-N2O	337.702	0.03	0.85
9	Emissions from Wastewater Handling	CH4	248.514	0.02	0.87
10	Non-CO2 Emissions from Stationary Combustion-biomass	CH4	246.732	0.02	0.89
11	Mobile Combustion: Railways	CO2	242.601	0.02	0.91
12	Emissions from Cement Production	CO2	171.811	0.01	0.93
13	Emissions from Manure Management	N2O	163.988	0.01	0.94
14	Fugitive Emissions from Oil and Gas Operations	CH4	108.444	0.01	0.95

Table 4 Key sources - Trend assessment in 2007 without LULUCF

	IPCC Source Categories (LULUCF isn't t included)	Direct Greenhouse Gas	Base year 1990, CO_2 eq.Gg	2007, CO_2 eq. Gg	Level Assessment, %	Trend Assessment, %	Contribution to Trend, %	Cumulative, %
1	Mobile Combustion: Road Vehicles	CO2	2313.57	3473.17	0.29	0.45	0.30	0.30
2	CO2 Emissions from Stationary Combustion-oil	CO2	7421.58	971.24	0.08	0.44	0.30	0.60
3	CO2 Emissions from Stationary Combustion-coal	CO2	2840.01	410.34	0.03	0.16	0.11	0.71
4	CO2 Emissions from Stationary Combustion-gas	CO2	5537.97	3160.78	0.26	0.12	0.08	0.79
5	Emissions from Solid Waste Disposal Sites	CH4	278.79	532.88	0.04	0.07	0.05	0.84
6	Emissions from Enteric fermentation in Domestic Livestock's	CH4	2057.23	592.12	0.05	0.06	0.04	0.89
7	Non-CO2 Emissions from Stationary Combustion-biomass	CH4	167.29	246.73	0.02	0.03	0.02	0.91
8	Emissions from Nitrogen Used in Agriculture	indirect-N2O	1033.87	337.70	0.03	0.02	0.02	0.92
9	Emissions from Manure Management	N2O	551.63	163.99	0.01	0.02	0.01	0.93
10	Pasture, Range and Paddock Manure	N2O	358.39	105.52	0.01	0.01	0.01	0.94
11	Emissions from Lime Production	CO2	121.42	1.13	0.00	0.01	0.01	0.95
12	Emissions from Consumption of HFCs	HFC	0.29	51.34	0.00	0.01	0.01	0.95

Table 5 Key sources - Level Assessment in 2006 without LULUCF

	IPCC Source Categories	GHG	2006	LA, %	Cumulative, %
1	CO2 Emissions from Stationary Combustion-gas	CO2	3267.894	0.28	0.28
2	Mobile Combustion: Road Vehicles	CO2	3084.400	0.26	0.55
3	CO2 Emissions from Stationary Combustion-oil	CO2	1051.084	0.09	0.64
4	Emissions from Agricultural Soils	direct-N2O	774.422	0.07	0.70
5	Emissions from Enteric fermentation in Domestic Livestock's	CH4	565.688	0.05	0.75
6	Emissions from Solid Waste Disposal Sites	CH4	513.996	0.04	0.79
7	CO2 Emissions from Stationary Combustion-coal	CO2	335.561	0.03	0.82
8	Emissions from Nitrogen Used in Agriculture	indirect-N2O	317.999	0.03	0.85
9	Non-CO2 Emissions from Stationary Combustion-biomass	CH4	247.509	0.02	0.87
10	Emissions from Wastewater Handling	CH4	240.660	0.02	0.89
11	Mobile Combustion: Railways	CO2	223.939	0.02	0.91
12	Emissions from Manure Management	N2O	157.858	0.01	0.93
13	Emissions from Cement Production	CO2	133.400	0.01	0.94
14	Fugitive Emissions from Oil and Gas Operations	CH4	105.735	0.01	0.95
15	Pasture, Range and Paddock Manure	N2O	100.560	0.01	0.95

Table 6 Key sources - Level Assessment in 2006 with LULUCF

	IPCC Source Categories	GHG	2006, absolute values	LA, %	Cumulative, %
1	Removals from Forest Land	CO2	32530.65	0.73	0.73
2	CO2 Emissions from Stationary Combustion-gas	CO2	3267.89	0.07	0.81
3	Mobile Combustion: Road Vehicles	CO2	3084.40	0.07	0.88
4	CO2 Emissions from Stationary Combustion-oil	CO2	1051.08	0.02	0.90
5	Emissions from Agricultural Soils	direct-N2O	774.42	0.02	0.92
6	Emissions from Enteric fermentation in Domestic Livestock's	CH4	565.69	0.01	0.93
7	Emissions from Solid Waste Disposal Sites	CH4	514.00	0.01	0.94
8	CO2 Emissions from Stationary Combustion-coal	CO2	335.56	0.01	0.95

Table 7 Key sources - Trend assessment in 2006 without LULUCF

	IPCC Source Categories (LULUCF isn't t included)	Direct Green house Gas	Base year 1990, CO2 eq.Gg	2006, CO2 eq. Gg	Level Assessment, %	Trend Assessment, %	Contribution to Trend, %	Cumulative, %
1	CO2 Emissions from Stationary Combustion-oil	CO2	7421.58	1051.08	0.09	0.43	0.28	0.28
2	Mobile Combustion: Road Vehicles	CO2	2313.57	3084.40	0.26	0.41	0.27	0.55
3	CO2 Emissions from Stationary Combustion-coal	CO2	2840.01	335.56	0.03	0.18	0.12	0.67
4	CO2 Emissions from Stationary Combustion-gas	CO2	5537.97	3267.89	0.28	0.17	0.11	0.78
5	Emissions from Solid Waste Disposal Sites	CH4	278.79	514.00	0.04	0.08	0.05	0.83
6	Emissions from Enteric fermentation in Domestic Livestock's	CH4	2057.23	565.69	0.05	0.07	0.04	0.87
7	Non-CO2 Emissions from Stationary Combustion-biomass	CH4	167.29	247.51	0.02	0.03	0.02	0.89
8	Emissions from Nitrogen Used in Agriculture	indirect -N2O	1033.87	318.00	0.03	0.03	0.02	0.91
9	Emissions from Manure Management	N2O	551.63	157.86	0.01	0.02	0.01	0.92
10	Pasture, Range and Paddock Manure	N2O	358.39	100.56	0.01	0.01	0.01	0.93
11	Emissions from Agricultural Soils	direct-N2O	1649.86	774.42	0.07	0.01	0.01	0.94
12	Emissions from Lime Production	CO2	121.42	1.34	0.00	0.01	0.01	0.94
13	Non-CO2 Emissions from Stationary Combustion-biomass	N2O	34.10	61.73	0.01	0.01	0.01	0.95
14	Emissions from Manure Management	CH4	279.52	82.30	0.01	0.01	0.01	0.95

Table 8 Key sources - Trend assessment in 2006 with LULUCF

	IPCC Source Categories (LULUCF is included)	Direct Greenhouse Gas	Base year 1990, CO2 eq.Gg	2006, CO2 eq.Gg	Level Assessment	Trend Assessment	Contribution to trend, %	Cumulative, %
1	Removals from Forest Land	CO2	20661.69	32530.65	0.73	0.32	0.45	0.45
2	CO2 Emissions from Stationary Combustion-oil	CO2	7421.58	1051.08	0.02	0.14	0.20	0.64
3	CO2 Emissions from Stationary Combustion-coal	CO2	2840.01	335.56	0.01	0.06	0.08	0.72
4	CO2 Emissions from Stationary Combustion-gas	CO2	5537.97	3267.89	0.07	0.05	0.06	0.79
5	Emissions from Enteric fermentation in Domestic Livestock's	CH4	2057.23	565.69	0.01	0.03	0.05	0.83
6	Mobile Combustion: Road Vehicles	CO2	2313.57	3084.40	0.07	0.02	0.03	0.86
7	Emissions from Agricultural Soils	direct-N2O	1649.86	774.42	0.02	0.02	0.03	0.89
8	Emissions from Nitrogen Used in Agriculture	indirect-N2O	1033.87	318.00	0.01	0.02	0.02	0.91
9	Emissions from Manure Management	N2O	551.63	157.86	0.00	0.01	0.01	0.92
10	Mobile Combustion: Railways	CO2	525.64	223.94	0.01	0.01	0.01	0.93
11	Emissions from Solid Waste Disposal Sites	CH4	278.79	514.00	0.01	0.01	0.01	0.94
12	Pasture, Range and Paddock Manure	N2O	358.39	100.56	0.00	0.01	0.01	0.95
13	Emissions from Wastewater Handling	CH4	504.78	240.66	0.01	0.01	0.01	0.96

ANNEX 2 DETAILED METHODOLOGY 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)

V.Bergmanis

Riga
2004

Annotation

The report is done in accordance with conditions of contract No. 15 of 17 May 2004. Guidance manual of CO_2 emissions from stationary fuel combustion installations estimations is developed in accordance to requirements from IPCC Guidelines. It means that according to developed guidance, CO_2 emissions from every object could be determined using physical characteristics of combusted fuel and amount of consumed fuel. In case such physical characteristics are not available, average estimated data for types of fuels used in Latvia could be used (Table 1).

Following additional information are given:

- capacity of combustion installations,
- particle content of fuel,
- concept of heat of combustion and use of it in estimations
- discretion in composition of thermal balance of combustion installation that provide better understanding of combustion installations operations and processes that generate CO_2 emissions.

The report is developed to help enterprises that operate with combustion installations, Regional Environmental Boards (REB) and environment experts calculate CO_2 emission from stationary fuel combustion.

Introduction

Guidance for practical determination of CO_2 emission factors in the case of:

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 is 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 CO2 emission determination it is assumed that all carbon stored in fuel transforms into CO2 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 CO2 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:

1. combusted type of fuel;
2. amount of combusted fuel B_n;
3. carbon content (C^d %) in working mass of fuel;
4. 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 ($10^3 \times m^3$)

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:

$$E_{CO_2} = E_{CO_2} \times p$$

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 $\mathbf{N_{nom}}$;
3. with fuel input installed capacity $\mathbf{N_{th}}$;

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.

$\mathbf{N_{nom}}$ – 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.

$\mathbf{N_{th}}$ – 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:

$$C + H + N + O + S + A + W = 100 \text{ (\% mass content)}$$

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	$\frac{100}{100 - W^d}$	$\frac{100}{100 - (A^d + W^d)}$
Dry	$\frac{100 - W^d}{100}$	1	$\frac{100}{100 - A^s}$
Burning	$\frac{100 - (A^d + W^d)}{100}$	$\frac{100 - A^s}{100}$	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:

$$Q_z^d = 339C^d + 1031H^d - 109(O^d - S_g^d) - 25W^d \text{ (kJ/kg)}$$

(S_g – fugitive sulphur amount)

Relevance between net and gross calorific values:

$$Q_z^d = Q_a^d - 25(9H^d + W) \text{ (kJ/kg)}$$

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 $Q_z^d \approx 0{,}95\ Q_a$

for gaseous fuels $Q_z^d \approx 0{,}9\ Q_a^d$

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 η_{ka}.

ANNEX 3 DETAILED METHODOLOGICAL DESCRIPTIONS FOR INDIVIDUAL SOURCE CATEGORIES

RELEVANT BACKGROUND INFORMATION – ENERGY SECTOR

Type of fuel	Sulphur content														EF (Gg/PJ)												
	1990-1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	NCV	1990-1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Diesel	0.3	0.3	0.3	0.3	0.3	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0,035	42,49	0.141	0.141	0.141	0.141	0.141	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0,016
RFO	2	2	2	2	2	1	1	1	1	1	1	1	1	40,60	0.966	0.966	0.966	0.966	0.966	0.483	0.483	0.483	0.483	0.483	0.483	0.483	0,483
Gasoline	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0,015	43,97	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	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0,05	43,20	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	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	43,20	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
Coal	1.80	1.80	1.20	1.19	1.18	1.12	1.12	0.82	0.68	0.66	0.70	0.661	0,4584	26,22	1.236	1.236	0.825	0.820	0.807	0.770	0.769	0.564	0.467	0.454	0.480	0.454	0,315
Coke	1.80	1.80	1.20	1.19	1.18	1.12	1.12	0.82	0.68	0.66	0.70	0.661	0,6	26,79	1.209	1.209	0.808	0.802	0.790	0.753	0.753	0.552	0.457	0.444	0.469	0.444	0,403
Shale oil	1	1	1	1	1	1	1	1	1	1	0.57	0.8	0,8125	39,35	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.290	0.407	0,413
Peat	0.3	0.3	0.24	0.21	0.21	0.21	0.21	0.27	0.25	0.24	0.15	0.224	0,2631	10,05	0.507	0.507	0.411	0.359	0.362	0.355	0.364	0.456	0.419	0.412	0.259	0.378	0,445

