LIETUVOS RESPUBLIKOS APLINKOS MINISTERIJA

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NATIONAL GREENHOUSE GAS EMISSION INVENTORY REPORT 1990-2011

REPUBLIC OF LITHUANIA

VILNIUS, 2013

PREFACE

Lithuania's GHG inventory submission under the United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and EU Decision No 280/2004/EC contains:

1. National Inventory Report (NIR)
2. CRF (Common Reporting Format) data tables for years 1990-2011 including KP-LULUCF data tables for years 2008-2011
3. SEF (Standard Electronic Format) tables for reporting of Kyoto units (AAUs, ERUs, CERs, tCERs, lCERs, RMUs) in the National registry during the year 2012.

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Abbreviations

AB	Stock company (SC)
AIRBC	Agricultural Information and Rural Business Centre
ARD	Afforestation, Reforestation and Deforestation
BOD	Biochemical Oxygen Demand
CC	Cropland remaining cropland
CC	Cropland remaining Cropland
CFC	Chlorofluorocarbon
CH_4	Methane
CHP	Combined Heat and Power
CM	Cropland management
CO_2	Carbon dioxide
CO_2 eq.	Carbon dioxide equivalent
COD	Chemical Oxygen Demand
COP	Conference of the Parties
CR	CORINAIR emission factor.
CRF	Common Reporting Format
CS	Country Specific emission factor
D	Default emission factors
D	Deforested areas
DOC	Degradable Organic Carbon
EF	Emission Factor
EPA	Lithuanian Environmental Protection Agency
ERT	Expert Review Team
FAO	Food and Agriculture Organization of the United Nations
FF	Forest Land remaining Forest Land
FM	Forest Management
FOD	First Order Decay
FRA	Forest Resources Assessment
GDP	Gross Domestic Product
GG	Grassland remaining Grassland
GHG	Greenhouse gases
GIS	Geographic Information System
GLM	Grazing land management
GPG	Good Practice Guidance
HFC	Hydrofluorocarbon
HSPP	Hydro Storage Power Plant
IE	Included elsewhere
IFA	International Fertilizer Industry Association
IPCC	Intergovernmental Panel on Climate Change
Kt	Thousand tonnes
L	Level
LF	Land converted to Forest Land
LSFC	Lithuanian State Forest Cadastre
LULUCF	Land Use, Land-Use Change and Forestry
MCF	Methane correction factor
MoE	Ministry of Environment
MSW	Municipal Solid Waste
Mtoe	Million Tonnes of Oil Equivalent

N_2O	Nitrous oxide
NA	Not applicable
NCV	Net Calorific Value
NE	Not estimated
NFI	National Forest Inventory
NGO	Non-governmental organization
NHF	Nature Heritage Fund
NIR	National Inventory Report
NLS	National Land Service
NMVOC	Nonmethane volatile organic compounds
NO	Not occuring
NPP	Nuclear Power Plant
PFC	Perfluorocarbon
PP	Power Plant
QA/QC	Quality Assurance/Quality Control
REPD	Regional Environmental Protection Departments
RES	Renewable Energy Source
REV	Revegetation
SEF	Standard electronic format
SF_6	Sulphur hexafluoride
SFS	State Forest Service
SWDS	Solid Waste Disposal Sites
T	Trend
TOE	Tonne of Oil Equivalent
TPP	Thermal Power Plant
UAB	Joint-stock company (JSC)
UNFCCC	United Nations Framework Convention on Climate Change
WD	Wood Density

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Executive Summary

ES.1 Background Information on Greenhouse Gas Inventories and Climate Change

Lithuania takes part in the global climate change mitigation process and is one of the 195 countries of the world that have ratified the United Nations (UN) Framework Convention on Climate Change (UNFCCC). The UNFCCC entered into force on 21st of March, 1994. The Seimas of the Republic of Lithuania ratified the UNFCCC in 1995. The Kyoto Protocol (KP) was signed in 1998 and ratified in 2002. In accordance with Kyoto Protocol Lithuania has undertaken to reduce it`s greenhouse gas (GHG) emissions by 8% below 1990 level during the first commitment period 2008-2012.

As a Party to the UNFCCC and in accordance with Article 5, paragraph 2 of the Kyoto Protocol, Lithuania is required to develop and regularly update national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not regulated by Montreal Protocol. As a member of the European Union, Lithuania also has reporting obligations under the Decision 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol.

The GHG inventory is prepared in accordance with the Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11 (FCCC/SBSTA/2006/9). Greenhouse gas inventory is compiled in accordance with the methodology recommended by the Intergovernmental Panel on Climate Change (IPCC) in its Revised 1996 Guidelines for National Greenhouse gas Inventories (IPCC, 1997), Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000) and Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003), the Annotated outline of the National Inventory Report including elements under the Kyoto protocol (UNFCCC secretariat, 2009) and taking into account remarks by the UNFCCC expert team, provided in the Reports of the individual review of the annual submission of Lithuania.

The first national GHG inventory data was submitted in 1996 for the first National Communication under the UNFCCC. In 2004 first National Inventory Report (NIR) and Common reporting format (CRF) tables have been developed. In 2006 for the first time complete time series for the period 1990-2004 of the GHG inventory has been developed and submitted to European Commission and the UNFCCC Secretariat together with Lithuania's Initial Report under the Kyoto Protocol.