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

RELEVANT BACKGROUND INFORMATION – TRANSPORT SECTOR

Subsector	Technology	Population	Mileage
Passenger Cars			
Gasoline <1,4 l	ECE 15/00-01	33	9000
Gasoline <1,4 l	ECE 15/02	401	10000
Gasoline <1,4 l	ECE 15/03	3178	10500
Gasoline <1,4 l	ECE 15/04	15800	12000
Gasoline <1,4 l	PC Euro 1 - 91/441/EEC	8427	14000
Gasoline <1,4 l	PC Euro 2 - 94/12/EEC	9372	15000
Gasoline <1,4 l	PC Euro 3 - 98/69/EC Stage2000	6419	18000
Gasoline <1,4 l	PC Euro 4 - 98/69/EC Stage2005	4971	20000
Gasoline 1,4 - 2,0 l	ECE 15/00-01	70	8000
Gasoline 1,4 - 2,0 l	ECE 15/02	1045	10000
Gasoline 1,4 - 2,0 l	ECE 15/03	11515	10000
Gasoline 1,4 - 2,0 l	ECE 15/04	72681	10000
Gasoline 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	41834	15000
Gasoline 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	50465	16000
Gasoline 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	37444	20000
Gasoline 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	30348	24000
Gasoline >2,0 l	ECE 15/00-01	8	8000
Gasoline >2,0 l	ECE 15/02	197	10000
Gasoline >2,0 l	ECE 15/03	2392	10000
Gasoline >2,0 l	ECE 15/04	16854	10000
Gasoline >2,0 l	PC Euro 1 - 91/441/EEC	9932	15000
Gasoline >2,0 l	PC Euro 2 - 94/12/EEC	12256	18000
Gasoline >2,0 l	PC Euro 3 - 98/69/EC Stage2000	9628	20000
Gasoline >2,0 l	PC Euro 4 - 98/69/EC Stage2005	8285	22000
Diesel <2,0 l	Conventional	29711	14000
Diesel <2,0 l	PC Euro 1 - 91/441/EEC	16085	15000
Diesel <2,0 l	PC Euro 2 - 94/12/EEC	20385	17000
Diesel <2,0 l	PC Euro 3 - 98/69/EC Stage2000	17069	21000
Diesel <2,0 l	PC Euro 4 - 98/69/EC Stage2005	21477	23000
Diesel >2,0 l	Conventional	10345	14000
Diesel >2,0 l	PC Euro 1 - 91/441/EEC	9859	16000
Diesel >2,0 l	PC Euro 2 - 94/12/EEC	16679	18000
Diesel >2,0 l	PC Euro 3 - 98/69/EC Stage2000	17069	22000
Diesel >2,0 l	PC Euro 4 - 98/69/EC Stage2005	11564	24000
LPG <1,4 l	Conventional	905	12000
LPG <1,4 l	PC Euro 1 - 91/441/EEC	340	14000
LPG <1,4 l	PC Euro 2 - 94/12/EEC	284	16000
LPG <1,4 l	PC Euro 3 - 98/69/EC Stage2000	7	20000
LPG <1,4 l	PC Euro 4 - 98/69/EC Stage2005	5	22000
LPG 1,4 - 2,0 l	Conventional	4971	14000
LPG 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	1871	18000
LPG 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	1741	20000
LPG 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	103	22000
LPG 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	83	25000

Subsector	**Technology**	**Population**	**Mileage**
LPG >2,0 l	Conventional	1982	16000
LPG >2,0 l	PC Euro 1 - 91/441/EEC	1191	20000
LPG >2,0 l	PC Euro 2 - 94/12/EEC	1527	21000
LPG >2,0 l	PC Euro 3 - 98/69/EC Stage2000	110	24000
LPG >2,0 l	PC Euro 4 - 98/69/EC Stage2005	92	25000
Light Duty Vehicles			
Gasoline <3,5t	Conventional	1759	16000
Gasoline <3,5t	LD Euro 1 - 93/59/EEC	1138	19000
Gasoline <3,5t	LD Euro 2 - 96/69/EEC	2532	20000
Gasoline <3,5t	LD Euro 3 - 98/69/EC Stage2000	2083	21000
Gasoline <3,5t	LD Euro 4 - 98/69/EC Stage2005	1548	25000
Diesel <3,5 t	Conventional	2550	18000
Diesel <3,5 t	LD Euro 1 - 93/59/EEC	2048	22000
Diesel <3,5 t	LD Euro 2 - 96/69/EEC	5143	25000
Diesel <3,5 t	LD Euro 3 - 98/69/EC Stage2000	5833	27000
Diesel <3,5 t	LD Euro 4 - 98/69/EC Stage2005	5807	29000
LPG <3,5t	Conventional	88	14000
LPG <3,5t	LD Euro 1 - 93/59/EEC	65	15000
LPG <3,5t	LD Euro 2 - 96/69/EEC	237	17000
LPG <3,5t	LD Euro 3 - 98/69/EC Stage2000	417	20000
LPG <3,5t	LD Euro 4 - 98/69/EC Stage2005	387	25000
Heavy Duty Trucks			
Gasoline >3,5 t	Conventional	2136	15800
Gasoline <=7,5 t	HD Euro I - 91/542/EEC Stage I	114	25000
Gasoline <=7,5 t	HD Euro II - 91/542/EEC Stage II	139	35000
Gasoline <=7,5 t	HD Euro III - 2000 Standards	104	45000
Gasoline <=7,5 t	HD Euro IV - 2005 Standards	49	45000
Gasoline7,5 - 12 t	HD Euro I - 91/542/EEC Stage I	94	22000
Gasoline7,5 - 12 t	HD Euro II - 91/542/EEC Stage II	135	30000
Gasoline7,5 - 12 t	HD Euro III - 2000 Standards	96	35000
Gasoline7,5 - 12 t	HD Euro IV - 2005 Standards	44	42000
Gasoline 12 - 14 t	HD Euro I - 91/542/EEC Stage I	1	22000
Gasoline 14 - 20 t	HD Euro I - 91/542/EEC Stage I	66	20000
Rigid <=7,5 t	Conventional	2383	40000
Rigid <=7,5 t	HD Euro I - 91/542/EEC Stage I	446	43000
Rigid <=7,5 t	HD Euro II - 91/542/EEC Stage II	739	45000
Rigid <=7,5 t	HD Euro III - 2000 Standards	647	54000
Rigid <=7,5 t	HD Euro IV - 2005 Standards	394	60000
Rigid 7,5 - 12 t	Conventional	1615	53000
Rigid 7,5 - 12 t	HD Euro I - 91/542/EEC Stage I	166	60000
Rigid 7,5 - 12 t	HD Euro II - 91/542/EEC Stage II	276	65000
Rigid 7,5 - 12 t	HD Euro III - 2000 Standards	251	70000
Rigid 7,5 - 12 t	HD Euro IV - 2005 Standards	165	75000
Rigid 12 - 14 t	Conventional	1148	55000
Rigid 12 - 14 t	HD Euro I - 91/542/EEC Stage I	117	60000

Subsector	Technology	Population	Mileage
Rigid 12 - 14 t	HD Euro II - 91/542/EEC Stage II	135	65000
Rigid 12 - 14 t	HD Euro III - 2000 Standards	52	70000
Rigid 12 - 14 t	HD Euro IV - 2005 Standards	32	75000
Rigid 14 - 20 t	Conventional	1319	65000
Rigid 14 - 20 t	HD Euro I - 91/542/EEC Stage I	494	70000
Rigid 14 - 20 t	HD Euro II - 91/542/EEC Stage II	1006	75000
Rigid 14 - 20 t	HD Euro III - 2000 Standards	966	75000
Rigid 14 - 20 t	HD Euro IV - 2005 Standards	1143	80000
Rigid 20 - 26 t	Conventional	697	65000
Rigid 20 - 26 t	HD Euro I - 91/542/EEC Stage I	498	70000
Rigid 20 - 26 t	HD Euro II - 91/542/EEC Stage II	1180	75000
Rigid 20 - 26 t	HD Euro III - 2000 Standards	1213	75000
Rigid 20 - 26 t	HD Euro IV - 2005 Standards	1467	80000
Rigid 26 - 28 t	Conventional	144	65000
Rigid 26 - 28 t	HD Euro I - 91/542/EEC Stage I	95	70000
Rigid 26 - 28 t	HD Euro II - 91/542/EEC Stage II	226	75000
Rigid 26 - 28 t	HD Euro III - 2000 Standards	243	75000
Rigid 26 - 28 t	HD Euro IV - 2005 Standards	293	80000
Rigid 28 - 32 t	Conventional	140	65000
Rigid 28 - 32 t	HD Euro I - 91/542/EEC Stage I	71	70000
Rigid 28 - 32 t	HD Euro II - 91/542/EEC Stage II	168	75000
Rigid 28 - 32 t	HD Euro III - 2000 Standards	173	75000
Rigid 28 - 32 t	HD Euro IV - 2005 Standards	210	80000
Articulated 14 - 20 t	Conventional	330	65000
Articulated 14 - 20 t	HD Euro I - 91/542/EEC Stage I	123	70000
Articulated 14 - 20 t	HD Euro II - 91/542/EEC Stage II	252	75000
Articulated 14 - 20 t	HD Euro III - 2000 Standards	241	75000
Articulated 14 - 20 t	HD Euro IV - 2005 Standards	286	80000
Articulated 20 - 28 t	Conventional	498	65000
Articulated 20 - 28 t	HD Euro I - 91/542/EEC Stage I	345	70000
Articulated 20 - 28 t	HD Euro II - 91/542/EEC Stage II	817	75000
Articulated 20 - 28 t	HD Euro III - 2000 Standards	855	75000
Articulated 20 - 28 t	HD Euro IV - 2005 Standards	1034	80000
Articulated 28 - 34 t	Conventional	777	65000
Articulated 28 - 34 t	HD Euro I - 91/542/EEC Stage I	403	70000
Articulated 28 - 34 t	HD Euro II - 91/542/EEC Stage II	955	75000
Articulated 28 - 34 t	HD Euro III - 2000 Standards	982	75000
Articulated 28 - 34 t	HD Euro IV - 2005 Standards	1187	80000
LPG<=7,5 t	Conventional	82	20000
LPG<=7,5 t	HD Euro I - 91/542/EEC Stage I	9	22000
LPG<=7,5 t	HD Euro II - 91/542/EEC Stage II	51	24000
LPG<=7,5 t	HD Euro III - 2000 Standards	84	26000
LPG<=7,5 t	HD Euro IV - 2005 Standards	49	30000
LPG<=7,5 t	Conventional	396	10000
LPG<=7,5 t	HD Euro I - 91/542/EEC Stage I	17	16000
LPG<=7,5 t	HD Euro II - 91/542/EEC Stage II	24	18000
LPG<=7,5 t	HD Euro III - 2000 Standards	22	22000
LPG<=7,5 t	HD Euro IV - 2005 Standards	11	23000
LPG<=7,5 t	Conventional		
Buses			

Subsector	Technology	Population	Mileage
Urban Buses Midi <=15 t	Conventional	926	50000
Urban Buses Midi <=15 t	HD Euro I - 91/542/EEC Stage I	269	53000
Urban Buses Midi <=15 t	HD Euro II - 91/542/EEC Stage II	447	58000
Urban Buses Midi <=15 t	HD Euro III - 2000 Standards	555	60000
Urban Buses Midi <=15 t	HD Euro IV - 2005 Standards	235	60000
Coaches Standard <=18 t	Conventional	617	50000
Coaches Standard <=18 t	HD Euro I - 91/542/EEC Stage I	203	58000
Coaches Standard <=18 t	HD Euro II - 91/542/EEC Stage II	396	60000
Coaches Standard <=18 t	HD Euro III - 2000 Standards	555	60000
Coaches Standard <=18 t	HD Euro IV - 2005 Standards	288	62000
Gasoline <3,5t	Conventional	21	30000
Gasoline <3,5t	HD Euro I - 91/542/EEC Stage I	18	35000
Gasoline <3,5t	HD Euro II - 91/542/EEC Stage II	27	45000
Gasoline <3,5t	HD Euro III - 2000 Standards	16	52000
Gasoline 3,5-12 t	Conventional	37	35000
Gasoline 3,5-12 t	HD Euro I - 91/542/EEC Stage I	9	45000
Gasoline 3,5-12 t	HD Euro II - 91/542/EEC Stage II	25	50000
Gasoline 3,5-12 t	HD Euro III - 2000 Standards	8	55000
LPG <3,5t	Conventional	3	30000
LPG <3,5t	HD Euro I - 91/542/EEC Stage I	3	35000
LPG <3,5t	HD Euro II - 91/542/EEC Stage II	5	45000
LPG <3,5t	HD Euro III - 2000 Standards	5	52000
LPG 3,5-12 t	Conventional	18	35000
LPG 3,5-12 t	HD Euro I - 91/542/EEC Stage I	5	45000
LPG 3,5-12 t	HD Euro II - 91/542/EEC Stage II	7	50000
LPG 3,5-12 t	HD Euro III - 2000 Standards	6	55000
LPG > 12t	Conventional	17	53000
LPG > 12t	HD Euro I - 91/542/EEC Stage I	4	55000
Mopeds			
<50 cm^3	Conventional	490	1500
<50 cm^3	Mop - Euro I	933	1500
<50 cm^3	Mop - Euro II	1228	1500
<50 cm^3	Mop - Euro III	4248	1500
Motorcycles			
2-stroke >50 cm^3	Conventional	1804	1500
2-stroke >50 cm^3	Mot - Euro I	621	2000
2-stroke >50 cm^3	Mot - Euro II	247	2000
2-stroke >50 cm^3	Mot - Euro III	361	2000
4-stroke 250 - 750 cm^3	Conventional	1021	2000
4-stroke 250 - 750 cm^3	Mot - Euro I	699	2500
4-stroke 250 - 750 cm^3	Mot - Euro II	298	2500
4-stroke 250 - 750 cm^3	Mot - Euro III	489	2500
4-stroke >750 cm^3	Conventional	653	2500
4-stroke >750 cm^3	Mot - Euro I	403	3000
4-stroke >750 cm^3	Mot - Euro II	165	3000
4-stroke >750 cm^3	Mot - Euro III	321	3000

English translation of document, June 27, 2007

Extract from research on the amount of organic soils (Histosols) in Latvia from 1990 – 2004 according to IPCC Good Practice Guidance and uncertainty management for national greenhouse gas inventories

Published too by the Latvian State Institute of Agrarian Economics

(Working papers2 (16)/2006, pages 11-13)

Dr. oec. Ligita Melece

INTRODUCTION

To support global climate change mitigation through implementing United Nations Framework Convention on Climate Change and its Kyoto Protocol and requirements of European Union (hereinafter –EU) legislation Latvia had to elaborate Climate Change Mitigation Program. This program stipulates Governmental policy and measures. EU member states and EU Council have ratified Kyoto Protocol by accepting regulation 280/2004/EC on GHG and implementation requirements of Kyoto Protocol monitoring mechanism in EU.

In accordance with this regulation EU member states have to elaborate Climate Change Mitigation Program which contains information of Governmental policy and measures for GGH emission reduction and limitation, as well as increase sequestration of carbon dioxide, application of Kyoto Protocol mechanism, measures for implementation EU legislation and policy of climate changes, sequestration forecast of GHG and carbon dioxide until 2020.

Until now the most important policy planning documents stipulating climate change reduction in Latvia are:

- Climate Change Mitigation Policy Plan (1998);
- Latvian Sustainable Development Strategy (2002);
- Implementation concept of joint implementation projects for 2002 – 2012 (2202);
- Implementation strategy of joint implementation projects for 2002. -2012 (29.10.2002);
- National Environmental Policy plan for 2004 - 2008 (03.02.2004).

In accordance with the obligations of Convention and Kyoto Protocol, as well as Conference decisions of Convention Parties and EU legislation, Latvia should annually submit to Convention secretary and European Commission national inventory report with overview on GHG emissions and sequestration of carbon dioxide.

Climate Change Mitigation Programme was elaborated according to the Prime Minister Order No. 142 „On Climate Change Mitigation Programme" and content of the programme corresponds to the obligations of EU Parliament and Council regulation. This Programme covers goals and obligations of Kyoto Protocol to United Nations Framework Convention on Climate Change including obligation that in the time period from 2008 – to 2012 the total amount of anthropogenic GHG emissions in Latvia will not exceed 92% of 1990 level.

Greenhouse gas emissions arise also from agricultural activity. Amount of nitrous oxide emissions from managed soils is considerable.

When estimating greenhouse gas emissions, it is important to estimate nitrous oxide - N_2O emissions from the management or use of organic soils – histosols or histosol soils (hereinafter in the text histosols) in agriculture.

ASSIGNMENT

In accordance with the assignment during contract elaboration amount of organic soils – Histosols was estimated in Latvia from 1990 – 2004 according to IPCC Good Practice Guidance and Uncertainty Management in national greenhouse inventories.

SOURCES AND METHODS

Sources

In order to fulfil the assignment during the project elaboration following sources was used:

Data from Ministry of Agriculture of the Republic of Latvia;

Instructions, methods and data from international organizations and institutions;

Published data and data base information of Central Statistics Bureau of the Republic of Latvia;

Information and data of State agency „Latvian Environmental, geology and meteorology agency";

Publications by foreign and Latvian scientists and specialists.

Methods

For the solution of assignments and estimates taking into account methods of international institutions (IPCC; EPAM/CORINAIR etc.) the most appropriate quantitative and qualitative economic research methods were applied:

- Grouping of data;
- Analysis and synthesis;
- Logically and abstractedly constructive;
- Interpolations of data;
- Experts etc.

RESULTS

Emissions from agricultural soils

Greenhouse gas emissions from agricultural soils differ according to the method agricultural land is managed with, which in its turn depend on the type of cultivated agriculture crop.

For easier emission estimate IPCC methodology distinguishes three types of the usage of agricultural lands. For cultivated plant sowings and plantations, as well as for intensively managed grasslands significant amounts of fertilizers are used, but for extensively managed grasslands fertilizers are not used at all or in very small amounts.

Because of this methane and nitrous oxide emissions from the territories of cultivated plants and intensively managed grasslands are considerably higher than emissions from extensively managed grasslands without the use of additional fertilizers.

Histosols

Histosols are formed of nitrogen rich organic substances. Depth of upper layer of these soils is more than 40 cm and content of organic substances is within 89% to 96%. Usually histosols form in places where atmospheric moisture is high, vaporization is low and drainage is limited which facilitates reinforced decomposition of the matters from plants and animals. Histosols is ecologically important because of the large quantities of organic substances they contain (Histosols, 2005).

Histosol soils theoretically can be divided into three groups:

First group histosols form in lowlands, mudflats, and mixed forests on wet peat soils or places where excessive moisture conditions in the upper layer of soil create anaerobic conditions;

Second group histosols form in flat topography where annual precipitation exceed amount of vaporization. Highland swamps and peatlands are typical to this group;

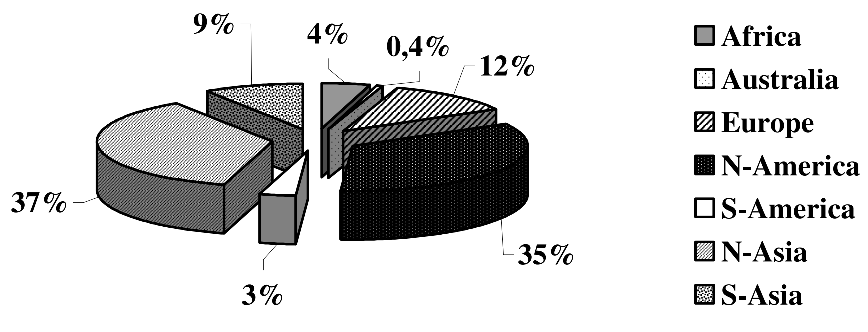
Third group histosols form in mountains where upper layer of soil is composed mainly from the remains of plants.

Taking into account the high content of organic substances, usage of histosol soils in agricultural production is limited.

Histosols possess specific characteristics – low mass density, colloidal character and specific thermal qualities. In order to ensure long-term use of histosols in agriculture, management of these soils should be particularly careful as histosol soils lose their structure when drying out quickly, mineralize and become trampled. If soil is not properly or timely managed then irreversible soil drying out processes take place and it becomes vulnerable to the wind erosion (Histosols, 2000).

Histosol soils of the first and second group mostly are met in North Europe and Baltic counties, including Latvia, and in the North America, but the third group soils – in South Asia.

Overall histosols take up 1,2% or 270 million hectares of the world land territory. Mainly histosols compose in boreal and mild climate regions. Looking at total areas occupied by histosols divided by continents we can see in the Picture 1 that the biggest territories occupied by histosols are in N-America (35%) and N-Asia (37%).



Picture 1 Histosol soils (%) by continents
Source: Histosols, 2000

In neighbouring countries of Latvia – in Estonia peatlands take up 22% or 9 000 km^2 from the total state territory (Global peat resources by country, 2001; Selge, 2002) or 23% (Reintman, 2001) and in Lithuania peat soils occupy 11% from the state territory (Land found and soil, 2004).

In Estonia histosol soils occupy 8.6% from arable land (*Kolli R., Ellermae O., 2003*), but there are no data on arable histosol soils in Lithuania.

In many European countries organic or histosol soils are not precisely defined, also experts from one country indicate different spread of these soils. Researchers Brito Soares and Ronco (Brito Soares F., Ronco R., 2005) while estimating greenhouse gas emissions under the Common agriculture policy in „old" 15 member states indicate how difficult it is to define arable histosol areas.

There is not unambiguous opinion of researchers regarding GHG emission from histosols management. For example, Swedish soil researchers (*Klemedtsoon et.al.,2005*) found that not always and not in all cases histosols are the sources of GHG, including nitrous oxide emissions.

Authors point out that in some cases nitrous oxide (N_2O) emissions from histosols are significant but in other cases nitrous oxide emissions are unimportant. This is why researchers suppose that in order to estimate total nitrous oxide emissions from histosols it is necessary to evaluate or map soil parameters that differ depending on emitting intensity of the place.

When analyzing annual measurement of N_2O emissions from histosol soils, Swedish researchers have concluded that there is close negative relation between N_2O emissions and soil C (carbon) and N (nitrogen) proportion - r^2_{adj}=0.96, where annual average N_2O emissions = ae $^{(\text{-bCN proportions})}$).

Klemedtsoon and other authors for estimating N_2O emissions from histosols in certain territories stipulate that correlation between N_2O emissions and CN proportion should be used. However, if C and N proportions are low then it should be taken into account that such parameters as climate, pH and level of ground waters will significantly influence amounts of nitrous oxide emissions.

Histosols in Latvia

Latvia lacks accurate data as regarding histosols areas in its territory, so as regarding those histosols areas that are situated within arable land and also regarding proportion of managed histosols due to various reasons:

There is a lack of financing for the soil researches, international soil classification or taxonomy is not implemented in Latvia. In order to introduce international soil classification system more in-depth soil researches are needed, because the old and existing soil classification does not correspond with the international and it is not possible to adapt it in a simplified way without performing researches;

Inventory in Latvia of agricultural lands including managed meadows and pastures is incomplete.

It is necessary to define areas of histosols or organic soils in Latvia as EU and international experts have expressed their dissatisfaction with the data Latvia has previously reported on histosols proportion from arable lands – 1,5% and histosols areas which considerably differed from the data of other countries, including neighbouring countries.

Regardless of the above-mentioned reasons we can acquire approximate area of managed histosols if we evaluate publications and information by researchers from Latvia and other countries.

Many authors (Busmanis, 1999; Shvangiradze, 2000; Nikodemus, 2003; Āboliņa, 2003; and other experts) indicate that proportion of histosols could be **approximately 7 %** from the agricultural lands in Latvia.

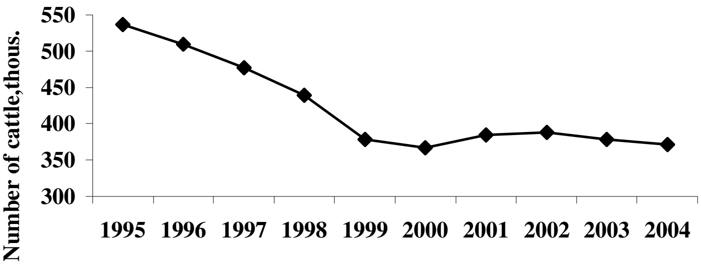
Comparing this proportion of histosols areas with the data of other countries we can agree with this assumption. In Denmark that is situated more to South from Latvia, areas occupied by histosols make 2377 km^2 or 5.5% from the state territory. In Denmark more than half of areas occupied by histosols or 184 000 hectares are used in agriculture.

Besides Danish researchers emphasize that 90% of these areas are used as grasslands and therefore do not emit nitrous oxide emissions. Remaining 10% from the total area occupied by histosols (18 400 hectares) during the year emit 0.14 kt N_2O emissions if emission factor is 5 kg N_2O-N/ha.

But the latest IPCC directions define new increased histosols emission factor - 8 kg N_2O-N/ha.

Soil researcher in Latvia Regīna Timbare (Timbare, 2002) in her report prepared in 2002 on histosols proportion in arable lands in Latvia observed that proportion of histosol soils is higher in fallow lands, i.e., not arable lands. Timbare concludes that in the last 10 years (after 1990) proportion of histosol soils in arable lands could not particularly change as practically there was no drainage of new areas (more or less only the management of existing drainages took place) or development of new lands, and in the result area of arable lands even in the last two years cannot significantly differ from the area defined in 1990. Also it should be taken into account that the area of arable land not used in agriculture increases.

Besides due to significant reduction of livestock, especially cattle (Picture 1), including dairy cows during the time period from 1990 – 2004, also the areas of managed meadows and grazing pastures reduced.



Picture 2 Dynamics of the number of cattle in Latvia, 1995 – 2004

Source: Data from CSB, 2005

If we assume and suppose that histosol soils in cultivated and natural meadows and pastures in 1990 occupied 19% then by making necessary adjustment we can find that proportion of histosols in agricultural lands is **7% from the total managed agricultural lands**.

When analyzing report and recalculation (Table 2) it was found that if we similarly to Danish experts exclude unmanaged meadows and pastures from managed meadows and pastures then we reach the result which corresponds with the opinion of above mentioned experts – 7% from managed/cultivated agricultural lands are histosols.

For the estimates of histosol areas we applied proportion of managed meadows and pastures in histosol soils given in percentage in Table 3.

Assuming that in Latvia from agricultural lands, 7%- arable land, permanent crop and managed meadows and pastures are histosols and where in 2004 according to Central Statistics Bureau data 13% was managed meadows and pastures, but in 2003 - 15,8%, then if estimate is done according to total area - in 2004 in Latvia ~ 77 thousand hectares were histosols. We suggest including this area in the estimates of nitrous oxide emissions in 2004.

Table 2 Adjusted proportions of histosol soils in agricultural lands, 1985-1990

Type of the land management	Inspected area, thousand ha	Proportion of histosol soils, % from total agricultural lands	Area of histosol soils, thousand ha
Fields	1565.95	1.5	23.85
Perennial plantations (orchards and berry fields)	2.98	0.7	0.021
Managed and natural pastures	300.19	6.9	20.57
Cultivated and natural meadows	172.65	19.0	108.87
Average arable land	2041.76	**7.03**	153.32

Source: author's estimates according to Timbare's,(Timbare, 2002) data

Table 3 Proportion of managed meadows and pastures in histosol soils, 1990 - 2004

Year	%
1990-2002	18.6
2003	15.8
2004	13.0

Source: author's estimates

Conclusions

Conclusions of the research are that in Latvia:

- organic – histosol soils take up **~ 7%** from managed/cultivated agricultural lands;
- with the decreasing number of livestock since 1990, proportion of managed meadows and pastures in histosol soils has decreased.

During the research conclusions are drawn that for the accurate and detailed estimates of histosols in agricultural lands soil classification in Latvia corresponding to scientific researches and international standards is lacking; also not all of the international database inventory parameters correspond with IPCC requirements or they are not sufficiently detailed.

<u>Detailed information about AWMS:</u>

In the Research (2005)[8] was reassessed AWMS due to:

Previously submitted information about AWMS in the Latvia's National Inventory report submitted under the UNFCCC in April 2005;

IPCC GPD (2003) Guidelines;

Central Statistical bureau (CSB) data – real situation in the country.

Problems that were listed in the Research are following:

For showing feasible situation was used CSB data base about agricultural structural survey which was made in 2003, but expert admit, that uncertainty could be 25-30%, but this is newest information which are available.

For AWMS determination was done calculations to classify AWMS according IPCC.

Calculation steps:

Step 1:

Amount of livestock was divided by size of farms and was calculated proportion of total amount/number of livestock in the each farm group (Table 1 – Table 4).

Table 1 Proportion of Dairy cows in different farm size

Type of farm	% from number of dairy cows
Farm with 1-2 cows	35,9
Farm with 3-9 cows	27,7
Farm with 10-19 cows	10,1
Farm with 20-49 cows	8,0
Farm with 50-99 cows	4,6
Farm with 100-399 cows	9,9
Farm with 400 and more	3,9
Total:	100,0

Source: CSP data and Latvian State Institute of Agrarian Economics calculations

Table 2 Proportion of Cattle in different farm size

Type of farm	% from number of cattle
Farm with 1-9 cattle	46,5
Farm with 10-49 cattle	27,2
Farm with 50-99 cattle	6,5
Farm with 100-399 cattle	8,8
Farm with 400 and more	11,1
Total:	100,0

Source: CSP data and Latvian State Institute of Agrarian Economics calculations

Table 3 Proportion of Swine in different farm size

Type of farm	% from number of Swine
Farm with 1-9 swine	25,5
Farm with 10-49 swine	14,3
Farm with 50-399 swine	14,6
Farm with 400-999 swine	5,2
Farm with 1000-4999 swine	10,1
Farm with 5000 and more	30,3
Total:	100,0

Source: CSP data and Latvian State Institute of Agrarian Economics calculations

Table 4 Proportion of Poultry in different farm size

Type of farm	% from number of poultry
Farm with 1-99 poultry	24,6
Farm with 100-999 poultry	0,6
Farm with 1000-49999 poultry	3,2
Farm with 50000 and more	71,6
Total:	100,0

Source: CSP data and Latvian State Institute of Agrarian Economics calculations

<u>Step 2:</u>

Data and different information about types of AWMS and AWMS distribution by group of farms as well as divided proportion when livestock are in the house and when in the pasture range and paddock was summarized (Table 5).

Table 5 housing and pasture range and paddock period for livestock, 1990 - 2004

Type of livestock	Amount of days of year	Number of days that is spends in the pasture range and paddock, 1990.-2003.	Pasture range and paddock, %	Housing, %	Number of Days which is spend in the pasture range and paddock,, 2004	Pasture range and paddock, %	Housing, %
Dairy cows	365	145	39,73	60,27	150	41,10	58,90
Other cattle	365	165	45,21	54,79	170	46,58	53,42
Horses	365	185	50,68	49,32	190	52,05	47,95
Sheep, goats	365	155	42,47	57,53	160	43,84	56,16

Source: CSP data and Latvian State Institute of Agrarian Economics calculations

Step 3:

AWMS was calculated by type of livestock taken into account previously mentioned calculations as well as different available information (expert judgements, researches etc.). The results are shown under sub category Manure Management in the section 6.3. (Table 6.6, Table 6.7 and 6.8.).

Detailed information about calculated average N excretion per head of livestock:

Average N excretion per head of livestock was reassessed in the Research [8] which was made by Latvian State Institute of Agrarian Economics if compared previously submitted. For N excretion calculations was used newest published information of "Centre of Agrochemical researches" on different produced manure amount of livestock type in year and N amount in the manure, which was justly with results of manure analyses (Table 6.9).

For reassessing values of N excretion per head of livestock was used in the Table 6.9 shown information, information from Research [21] previously submitted as well as IPCC Guidelines.

Table 6 Additional standards for manure of livestock type

Livestock and holding way	Type of manure	Extraction in year, t	N in natural manure, kg/t	N /year /from manure, kg
Dairy cows, milk yield, 3500-5000 kg, all-round floor	Solid storage ad dry lot	10,5	4,1	43,1
Dairy cows, milk yield, 5000-6000 kg, all-round floor	Solid storage ad dry lot	12,5	4,4	55,0
Dairy cows, milk yield, 6000 kg, all-round floor	Solid storage ad dry lot	13,7	3,3	45,2
Dairy cows, milk yield 7600 kg, rack floor	Partly liquid	18,2	3,1	56,4
Heifer (until 6 month), all-round floor	Solid storage ad dry lot	2,6	3,7	9,6
Heifer (6 month and older), all-round floor	Solid storage ad dry lot	8,0	3,4	27,2
Feedlot stock (heifer and bull), deep byre	Solid storage ad dry lot	11,1	3,8	42,2
Bulls for meet (feed with distiller's grain), all-round floor	liquid	16,0	3,7	59,2
Cows, calf for, all-round floor	Solid storage ad dry lot	12,0	3,4	40,8
Breeding bulls, all-round floor	Solid storage ad dry lot	13,0	4,3	55,9
Feedlot swine (30 –100 kg), all-round floor, rack floor (partial)	Solid storage ad dry lot	0,5	7,1	3,6
	liquid	1,0	4,9	4,9
Pregnant sow, all-round floor, rack floor (partial)	Solid storage ad dry lot	1,4	7,1	9,9
	liquid	2,8	4,6	12,9
Suckling sow, all-round floor, rack floor (partial)	Solid storage ad dry lot	1,5	5,4	8,1
	liquid	2,5	3,1	7,8
Weanling (7,5-30 kg), all-round floor, rack floor (partial)	Solid storage ad dry lot	0,06	6,4	0,4
	liquid	0,1	3,8	0,4
Boar, all-round floor	Solid storage ad dry lot	1,5	2,6	3,9
Goats with yeanling, all-round floor	Solid storage ad dry lot	1,5	6,3	9,5
Sheep with yeanling, deep farm	Solid storage ad dry lot	1,3	7,4	9,6
Horses, all-round floor	Solid storage ad dry lot	8,0	5,2	41,6
Broiler	Solid storage ad dry lot	0,02	21,7	0,43
Lying hen, cage		0,05	15,9	0,80
Lying hen, cage	liquid	0,10	6,4	0,64

Source: Timbare, 2002 and Latvian State Institute of Agrarian Economics calculations

RELEVANT BACKGROUND INFORMATION – LULUCF SECTOR

New methodology which is planed to use for submission 2009 regarding LULUCF

1. General methods of Latvian NFI

In accordance with Republic of Latvia Cabinet Regulation No 169 Adopted 15 April 2003 „Regulations regarding Circulation of State Forest Register Information" (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.

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

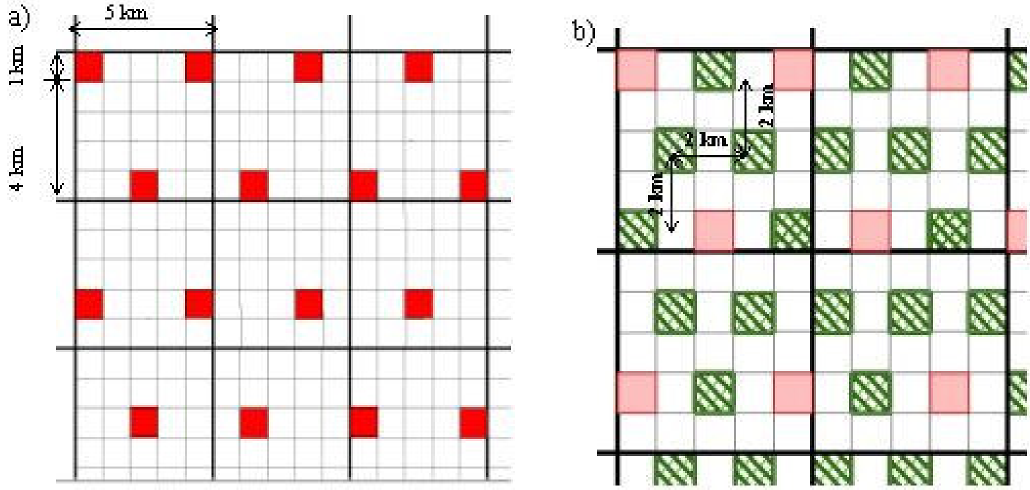
Forest statistical inventory is based on the method of continuous, combined, multistage sampling and GIS technology.

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:

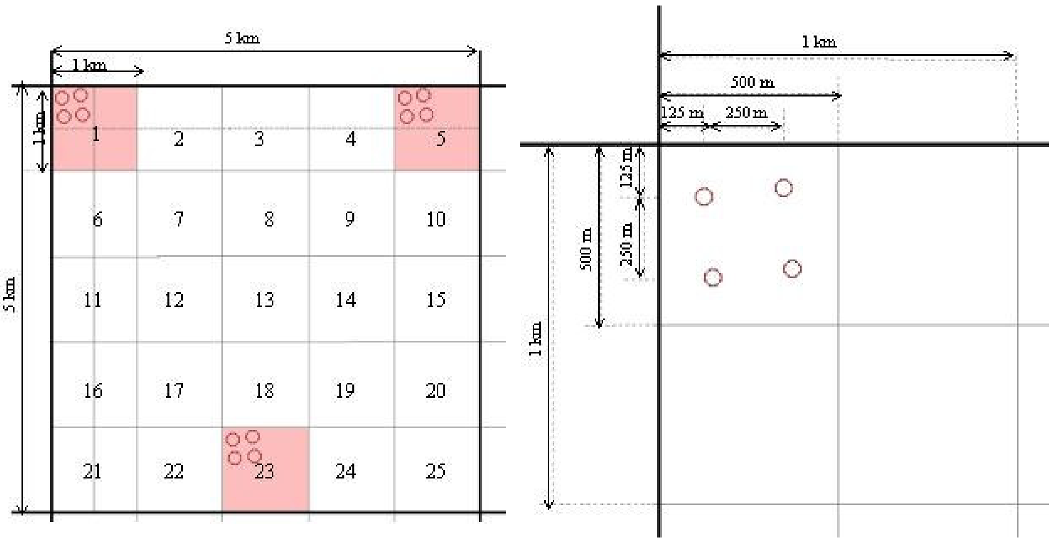
2.1. The net of permanent SP tracts is placed evenly in whole territory of country in distance 4*4 km from each other in a way that they are making equilateral triangles (picture 1.a.). Each year 1/5 from all permanent SP is measured.



Picture 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).



Picture 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.

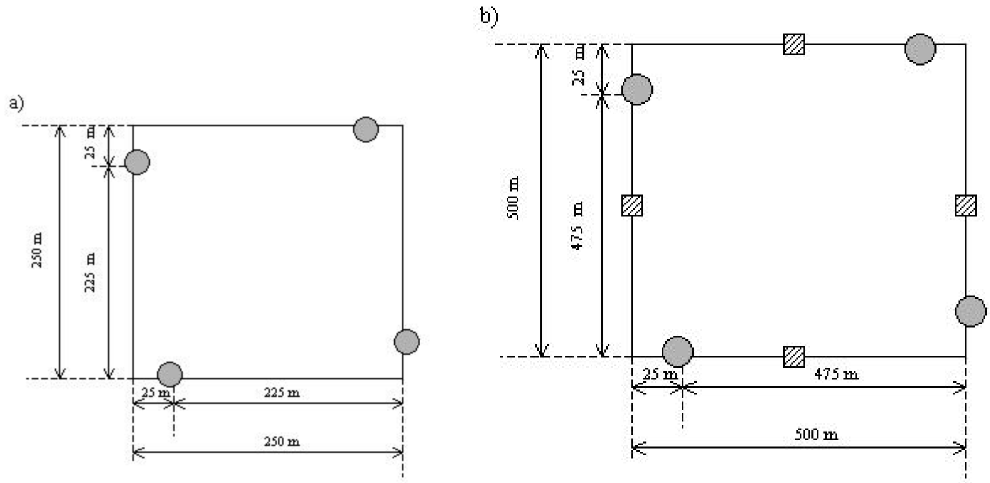
Each temporary plot after one year measurement represents territory of 6000 ha, but during 5 years – 1200 ha. Taking together permanent and temporary SPs, each plot during one year represents 1500ha, but during 5 years 300 ha. By making repeated measurements in permanent SPs changes in 5 years period 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)

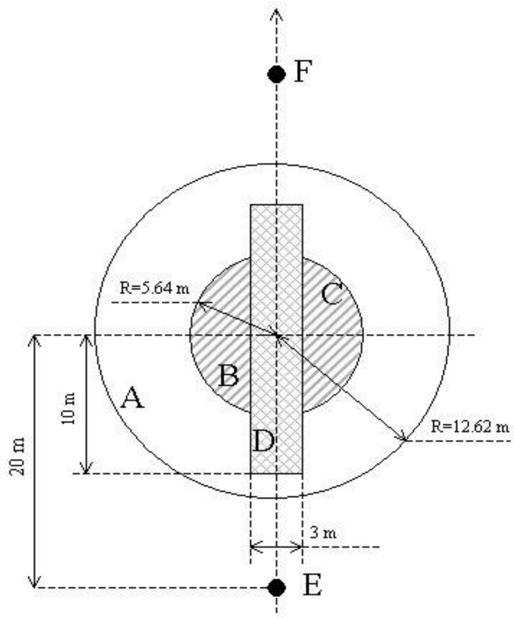
Temporary SPs are placed in quadrates of 500*500 m and they are divided in two parts - stump SPs, where only stumps are measured and SPs for accounting of trees which are measured like permanent SPs, but without fixation of placement of trees.

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).



Picture 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).



Picture 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)

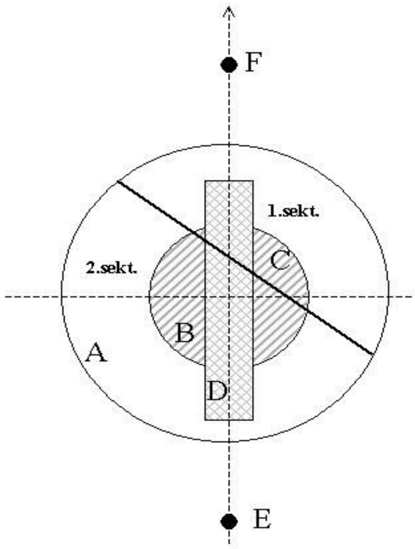
In the centre of SP another circular sample plot is singled out (B) - 100 m^2 (R=5.64 m), where all trees, stumps and deadwood with diameter >= 6.1 cm are measured. In the first ¼ of this SP (accounting from north direction) in 25 m2 (C) all naturally growing saplings and shoots with diameter >=2.1 cm 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.

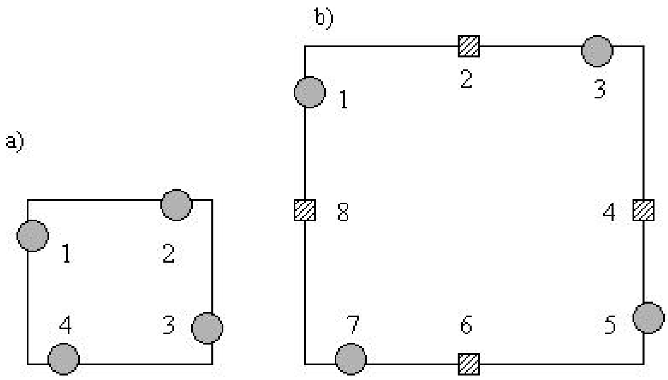
During identifying sectors of SP, azimuths and distances till centre of SP for those points, where sectors making line crossing border of SP, is fixed. (5.picture)



Picture 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).



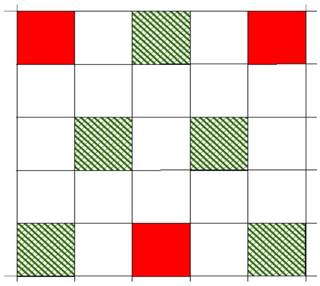
Picture 6 Schema of numbering permanent sample plots (a) and temporary sample plots (b)

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).



Picture 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, 10th and 17th 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:

measurements of NFI:

year 2006: age – 50 years; averageD =27 cm; Z_5 2002-2006 = 9mm, $Z_5$1997_2001=12 mm;
bark - 6 mm

parameters to be calculated:

$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:

$$G=PI()*D_{vid}.^2/4*N.$$

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 1.B)

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 Fossil	Primary Fuels	Crude Oil	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Orimulsion	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Natural Gas Liquids	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
	Secondary Fuels	Gasoline	TJ		19 390,77	1 934,68	NO	-835,43	18 291,52	1,00	NCV	18 291,52	18,90	345,66	NA	345,66	0,99	1 254,75
		Jet Kerosene	TJ		3 413,59	NO	3 370,38	NO	43,21	1,00	NCV	43,21	19,52	0,84	NA	0,84	0,99	3,06
		Other Kerosene	TJ		86,40	NO	NO	86,40		1,00	NCV		19,70		NA		0,99	
		Shale Oil	TJ		1 141,15	NO		1 023,10	118,05	1,00	NCV	118,05	20,78	2,45	NA	2,45	0,99	8,90
		Gas / Diesel Oil	TJ		40 535,46	1 742,09	2 506,91	-5 056,31	41 342,77	1,00	NCV	41 342,77	20,38	842,72	NO	842,72	0,99	3 059,06
		Residual Fuel Oil	TJ		4 953,20	NO	4 953,20	-1 624,00	1 624,00	1,00	NCV	1 624,00	21,10	34,26	NA	34,26	0,99	124,38
		Liquefied Petroleum Gas (LPG)	TJ		4 326,30	1 867,14		45,54	2 413,62	1,00	NCV	2 413,62	17,11	41,31	NO	41,31	1,00	150,70
		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		3 432,52	NO		83,72	3 348,80	1,00	NCV	3 348,80	22,00	73,67	73,67	0,00	0,99	0,00
		Lubricants	TJ		1 548,82	627,90	NO	-167,44	1 088,36	1,00	NCV	1 088,36	10,00	10,88	10,88	0,00	0,99	0,00
		Petroleum Coke	TJ		NO	NO		-131,92	131,92	1,00	NCV	131,92	27,50	3,63	NA	3,63	0,99	13,17
		Refinery Feedstocks	TJ		NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Other Oil	TJ		1 197,00	NO		NO	1 197,00	1,00	NCV	1 197,00	20,00	23,94	NA	23,94	0,99	86,90
Other Liquid Fossil												334,88		7,20	7,20			
White Spirit			TJ	NO	83,72	NO	NO	NO	83,72	1,00	NCV	83,72	20,00	1,67	1,67		0,99	
Paraffin Waxes			TJ	NO	293,02	41,86	NO	NO	251,16	1,00	NCV	251,16	22,00	5,53	5,53		0,99	
Gasoline type jet fuel			TJ	NO	86,42	NO	NO	86,42		1,00	NCV		18,90		NO		0,99	

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 Fossil Totals												69 934,13		1 386,57	91,76	1 294,81		4 700,92
Solid Fossil	Primary Fuels	Anthracite [2]	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Coking Coal	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Other Bituminous Coal	TJ	NO	3 933,00	NO	NO	-314,64	4 247,64	1,00	NCV	4 247,64	25,66	108,99	NA	108,99	0,98	391,63
		Sub-bituminous Coal	TJ	NO	NO	NO	NO	NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Lignite	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Oil Shale	TJ	NO	NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Peat	TJ	110,55	NO	100,50		-80,40	90,45	1,00	NCV	90,45	27,68	2,50	NA	2,50	0,98	9,00
	Secondary Fuels	BKB [3] and Patent Fuel	TJ		NO	NO		NO	NO	NO	NCV	NO	NO	NO	NO	NO	NO	NO
		Coke Oven/Gas Coke	TJ		80,37	NO		-26,79	107,16	1,00	NCV	107,16	24,20	2,59	NA	2,59	0,98	9,32
Other Solid Fossil												NA		NA	NA	NA		NA
Solid Fossil Totals												4 445,25		114,08	NA,NO	114,08		409,94
Gaseous Fossil		Natural Gas (Dry)	TJ	NO	55 181,90	NO		-1 509,36	56 691,27	1,00	NCV	56 691,27	15,30	867,38	NO	867,38	1,00	3 164,48
Other Gaseous Fossil												NA		NA	NA	NA		NA
Gaseous Fossil Totals												56 691,27		867,38	NA,NO	867,38		3 164,48
Total												131 070,65		2 368,03	91,76	2 276,27		8 275,34
Biomass total												49 165,93		1 468,10	NA	1 468,10		5 275,89
		Solid Biomass	TJ	64 392,00	197,00	16 292,00		-410,00	48 707,00	1,00	NCV	48 707,00	29,99	1 460,94	NA	1 460,94	0,98	5 249,66
		Liquid Biomass	TJ	647,76	3,79	559,19		19,87	72,49	1,00	NCV	72,49	19,30	1,40	NA	1,40	1,00	5,13
		Gas Biomass	TJ	386,43	NO	NO		NO	386,43	1,00	NCV	386,43	14,89	5,75	NA	5,75	1,00	21,10

Table 2 Comparison of CO_2 emissions from fuel combustion (Table 1.C)

FUEL TYPES	REFERENCE APPROACH			SECTORAL APPROACH [1]		DIFFERENCE [2]	
	Apparent energy consumption [3] (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)	69,93	65,16	4 700,92	65,22	4 697,29	-0,09	0,08
Solid Fuels (excluding international bunkers) [5]	4,45	4,45	409,94	4,45	410,34	0,00	-0,10
Gaseous Fuels	56,69	56,69	3 164,48	56,69	3 160,78	0,00	0,12
Other [5]	0,21	0,21	16,67	0,21	16,67	0,00	0,00
Total [5]	***131,28***	***126,51***	***8 292,01***	***126,57***	***8 285,09***	***-0,04***	***-0,12***

Table 3 Energobalance of Latvia in year 2007 (TJ)

sectors	motor and aviation gasoline	kerosene	kerosene type jet fuel	gasoline type jet fuel	diesel oil	residual fuel oil	LPG	white spirit	paraffin waxes	petroleum coke	other oil products	oil bitumen	lubricants	used oils	shale oil	coal	peat	peat briquettes	coke oven coke	used tires	natural gas	firewood	wood wastes	woodchips	wood briquettes	wood granules	charcoal	bioethanol	biodiesel	landfill gas	sludge gas	straw	heat Energy	electricity	Total
NCV	43.97	43.2	43.21	43.21	42.49	40.6	45.54	41.86	41.86	32.98	38.61	41.86	41.86	29.23	39.35	26.22	10.05	15.49	26.79	26.20	33.55	6.70	2.68	3.40	17.00	18.00	30.0	0.03	0.04	16.99	23.04	14.40			
production of energy resources																	111	1				36448	7584	11152	629	8293	270	310	338	224	92	16		10030*	**75498**
primary product receipts																																			
recycled products														234						210															**444**
import	19398	86	3414	86	40535	4953	4326	84	293		963	3433	1549		1141	3933			80		55182	33	94	65		5	15		4					17870	**157542**
export	1935				1742		1867		42				628				101					3015	606	4556	255	7650	210	307	252					7070	**30236**
bunkering					2507	4953																													**7460**
interproduct transfer		-129		-86	127	1218					-42		42		-1102																				**28**
stock changes	836	43			-425	406	-45			132	42	-84	125		79	315	80		27		1845	342	-61	700	-136	-360	-30	-3	-17						**3811**
statistical differences					5355																														**5355**
gross energy - total	**18299**		**3414**		**41343**	**1624**	**2414**	**84**	**251**	**132**	**963**	**3349**	**1088**	**234**	**118**	**4248**	**90**	**1**	**107**	**210**	**57027**	**33808**	**7011**	**7361**	**238**	**288**	**45**		**73**	**224**	**92**	**16**		**20830**	**204982**
consumed in transformation sector					**43**	**1056**									**39**	**420**	**70**				**34183**	**1749**	**603**	**4740**		**18**				**139**	**92**	**11**			**43163**
produced in transformation sector																																	**28685**	**7146**	**35831**
transformation sector					**43**	**1056**									**39**	**420**	**70**				**34183**	**1749**	**603**	**4740**		**18**				**139**	**92**	**11**	**28685**	**7146**	**7333**
public CHP						528										210					24756		5	592							92		15635	6901	**3647**
public heat plants					43	528									39	105	20				7347	442	389	3067		18							9558		**2440**
autoproducer CHP																					671		5							136			443	241	**128**
autoproducer heat plants																105	50				1409	764	204	1081								11	3049		**575**
autoproducer electricity plants																														3				3	
charcoal production plants																						543													**543**
Energy sector**					170	81										26	10				571	33	27	102									659	1321	**3000**
Losses																					335		27			18							4432	2873	**7685**
Final consumption:	**18299**		**3414**		**41130**	**487**	**2414**	**84**	**251**	**132**	**963**	**3349**	**1088**	**234**	**79**	**3802**	**10**	**1**	**107**	**210**	**21938**	**32026**	**6354**	**2519**	**238**	**252**	**45**		**73**	**85**		**5**	**23594**	**23782**	**186965**
industry	**44**				**807**	**406**	**137**	**84**	**251**	**132**	**963**			**205**	**79**	**1967**			**107**	**210**	**11439**	**683**	**2551**	**1550**	**17**	**90**			**2**				**468**	**6138**	**28330**
construction	**44**				**1190**	**41**						**3349**									**402**	**54**	**11**	**71**									**86**	**400**	**5648**
transport:	**17859**		**3390**		**32845**		**1093**						**1088**								**67**								**71**					**504**	**56917**
international air			**3371**																																**3371**

sectors	motor and aviation gasoline	kerosene	kerosene type jet fuel	gasoline type jet fuel	diesel oil	residual fuel oil	LPG	white spirit	paraffin waxes	petroleum coke	other oil products	oil bitumen	lubricants	used oils	shale oil	coal	peat	peat briquettes	coke oven coke	used tires	natural gas	firewood	wood wastes	woodchips	wood briquettes	wood granules	charcoal	bioethanol	biodiesel	landfill gas	sludge gas	straw	heat Energy	electricity	Total
domestic air	7		19																																**26**
road	17852				29488		1093						1088								67								71					277	**49936**
railways					3314																													141	**3455**
domestic navigation					43																														**43**
pipelines																																		86	**86**
other sectors:	**352**		**24**		**6288**	**40**	**1184**							**29**		**1835**	**10**	**1**			**10030**	**31289**	**3792**	**898**	**221**	**162**	**45**			**85**		**5**	**23040**	**16740**	**96070**
agriculture / forestry / hunting	44				3994											52					637	281	21	340		18							104	490	**5981**
fisherie					510																	7												32	**549**
residential	264				127		1047									813					4596	28053	2112		187	36	45						17316	6458	**61054**
other consumers	44		24		1657	40	137							29		970	10	1			4797	2948	1659	558	34	108				85		5	5620	9760	**28457**

* Electricity produced in hydroelectric power station and in wind power station

** Energy sector includes consumption of electric energy in power stations, technological consumption in power lines, and the consumption in energy sector.

ANNEX 6 DIRECT GHG EMISSION TRENDS 1990-2007

Table 1 CO_2 emissions and sinks per sector (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	(Gg)																	
1. Energy	**18 656.292**	**17 129.003**	**13 861.608**	**11 753.576**	**10 156.447**	**8 934.611**	**9 005.702**	**8 470.349**	**8 073.951**	**7 460.110**	**6 868.098**	**7 271.752**	**7 261.687**	**7 417.548**	**7 442.080**	**7 544.995**	**8 026.292**	**8 307.141**
A. Fuel Combustion (Sectoral Approach)	18 656.292	17 129.003	13 861.608	11 753.576	10 156.447	8 934.611	9 005.702	8 470.349	8 073.951	7 460.110	6 868.098	7 271.752	7 261.687	7 417.548	7 442.080	7 544.995	8 026.292	8 307.141
1. Energy Industries	6 332.171	5 805.698	4 955.130	3 990.002	3 748.759	3 440.437	3 565.897	3 327.255	3 368.298	2 944.781	2 490.223	2 442.601	2 335.071	2 269.729	2 077.392	2 067.757	2 091.230	1 964.122
2. Manufacturing Industries and Construction	3 777.202	2 833.564	2 385.209	2 112.185	1 913.598	1 876.204	1 836.530	1 789.771	1 567.993	1 420.951	1 170.122	1 077.586	1 129.964	1 119.438	1 121.657	1 139.973	1 198.825	1 227.570
3. Transport	2 856.733	2 686.738	2 407.190	2 234.628	2 125.006	2 031.139	1 999.294	1 991.358	1 968.980	1 941.020	2 151.627	2 538.914	2 616.697	2 759.292	2 915.453	3 035.979	3 358.235	3 744.984
4. Other Sectors	5 690.186	5 803.003	4 114.079	3 416.761	2 369.084	1 580.601	1 600.865	1 349.505	1 165.565	1 144.013	1 056.126	1 212.651	1 179.955	1 269.089	1 324.462	1 301.286	1 374.886	1 367.349
5. Other	NA	NA	NA	NA	NA	6.229	3.115	12.459	3.115	9.344	NA	NA	NA	NA	3.115	NA	3.115	3.115
B. Fugitive Emissions from Fuels	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
1. Solid Fuels	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
2. Oil and Natural Gas	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
2. Industrial Processes	**510.348**	**430.497**	**189.458**	**46.334**	**132.418**	**143.978**	**143.475**	**149.758**	**152.865**	**183.370**	**138.915**	**154.759**	**167.736**	**181.540**	**187.406**	**203.828**	**207.318**	**248.726**
A. Mineral Products	497.510	421.779	183.720	39.322	125.861	139.542	139.987	141.756	144.357	175.653	130.483	146.712	160.129	169.368	174.481	191.462	194.737	235.945
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal Production	12.838	8.718	5.738	7.012	6.557	4.436	3.487	8.002	8.508	7.717	8.432	8.047	7.607	12.173	12.925	12.366	12.582	12.781
D. Other Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	55.698	51.465	49.145	46.184	45.263	41.640	43.155	43.541	44.413	45.185	45.913	46.727	47.463	48.125	49.118	51.095	52.255	51.029
5. Land Use, Land-Use Change and Forestry(2)	**-21 439.325**	**-22 816.081**	**-23 943.378**	**-24 058.087**	**-24 099.657**	**-24 164.643**	**-25 166.890**	**-23 786.685**	**-23 413.471**	**-23 456.606**	**-24 456.979**	**-30 012.284**	**-25 823.391**	**-26 230.243**	**-28 107.288**	**-28 282.986**	**-32 587.594**	**-32 018.851**
A. Forest Land	-21 660.405	-23 016.976	-24 113.671	-24 185.662	-24 054.332	-24 071.974	-25 075.982	-23 683.348	-23 304.415	-23 334.091	-24 326.705	-29 876.219	-25 715.442	-26 130.949	-27 978.106	-28 163.779	-32 530.652	-31 730.567
B. Cropland	405.845	404.367	392.282	356.279	196.163	153.685	161.482	162.093	159.628	148.339	145.699	139.759	155.206	160.076	145.064	161.737	181.320	209.407
C. Grassland	-4.779	-6.177	-9.217	-11.905	-12.933	-13.462	-14.386	-20.672	-20.597	-21.461	-24.733	-23.808	-11.612	-7.682	-22.386	-28.992	13.755	-39.164
D. Wetlands	-28.134	-28.468	-28.142	-28.142	-28.472	-28.142	-28.512	-28.651	-29.381	-29.381	-29.414	-29.531	-29.425	-29.462	-29.465	-29.465	-29.531	-47.190
E. Settlements	-146.747	-163.724	-179.527	-183.553	-194.491	-199.159	-203.900	-210.514	-213.114	-214.419	-216.234	-216.880	-216.528	-216.634	-216.788	-216.880	-216.880	-393.250
F. Other Land	-5.104	-5.104	-5.104	-5.104	-5.592	-5.592	-5.592	-5.592	-5.592	-5.592	-5.592	-5.606	-5.592	-5.592	-5.606	-5.606	-5.606	-18.088
G. Other	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
6. Waste	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**0.738**	**1.180**	**2.344**	**0.299**	**0.365**	**0.439**	**0.439**	**1.510**	**1.181**
A. Solid Waste Disposal on 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
C. Waste Incineration	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.738	1.180	2.344	0.299	0.365	0.439	0.439	1.510	1.181
D. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Total CO2 emissions including net CO2 from LULUCF	**-2 216.988**	**-5 205.116**	**-9 843.168**	**-12 211.993**	**-13 765.528**	**-15 044.415**	**-15 974.558**	**-15 123.038**	**-15 142.243**	**-15 767.202**	**-17 402.872**	**-22 536.703**	**-18 346.206**	**-18 582.664**	**-20 428.246**	**-20 482.629**	**-24 300.219**	**-23 410.775**
Total CO2 emissions excluding net CO2 from LULUCF	**19 222.337**	**17 610.965**	**14 100.210**	**11 846.094**	**10 334.129**	**9 120.229**	**9 192.332**	**8 663.647**	**8 271.228**	**7 689.403**	**7 054.107**	**7 475.582**	**7 477.186**	**7 647.579**	**7 679.043**	**7 800.357**	**8 287.375**	**8 608.076**
Memo Items:																		
International Bunkers	**1 721.083**	**747.499**	**653.735**	**756.981**	**963.498**	**554.584**	**408.312**	**324.274**	**137.422**	**121.769**	**106.137**	**697.075**	**733.885**	**714.898**	**788.190**	**1 003.690**	**825.814**	**810.743**
Aviation	221.145	299.013	84.097	84.097	77.868	77.868	99.671	99.671	90.327	90.327	80.983	80.983	84.097	121.502	148.076	179.573	201.592	245.817
Marine	1 499.938	448.486	569.637	672.883	885.630	476.716	308.641	224.603	47.095	31.443	25.154	616.092	649.787	593.396	640.114	824.116	624.222	564.926
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 Emissions from Biomass	2 964.058	3 476.228	3 466.420	3 865.864	4 007.828	4 542.767	4 747.487	4 759.293	4 697.487	4 611.435	4 283.301	4 749.733	4 720.833	5 074.749	5 351.506	5 356.552	5 389.614	5 275.866

Table 2 CH_4 emissions per sectors (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	(Gg)																	
1. Energy	25.277	26.214	23.815	23.941	23.566	23.770	23.775	22.431	21.215	20.549	19.235	20.109	20.203	19.070	19.580	20.276	18.020	18.039
A. Fuel Combustion (Sectoral Approach)	12.227	13.644	12.355	12.981	12.856	13.340	13.725	13.051	12.215	11.968	11.295	12.409	12.173	12.789	13.367	13.332	12.985	12.875
1. Energy Industries	0.275	0.260	0.255	0.237	0.244	0.233	0.252	0.286	0.282	0.229	0.220	0.196	0.201	0.230	0.207	0.181	0.197	0.195
2. Manufacturing Industries and Construction	0.264	0.195	0.168	0.177	0.167	0.166	0.176	0.173	0.182	0.174	0.156	0.198	0.194	0.187	0.234	0.262	0.291	0.266
3. Transport	0.489	0.474	0.431	0.415	0.408	0.385	0.381	0.372	0.392	0.411	0.447	0.463	0.471	0.505	0.705	0.636	0.607	0.528
4. Other Sectors	11.199	12.715	11.501	12.151	12.037	12.556	12.917	12.219	11.360	11.154	10.472	11.552	11.306	11.867	12.221	12.253	11.890	11.887
5. Other	NA	NA	NA	NA	NA	0.000	0.000	0.000	0.000	0.000	NA	NA	NA	NA	0.000	NA	0.000	0.000
B. Fugitive Emissions from Fuels	13.050	12.570	11.460	10.960	10.710	10.430	10.050	9.380	9.000	8.581	7.940	7.700	8.030	6.281	6.213	6.944	5.035	5.164
2. Oil and Natural Gas	13.050	12.570	11.460	10.960	10.710	10.430	10.050	9.380	9.000	8.581	7.940	7.700	8.030	6.281	6.213	6.944	5.035	5.164
2. Industrial Processes	**0.003**	**0.002**	**0.001**	**0.002**	**0.002**	**0.001**	**0.001**	**0.002**	**0.002**	**0.002**	**0.003**	**0.003**	**0.003**	**0.003**	**0.003**	**0.003**	**0.003**	**0.003**
C. Metal Production	0.003	0.002	0.001	0.002	0.002	0.001	0.001	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
4. Agriculture	**111.274**	**107.106**	**88.772**	**54.598**	**45.788**	**44.633**	**41.787**	**39.191**	**35.858**	**31.353**	**30.603**	**32.069**	**32.307**	**31.206**	**30.698**	**31.472**	**30.857**	**32.209**
A. Enteric Fermentation	97.964	94.636	79.269	48.876	40.614	39.310	37.019	34.719	31.666	27.524	26.877	28.078	28.196	27.198	26.751	27.501	26.938	28.196
B. Manure Management	13.310	12.470	9.503	5.722	5.174	5.323	4.768	4.472	4.192	3.829	3.727	3.991	4.111	4.008	3.946	3.971	3.919	4.013
5. Land Use, Land-Use Change and Forestry	**0.918**	**1.070**	**1.666**	**1.201**	**1.391**	**1.714**	**1.719**	**2.201**	**2.452**	**2.740**	**2.780**	**1.562**	**1.865**	**1.785**	**1.620**	**1.657**	**1.766**	**1.488**
A. Forest Land	0.918	1.070	1.666	1.201	1.391	1.713	1.716	2.200	2.449	2.733	2.775	1.551	1.837	1.751	1.603	1.652	1.704	1.478
C. Grassland	NE,NO	NE,NO	NE,NO	0.000	0.000	0.001	0.003	0.001	0.003	0.006	0.005	0.012	0.028	0.034	0.016	0.005	0.062	0.010
6. Waste	**37.313**	**37.423**	**35.240**	**30.059**	**29.889**	**30.468**	**31.459**	**32.626**	**33.783**	**34.190**	**35.739**	**37.712**	**37.575**	**36.390**	**36.744**	**37.291**	**35.983**	**37.247**
A. Solid Waste Disposal on Land	13.276	14.237	15.245	16.299	17.394	18.530	19.702	20.781	21.724	22.574	23.580	24.793	25.015	23.565	22.953	23.661	24.476	25.375
B. Waste-water Handling	24.037	23.186	19.995	13.760	12.495	11.938	11.757	11.845	12.059	11.616	12.159	12.919	12.560	12.817	13.759	13.604	11.460	11.834
Total CH4 emissions including CH4 from LULUCF	**174.784**	**171.815**	**149.494**	**109.800**	**100.637**	**100.587**	**98.741**	**96.451**	**93.309**	**88.834**	**88.361**	**91.456**	**91.951**	**88.454**	**88.644**	**90.699**	**86.629**	**88.986**
Total CH4 emissions excluding CH4 from LULUCF	**173.866**	**170.745**	**147.829**	**108.600**	**99.246**	**98.872**	**97.022**	**94.250**	**90.858**	**86.095**	**85.581**	**89.894**	**90.086**	**86.669**	**87.024**	**89.042**	**84.863**	**87.498**
Memo Items:																		
International Bunkers	0.095	0.031	0.037	0.043	0.056	0.031	0.020	0.015	0.003	0.002	0.002	0.037	0.040	0.037	0.040	0.052	0.040	0.037
Aviation	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002
Marine	0.094	0.029	0.037	0.043	0.055	0.030	0.019	0.014	0.003	0.002	0.001	0.037	0.039	0.036	0.039	0.051	0.038	0.035

Table 3 N_2O emissions per sectors (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	(Gg)																	
1. Energy	**0.499**	**0.499**	**0.451**	**0.397**	**0.381**	**0.393**	**0.407**	**0.405**	**0.394**	**0.379**	**0.377**	**0.400**	**0.412**	**0.452**	**0.476**	**0.451**	**0.457**	**0.454**
A. Fuel Combustion (Sectoral Approach)	0.499	0.499	0.451	0.397	0.381	0.393	0.407	0.405	0.394	0.379	0.377	0.400	0.412	0.452	0.476	0.451	0.457	0.454
1. Energy Industries	0.046	0.042	0.041	0.039	0.040	0.036	0.039	0.041	0.041	0.034	0.030	0.027	0.027	0.031	0.027	0.024	0.026	0.026
2. Manufacturing Industries and Construction	0.026	0.018	0.016	0.021	0.022	0.022	0.023	0.023	0.022	0.022	0.018	0.021	0.020	0.019	0.025	0.028	0.032	0.029
3. Transport	0.263	0.260	0.228	0.169	0.160	0.166	0.170	0.176	0.174	0.170	0.185	0.196	0.211	0.241	0.258	0.233	0.236	0.238
4. Other Sectors	0.164	0.179	0.167	0.168	0.160	0.170	0.175	0.165	0.156	0.153	0.144	0.156	0.154	0.162	0.166	0.166	0.162	0.162
5. Other	NA	NA	NA	NA	NA	0.000	0.000	0.000	0.000	0.000	NA	NA	NA	NA	0.000	NA	0.000	0.000
3. Solvent and Other Product Use	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.015	0.017	0.017	0.013	0.014	0.010	0.027	0.019	0.019	0.020	0.010	0.038	0.013
4. Agriculture	**11.593**	**10.739**	**8.273**	**5.710**	**4.696**	**3.852**	**3.893**	**3.920**	**3.742**	**3.415**	**3.456**	**3.812**	**3.784**	**3.984**	**3.907**	**4.258**	**4.358**	**4.460**
B. Manure Management	1.779	1.709	1.369	0.852	0.730	0.724	0.671	0.629	0.578	0.513	0.501	0.530	0.538	0.521	0.506	0.515	0.509	0.529
D. Agricultural Soils	9.813	9.030	6.903	4.858	3.966	3.128	3.222	3.291	3.163	2.901	2.955	3.282	3.246	3.463	3.401	3.743	3.848	3.931
5. Land Use, Land-Use Change and Forestry	**0.006**	**0.007**	**0.017**	**0.009**	**0.010**	**0.012**	**0.013**	**0.016**	**0.017**	**0.020**	**0.020**	**0.011**	**0.016**	**0.014**	**0.012**	**0.012**	**0.017**	**0.011**
A. Forest Land	0.006	0.007	0.017	0.009	0.010	0.012	0.012	0.015	0.017	0.020	0.020	0.011	0.014	0.012	0.011	0.011	0.014	0.010
B. Cropland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C. Grassland	NE,NO	NE,NO	NE,NO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.001	0.000	0.003	0.000
6. Waste	**0.184**	**0.183**	**0.182**	**0.178**	**0.175**	**0.172**	**0.170**	**0.168**	**0.167**	**0.165**	**0.164**	**0.163**	**0.162**	**0.162**	**0.163**	**0.161**	**0.162**	**0.160**
B. Waste-water Handling	0.184	0.183	0.182	0.178	0.175	0.172	0.170	0.168	0.167	0.165	0.164	0.163	0.162	0.161	0.161	0.159	0.158	0.157
Total N2O emissions including N2O from LULUCF	**12.282**	**11.428**	**8.923**	**6.294**	**5.262**	**4.444**	**4.499**	**4.526**	**4.332**	**3.993**	**4.027**	**4.414**	**4.392**	**4.631**	**4.578**	**4.892**	**5.031**	**5.098**
Total N2O emissions excluding N2O from LULUCF	**12.275**	**11.421**	**8.905**	**6.285**	**5.252**	**4.432**	**4.486**	**4.511**	**4.315**	**3.973**	**4.007**	**4.403**	**4.377**	**4.617**	**4.566**	**4.881**	**5.014**	**5.087**
Memo Items:																		
International Bunkers	**0.186**	**0.043**	**0.035**	**0.059**	**0.109**	**0.046**	**0.037**	**0.032**	**0.019**	**0.015**	**0.012**	**0.138**	**0.121**	**0.106**	**0.111**	**0.135**	**0.101**	**0.093**
Aviation	0.006	0.008	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.002	0.002	0.002	0.003	0.005	0.006	0.007	0.008
Marine	0.180	0.034	0.033	0.057	0.107	0.043	0.034	0.030	0.017	0.013	0.010	0.135	0.118	0.103	0.106	0.129	0.094	0.085

Table 4 Actual HFCs and SF_6 emissions per sectors

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	(Gg)												
Emissions of HFCs (Gg CO2 equivalent)	**0.285**	**1.137**	**2.068**	**3.978**	**6.161**	**7.867**	**9.298**	**10.808**	**12.745**	**17.070**	**22.462**	**40.486**	**51.341**
HFC-23	0.000	0.000	0.000	0.000	NA,NO	0.000	0.000	0.000	0.000	NA,NO	NA,NO	NA,NO	NA,NO
HFC-32	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.000	0.000	0.000	0.000
HFC-41	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
HFC-43-10mee	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
HFC-125	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.000	0.000	0.001	0.001
HFC-134	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
HFC-134a	0.000	0.001	0.002	0.003	0.005	0.006	0.007	0.008	0.010	0.013	0.017	0.025	0.032
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.000	NA,NO
HFC-143	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
HFC-143a	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.000	0.000	0.001	0.001
HFC-227ea	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.000	0.000	0.000	0.000	0.000	0.000	NA,NO
HFC-236fa	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
HFC-245ca	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
Unspecified mix of listed HFCs(4) - (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
Emissions of PFCs - (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**
CF4	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
C2F6	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
C 3F8	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
C4F10	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
c-C4F8	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
C5F12	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
C6F14	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
Unspecified mix of listed PFCs(4) - (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
Emissions of SF6(3) - (Gg CO2 equivalent)	**0.251**	**0.287**	**0.508**	**0.710**	**0.977**	**1.275**	**1.977**	**3.382**	**4.413**	**5.370**	**7.530**	**7.124**	**8.702**
SF6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

ANNEX 7 UNCERTAINTIES

Table 1 The uncertainties in CO_2 emissions

IPCC Source Categories (LULUCF not included)	Base Year (1990) Estimate,	Current Year (2007) Estimate,	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2007	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emissions factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	Gg CO2-eq	Gg CO2-eq	%	%	%	%	%	%	%	%	%
CO2 Emissions from Stationary Combustion-oil	7421.580	971.244	2%	5%	5%	1%	-12%	5%	-1%	0%	1%
CO2 Emissions from Stationary Combustion-coal	2840.005	410.342	2%	5%	5%	0%	-4%	2%	0%	0%	0%
CO2 Emissions from Stationary Combustion-gas	5537.973	3160.782	2%	5%	5%	2%	4%	16%	0%	0%	0%
Mobile Combustion: Road Vehicles	2313.569	3495.215	5%	5%	7%	3%	13%	18%	1%	1%	1%
Mobile Combustion: Waterborne Navigation	17.463	5.290	50%	5%	50%	0%	0%	0%	0%	0%	0%
Mobile Combustion: Aircraft	0.066	1.877	20%	5%	21%	0%	0%	0%	0%	0%	0%
Mobile Combustion: Railways	525.635	242.601	2%	5%	5%	0%	0%	1%	0%	0%	0%
Emissions from Cement Production	366.123	171.811	2%	2%	3%	0%	0%	1%	0%	0%	0%
Emissions from Lime Production	121.424	1.134	2%	2%	3%	0%	0%	0%	0%	0%	0%
Emissions from Limestone and Dolomite use	0.352	32.966	2%	10%	10%	0%	0%	0%	0%	0%	0%
Emissions from Asphalt Roofing	0.008	0.017	70%	70%	99%	0%	0%	0%	0%	0%	0%
Emissions from Road Paving with Asphalt	9.603	19.699	70%	70%	99%	0%	0%	0%	0%	0%	0%
Emissions from other mineral products	4.678	10.233	2%	10%	10%	0%	0%	0%	0%	0%	0%
Emissions from the Iron and Steel Industry	12.838	12.582	2%	2%	3%	0%	0%	0%	0%	0%	0%
Emissions from Solvent and other product use	55.698	51.029	25%	50%	56%	0%	0%	0%	0%	0%	0%
Emissions from Waste Incineration	0.738	1.181	20%	50%	54%	0%	0%	0%	0%	0%	0%

Table 2 The uncertainties in CH_4 emissions

IPCC Source Categories (LULUCF not included)	Base Year (1990) Estimate	Current Year (2007) Estimate	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2003	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emissions factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	Gg CO2-eq	Gg CO2-eq	%	%	%	%	%	%	%	%	%
Non-CO2 Emissions from Stationary Combustion-oil	13.269	2.716	2%	50%	50%	0%	0%	0%	0%	0%	0%
Non-CO2 Emissions from Stationary Combustion-coal	59.639	6.518	2%	50%	50%	0%	-1%	0%	0%	0%	0%
Non-CO2 Emissions from Stationary Combustion-gas	6.299	3.201	2%	50%	50%	0%	0%	0%	0%	0%	0%
Non-CO2 Emissions from Stationary Combustion-biomass	167.286	246.732	10%	50%	51%	7%	4%	7%	2%	1%	2%
Mobile Combustion: Road Vehicles	9.603	10.775	5%	40%	40%	0%	0%	0%	0%	0%	0%
Mobile Combustion: Waterborne Navigation	0.038	0.028	50%	10%	51%	0%	0%	0%	0%	0%	0%
Mobile Combustion: Aircraft	0.000	0.001	20%	10%	22%	0%	0%	0%	0%	0%	0%
Mobile Combustion: Railways	0.626	0.278	2%	10%	10%	0%	0%	0%	0%	0%	0%
Fugitive Emissions from Oil and Gas Operations	274.050	108.444	2%	2%	3%	0%	-1%	3%	0%	0%	0%
Emissions from the Iron and Steel Industry	0.058	0.059	2%	5%	5%	0%	0%	0%	0%	0%	0%
Emissions from Enteric fermentation in Domestic Livestock's	2057.234	592.116	2%	40%	40%	13%	-12%	16%	-5%	0%	5%
Emissions from Manure Management	279.518	84.274	2%	30%	30%	1%	-2%	2%	0%	0%	0%
Emissions from Solid Waste Disposal Sites	278.786	532.875	20%	15%	25%	7%	11%	15%	2%	4%	4%
Emissions from Wastewater Handling	504.777	248.514	2%	10%	10%	1%	0%	7%	0%	0%	0%
Emissions from Compost production	0.187	0.791	20%	100%	102%	0%	0%	0%	0%	0%	0%

Table 3 The uncertainties in N_2O emissions

IPCC Source Categories (LUCF not included)	Base Year (1990) Estimate	Current Year (2007) Estimate	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2003	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emissions factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	Gg CO2-eq	Gg CO2-eq	%	%	%	%	%	%	%	%	%
Non-CO2 Emissions from Stationary Combustion-oil	19.50	2.67	2%	50%	50%	0%	0%	0%	0%	0%	0%
Non-CO2 Emissions from Stationary Combustion-coal	16.48	2.00	2%	50%	50%	0%	0%	0%	0%	0%	0%
Non-CO2 Emissions from Stationary Combustion-gas	3.08	1.76	2%	50%	50%	0%	0%	0%	0%	0%	0%
Non-CO2 Emissions from Stationary Combustion-biomass	34.10	60.41	10%	50%	51%	7%	4%	5%	2%	1%	2%
Mobile Combustion: Road Vehicles	15.90	43.43	5%	50%	50%	5%	3%	4%	2%	0%	2%
Mobile Combustion: Waterborne Navigation	1.99	0.42	50%	10%	51%	0%	0%	0%	0%	0%	0%
Mobile Combustion: Aircraft	0.00	0.02	20%	10%	22%	0%	0%	0%	0%	0%	0%
Mobile Combustion: Railways	63.67	29.79	2%	10%	10%	1%	0%	3%	0%	0%	0%
Emissions from Manure Management	551.63	163.99	40%	30%	50%	18%	-6%	15%	-2%	8%	8%
Pasture, Range and Paddock Manure	358.39	105.52	40%	25%	47%	11%	-4%	9%	-1%	5%	5%
Emissions from Wastewater Handling	56.92	48.79	2%	10%	10%	1%	2%	4%	0%	0%	0%
Emissions from Compost production	0.21	0.88	20%	90%	92%	0%	0%	0%	0%	0%	0%

Table 4 The uncertainties in CO_2 emissions (LULUCF is included)

IPCC Source Categories (LULUCF is included)	Direct Greenhouse Gas	Base Year (1990) Estimate,	Current Year (2007) Estimate,	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2003	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emissions factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO2-eq	Gg CO2-eq	%	%	%	%	%	%	%	%	%
								Note B		I*F	J*E*sqrt(2)	SQRT(k^2+l^2)
CO2 Emissions from Stationary Combustion-oil	CO2	CO2	7421.58	971.24	2%	5%	5%	0%	-15%	2%	-1%	0%
CO2 Emissions from Stationary Combustion-coal	CO2	CO2	2840.01	410.34	2%	5%	5%	0%	-6%	1%	0%	0%
CO2 Emissions from Stationary Combustion-gas	CO2	CO2	5537.97	3160.78	2%	5%	5%	0%	-6%	8%	0%	0%
Mobile Combustion: Road Vehicles	CO2	CO2	2313.57	3495.22	5%	5%	7%	1%	3%	8%	0%	1%
Mobile Combustion: Waterborne Navigation	CO2	CO2	17.46	5.29	50%	5%	50%	0%	0%	0%	0%	0%
Mobile Combustion: Aircraft	CO2	CO2	0.07	1.88	20%	5%	21%	0%	0%	0%	0%	0%
Mobile Combustion: Railways	CO2	CO2	525.64	242.60	2%	5%	5%	0%	-1%	1%	0%	0%
Emissions from Cement Production	CO2	CO2	366.12	171.81	2%	2%	3%	0%	0%	0%	0%	0%
Emissions from Lime Production	CO2	CO2	121.42	1.13	2%	2%	3%	0%	0%	0%	0%	0%
Emissions from Limestone and Dolomite use	CO2	CO2	0.35	32.97	2%	10%	10%	0%	0%	0%	0%	0%
Emissions from Asphalt Roofing	CO2	CO2	0.01	0.02	70%	70%	99%	0%	0%	0%	0%	0%
Emissions from Road Paving with Asphalt	CO2	CO2	9.60	19.70	70%	70%	99%	0%	0%	0%	0%	0%
Emissions from other mineral products	CO2	CO2	4.68	10.23	2%	10%	10%	0%	0%	0%	0%	0%
Emissions from the Iron and Steel Industry	CO2	CO2	12.84	12.58	2%	2%	3%	0%	0%	0%	0%	0%
Forest Land remaining Forest Land	CO2	CO2	21660.4	31730.6	8%	30%	31%	24%	25%	77%	8%	9%
Emissions from Cropland	CO2	CO2	405.8	209.4	74%	30%	80%	0%	0%	1%	0%	1%
Removals from Grassland	CO2	CO2	4.8	39.2	56%	30%	63%	0%	0%	0%	0%	0%
Emissions from Solvent and other product use	CO2	CO2	55.7	51.0	25%	50%	56%	0%	0%	0%	0%	0%
Emissions from Waste Incineration	CO2	CO2	0.7	1.2	20%	50%	54%	0%	0%	0%	0%	0%

ANNEX 8 STANDARD ELECTRONIC FORMAT TABLES FOR REPORTING OF LATVIA'S EMISSION TRADING REGISTRY

Table 1. Total quantities of Kyoto Protocol units by account type at beginning of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	NO	NO	NO	NO	NO	NO
Entity holding accounts	NO	NO	NO	NO	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	NO	NO	NO	NO	NO	NO
Retirement account	NO	NO	NO	NO	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	NO	NO	NO	NO	NO	NO

Table 2 (a). Annual internal transactions

Transaction type	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Article 6 issuance and conversion												
Party-verified projects		NO					NO		NO			
Independently verifed projects		NO					NO		NO			
Article 3.3 and 3.4 issuance or cancellation												
3.3 Afforestation and reforestation			NO				NO	NO	NO	NO		
3.3 Deforestation			NO				NO	NO	NO	NO		
3.4 Forest management			NO				NO	NO	NO	NO		
3.4 Cropland management			NO				NO	NO	NO	NO		
3.4 Grazing land management			NO				NO	NO	NO	NO		
3.4 Revegetation			NO				NO	NO	NO	NO		
Article 12 afforestation and reforestation												
Replacement of expired tCERs							NO	NO	NO	NO	NO	
Replacement of expired lCERs							NO	NO	NO	NO		
Replacement for reversal of storage							NO	NO	NO	NO		NO
Replacement for non-submission of certification report							NO	NO	NO	NO		NO
Other cancellation							NO	NO	NO	NO	NO	NO
Sub-total		NO	NO				NO	NO	NO	NO	NO	NO

Transaction type	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Retirement	NO	NO	NO	NO	NO	NO

Table 2 (b). Annual external transactions

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Transfers and acquisitions												
CH	NO	NO	NO	90000	NO	NO	NO	NO	NO	NO	NO	NO
GB	NO	NO	NO	20000	NO	NO	25476	NO	NO	NO	NO	NO
FR	10000	NO	NO	NO	NO	NO	28149	NO	NO	NO	NO	NO
DK	NO	NO	NO	NO	NO	NO	38000	NO	NO	NO	NO	NO
AT	NO	NO	NO	NO	NO	NO	5743	NO	NO	NO	NO	NO
ES	20000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
FI	250000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
EE	15088	NO	NO	NO	NO	NO	15088	NO	NO	NO	NO	NO
Sub-total	295088	NO	NO	110000	NO	NO	112456	NO	NO	NO	NO	NO

Additional information

Independently verified ERUs								NO				

Table 2 (c). Total annual transactions

Total (Sum of tables 2a and 2b)	295088	NO	NO	110000	NO	NO	112456	NO	NO	NO	NO	NO

Table 3. Expiry, cancellation and replacement

Transaction or event type	Expiry, cancellation and requirement to replace		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Temporary CERs (tCERS)								
Expired in retirement and replacement accounts	NO							
Replacement of expired tCERs			NO	NO	NO	NO	NO	
Expired in holding accounts	NO							
Cancellation of tCERs expired in holding accounts	NO							
Long-term CERs (lCERs)								
Expired in retirement and replacement accounts		NO						
Replacement of expired lCERs			NO	NO	NO	NO		
Expired in holding accounts		NO						
Cancellation of lCERs expired in holding accounts		NO						
Subject to replacement for reversal of storage		NO						
Replacement for reversal of storage			NO	NO	NO	NO		NO
Subject to replacement for non-submission of certification report		NO						
Replacement for non-submission of certification report			NO	NO	NO	NO		NO
Total			NO	NO	NO	NO	NO	NO

Table 4. Total quantities of Kyoto Protocol units by account type at end of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	116612408	NO	NO	NO	NO	NO
Entity holding accounts	2752354	NO	NO	110000	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	NO	NO	NO	NO	NO	NO
Retirement account	NO	NO	NO	NO	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	119364762	NO	NO	110000	NO	NO

Table 5 (a). Summary information on additions and subtractions

	Additions						Subtractions					
	Unit type						Unit type					
Starting values	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**	**AAUs**	**ERUs**	**RMUs**	**CERs**	**tCERs**	**lCERs**
Issuance pursuant to Article 3.7 and 3.8	119182130											
Non-compliance cancellation							NO	NO	NO	NO		
Carry-over	NO	NO		NO								
Sub-total	119182130	NO		NO			NO	NO	NO	NO		
Annual transactions												
Year 0 (2007)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 1 (2008)	295088	NO	NO	110000	NO	NO	112456	NO	NO	NO	NO	NO
Year 2 (2009)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 3 (2010)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 4 (2011)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sub-total	295088	NO	NO	110000	NO	NO	112456	NO	NO	NO	NO	NO
Total	119477218	NO	NO	110000	NO	NO	112456	NO	NO	NO	NO	NO

Table 5 (b). Summary information on replacement

	Requirement for replacement		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Previous CPs			NO	NO	NO	NO	NO	NO
Year 1 (2008)		NO	NO	NO	NO	NO	NO	NO
Year 2 (2009)		NO	NO	NO	NO	NO	NO	NO
Year 3 (2010)		NO	NO	NO	NO	NO	NO	NO
Year 4 (2011)		NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO	NO	NO

Table 5 (c). Summary information on retirement

	Retirement					
	Unit type					
Year	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Year 1 (2008)	NO	NO	NO	NO	NO	NO
Year 2 (2009)	NO	NO	NO	NO	NO	NO
Year 3 (2010)	NO	NO	NO	NO	NO	NO
Year 4 (2011)	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO

Table 6 (a). Memo item: Corrective transactions relating to additions and subtractions

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Table 6 (b). Memo item: Corrective transactions relating to replacement

	Requirement for replacement		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Table 6 (c). Memo item: Corrective transactions relating to retirement

	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

ANNEX 9 QUALITY IMPROVEMENT PLAN

Quality Improvement Plan
GHG inventory 2009

Latvian Environment, Geology and Meteorology Agency collaborating with involved institutions

Introduction

Quality improvement plan of GHG inventory submission 2009, was prepared according to Quality Control and Quality Assurance program made by LEGMA and taking into account recommendations made by ERT (in FCCC/IRR/2007/LVA (14 December 2008), Centralized review (2008), Report of the review of the initial report of Latvia [FCCC/IRR/2007/LVA, 14.12.2007).

In June 2008 meeting was organized, where the necessary changes and improvements for submission 2009 were presented. Until August 2008 changes and improvements were approved by institutions involved in preparation of GHG inventory.

Aims of quality control and quality assurance for GHG inventory

The general aim is to prepare a good quality feasible GHG inventory where quality assurance and quality control activities are implemented taking into account emission uncertainties.

Salient aims are according to inventory principles about data and information transparency, completeness, consistency, comparability and accuracy.

Planned aims, responsible institutions and activities for GHG inventory 2009:

Planned General aims	Responsible institution	Activity
Elaborate the national legislation that determine involved institutions, their roles, QA/QC procedures for the GHG inventory	MoE	-) New Regulation No.157 was approved by Cabinet of Ministers on 17 of February 2009 it determinates the institutions that are responsible for GHG inventory preparation, roles and QA/OC procedures (Detailed description in the chapter 1.2 of NIR 2009). -) Article 12 of Regulation stated that MoE supervise and together with LEGMA coordinate QA/QC procedures.
Take into account QC/QA procedures in process of inventory preparation	All institutions involved in preparation process of GHG inventory	-)General QC procedures was done for all sectors by experts who prepare inventory. The Tier 1 method was used for QC by sectoral experts. Special template was used for documentation of the findings. -) Inventory was sent to the responsible ministries, CSB for checking and approval. -) The final check was done by MoE.
Inclusion of transparent information in the NIR		The NIR is prepared according to the UNFCCC reporting requirements and guidelines.

Enforce recommendations made by UNFCCC reviewers		QA/QC was elaborated according to the new legislation only in the beginning 2009. Implemented recommendations are described in the NIR under each sub sector and below of this table related sectors.
Submit emissions in all IPCC categories and possible gases		-) Emissions were reported for all IPCC categories where data was available. -) For categories where emissions aren't calculated due to lack of activity data or other essential information indicators according to reporting guidelines were used. -) new emission sources in the emission estimation is included, particularly in the sector 1A4a where stationary combustion of natural gas in pipeline enterprise is included for 1990-1993 and in 1A2a sector where coke consumption was included for all years
Checking the time series and succession		Time series were checked during internal quality control as well as within EU consistency report checking. Any fluctuations were described in the NIR 2009. For example, CH_4 emissions from industrial Waste Water Handling were corrected due to mistake in data calculation.
Inclusion of information about recalculations in the National inventory report		Information about recalculations is included in the NIR under each sub category as well as in the chapter 9.
Usage of methodologies and formats for emission calculation and submitting according to IPCC, UNFCCC and Kyoto Protocol requirements		Emissions were calculated according to IPCC Guidelines, additional using national studies for several parameters. Usages of national studies detailed are described in the NIR 2009.
Preparation and submission of GHG inventory to the EC and UNFCCC in due time		GHG inventories for EC and UNFCCC were prepared in time.
Planned aims related sectors	**Responsible institution**	**Activity**
Energy		
Improve of emission factors, methodologies and activity data	LEGMA	-) CO_2 emission factors for liquid and gaseous biofuels are taken from IPCC 2006 corresponding to biofuels instead of use of CO2 emission factor for natural gas also for gaseous biofuels; -)CO_2 EF for industrial wastes (used tires) was changed to the EF reported by the cement production plant within EU ETS; -)use of bottom-up data for the fugitive

		NMVOC emission report from the activities with oil products; -) NOx, SOx emissions for 2002 – 2007 from LCP are taken from database 2-AIR; -) natural gas consumption for 1990-1993 in the pipeline enterprise is included in 1A4a as it is stacionary combustion; -) coke consumption was included in 1A2a as coke is not used as feedstock.
Transport		
Improve of emission factors, methodologies and activity data	MoE, FEI	-)COPERT IV was used only for 2004-2007.
ERT For marine bunkers all fuels delivered to the ports are also considered to be for international bunker fuel uses. To differentiate bunker fuel use from domestic use, a study of domestic navigation was also carried out on seasonal watercraft use in Latvia. Both studies are only available in Latvian, making it difficult for the ERT to fully review them. It also remains unclear how the current use of the CSB surveys on the ports differentiates the potential uses for domestic navigation along the Daugava River from international bunker uses. The ERT recommends that the results of the surveys be further explained and investigated by the CSB, to verify that the assumption that all fuel deliveries to the ports are indeed only for international bunker fuel uses is correct. In response to the ERT's recommendations, Latvia advised the ERT that this will be clarified in the 2008 inventory submission.	LEGMA, CSB, MoT	The problem wasn't solved. For submission 2009, responsible institution was changed.
Industrial Processes		
Improve of emission factors, methodologies and activity data	LEGMA	-) NMVOC emission factor for CRF 2D2 spirits category is changed to emission factor for other spirits as strong alcohol is produced only from grains in Latvia.
Agriculture		
ERT It recommends Latvia to conduct an expert peer review on the agriculture sector according to the IPCC good practice guidance, with the review to include impartial reviewers such as agriculture experts not currently involved in the inventory compilation (e.g. university professors).	MoE, MoA, LEGMA	Emission calculation is done by LEGMA. Several additional meetings were organized where all involved institutions discussed existing problems (national studies, emissions from field and agricultural residue etc.). Conclusions were recorded in minutes and archived by MoE and LEGMA. Development of country specific data and emission factors is impossible due to lack of finances.

ERT The ERT recommends Latvia to apply a higher-tier method to estimate CH_4 emissions from enteric fermentation from significant livestock species, such as dairy cattle, in line with recommendations of the good practice guidance, in its future submissions	MoE, MoA, LEGMA	In submission 2009, emissions were estimated according to IPCC Tier1.
ERT The ERT identified from the NIR that Latvia has allocated livestock according to animal waste management systems, which is already an important step towards the application of a tier 2 methodology. It recommends Latvia to apply the tier 2 methodology, together with country-specific data, in its future submissions. If data are not available, Latvia should explain how the IPCC default EFs, that it has chosen correspond to the national circumstances.	MoE, MoA, LEGMA	
ERT The ERT recommends that in its next inventory submission, to improve transparency, Latvia document the assumptions and methods used and the values of the parameters used to calculate area of cultivated histosols. Also, Latvia should take into account any changes in N excretion from animals (manure management (4.B.2) in calculating direct N_2O emissions from agricultural soils.	MoE, MoA, LEGMA	Parameters used for inventory preparation are described in NIR.
LULUCF		
ERT The methodology used to estimate the LULUCF categories is the IPCC tier 1 method. The ERT recommends Latvia to progress to a higher-tier method, in line with recommendations of the IPCC good practice guidance for key categories in its next inventory submission. In response to the ERT's recommendations, Latvia advised the ERT that it will implement and document a higher-tier method in the 2008 inventory submission	MoE, MoA	For submission 2009, CO_2 removals and emissions was calculated according to new methodology. Detailed description is included in NIR.
ERT The ERT found that the inter-annual variations of CO_2 emissions are not well described in the NIR. To increase the transparency of the inventory, the ERT recommends that Latvia provide information on major changes associated with the volume of timber harvesting (e.g. resulting from natural causes such as storms, or from changes in policies or economic development).	MoA	Information is included in the NIR.
ERT Emissions from wildfires are reported as .NE.. However, a national study (Forest Fire Situation in Latvia, IFFN no. 24 April 2001, pp. 31.34) identifies that, in 1990, an average of over 500 ha forest land were burned. The ERT recommends Latvia to estimate the emissions from wildfires in its future submissions. Following the in-country review Latvia advised the ERT that the estimation of emissions from wildfires will be addressed in the 2008 inventory submission.	MoA	Emissions are included in the submission 2009.

Waste		
ERT The ERT also recommends Latvia to improve the consistency between the CRF tables and the NIR with regard to the methodology used to estimate N_2O emissions from wastewater handling.	LEGMA	Information in CRF and NIR was checked and corrections were done.
ERT The ERT recommends that for its future submissions Latvia use surveys and thoroughly documented expert judgment to collect country-specific data on the amount of wastewater treated in anaerobic conditions in the different existing systems (e.g. latrine, septic tank, lagoon) in order to be able to move to a tier 2 methodology for estimating CH_4 emissions from wastewater handling (6.B.1). Latvia should also apply the appropriate parameters (e.g. methane conversion factor (MCF); methane producing capacity (Bo); and biochemical oxygen demand (BOD)) based on research. In addition, the ERT recommends that the method used by Latvia to estimate emissions from industrial wastewater be reported in both the NIR and the CRF tables in the next inventory submission, in order to improve consistency.	LEGMA	BOD is determined according to national legislation (Regulations No.34 of Cabinet of Ministers) as 60g O_2/person/day. Emissions from industrial wastewater were included in CRR and described in NIR. Development of country specific data and emission factors is impossible due to lack of finances.
ERT The ERT recommends Latvia to increase the transparency of its reporting by explaining in its next inventory submission the rationale used for the allocation of emissions between the waste and energy sectors for the years 1999.-2004.	LEGMA	Emissions from waste incineration with energy recovery are counted under Energy sector and this information is included in the NIR.