In accordance with the order of Minister of Environment of 22nd of December, 2010, the Lithuanian Environmental Protection Agency (EPA) under the Ministry of Environment was announced as an institution responsible for the GHG inventory preparation starting from 2011. EPA responsibilities *inter alia* include monitoring of environmental quality, collection and storage of environmental data and information as well as assessment and forecasting of environmental quality. The working group for GHG inventory preparation include members from Lithuanian Energy Institute, Institute of Physics of the Centre for Physical Sciences and Technology, Institute of Animal Science of the Lithuanian University of Health Sciences, Public body Centre for Environmental Policy, The State Forest Service (SFS) and State-owned enterprise State Land Fund. External experts, independent specialists providing data for the GHG inventory, may also be involved during the inventory process. The Ministry of Environment is a supervisor and coordinator for preparation of NIR and nominated as a National Focal Point to the UNFCCC.

The greenhouse gas inventory presented here is the ninth national GHG inventory report and contains information on anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by Montreal Protocol:

- Carbon dioxide CO_2,
- Methane CH_4,
- Nitrous oxide N_2O,
- Hydrofluorocarbons HFCs,
- Perfluorocarbons PFCs,
- Sulphur hexafluoride SF_6.

In addition, the inventory includes estimates of emissions of the precursors: nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), and carbon monoxide (CO), as well as for sulfur dioxide (SO_2).

The national GHG inventory report contains detailed information about Lithuania's emissions by sources and removals by sinks for the period from 1990 to 2011.

For the preparation of the inventory CRF Reporter v.3.6 software has been used. The NIR includes trends in greenhouse gas emissions, description of each emission category of the CRF, key sources, uncertainty estimates, explanations on recalculations, planned improvements and procedure for quality assurance and quality control (QA/QC).

This report also includes supplementary information in accordance with Article 7, paragraph 1 ofthe Kyoto Protocol:

- information on emissions and removals from the land use, land use change and forestry (LULUCF) sector under Article 3 paragraphs 3 and 4 of the Kyoto Protocol (see Chapter 7),
- information on the national registry which is responsible for emission accounting and removal units of each Party (see Chapter 14),
- information on changes that have occurred in the national system comparing with the information reported in the last submission (see Chapter 13),
- information on the minimization of adverse impacts in accordance with Article 3, paragraph 14 (see Chapter 15), and
- Summary information on the accounting of Kyoto units (emission reduction units (ERUs), certified emission reductions (CERs), temporary certified emission reductions (tCERs), long-term certified emission reductions (lCERs), assigned amount units (AAUs) and removal units (RMUs)) (see Chapter 12).

ES.2 Summary of national emission and removal related trends

A summary of Lithuania's GHG emissions and removals for 1990-2011 is presented in Table 1.

Table 1. Trends of greenhouse gas emissions by sectors, CO_2 eq., Gg

GHG source and sink categories	Energy	Industrial Processes	Solvent and Other Product Use	Agriculture	LULUCUF	Waste	Total (including LULUCF)	Total (excluding LULUCF)
1990	32744,95	4396,79	197,52	10292,09	-4286,58	1122,51	44467,29	48753,87
1991	34883,84	4434,17	195,83	9464,70	-4204,40	1143,96	45918,10	50122,50
1992	19646,13	2561,62	193,87	6651,94	-4166,96	1158,36	26044,95	30211,91
1993	15789,18	1642,78	191,53	5530,83	-5523,22	1175,92	18807,03	24330,24
1994	14849,86	1827,47	188,98	4866,13	-4355,65	1176,21	18553,01	22908,66
1995	13903,45	2111,50	186,36	4680,76	-3375,69	1178,88	18685,27	22060,96
1996	14407,93	2525,83	183,75	5046,05	1823,18	1181,41	25168,14	23344,97
1997	13963,72	2484,35	181,17	5221,04	207,24	1186,69	23244,20	23036,97
1998	14676,63	2910,30	178,61	4848,59	-7659,21	1188,91	16143,83	23803,04
1999	12331,85	2856,09	176,07	4704,95	-7699,94	1186,56	13555,57	21255,52
2000	10807,37	3018,96	173,54	4457,30	-9240,01	1190,58	10407,73	19647,75
2001	11461,38	3265,63	170,87	4599,14	-12713,88	1216,25	7999,39	20713,27
2002	11551,44	3445,00	168,22	4862,90	-5343,31	1220,74	15904,99	21248,30
2003	11544,79	3528,66	165,58	4987,46	-9755,72	1224,69	11695,45	21451,18
2004	12164,11	3724,08	162,64	4993,67	-6598,59	1196,99	15642,91	22241,50
2005	12858,95	4088,94	159,22	5062,77	-4745,58	1173,40	18597,71	23343,28
2006	13049,23	4341,00	127,72	5086,29	-4712,91	1143,73	19035,06	23747,97
2007	13283,25	6195,16	117,56	5439,91	-3504,75	1121,50	22652,62	26157,37
2008	13132,81	5525,20	90,95	5057,12	-8435,51	1113,19	16483,76	24919,27
2009	11861,22	2367,15	95,38	5008,98	-10629,82	1090,37	9793,28	20423,10
2010	12757,79	2227,99	87,41	4984,65	-10397,49	1062,74	10723,09	21120,58
2011	11820,46	3735,01	85,95	4979,97	-10483,49	990,31	11128,20	21611,70
2011/1990%	**-63,90**	**-15,05**	**-56,49**	**-51,61**	**144,57**	**-11,78**	**-74,97**	**-55,67**

The most significant source of greenhouse gas emissions in Lithuania is energy sector with 54,7% share of the total emissions in 2011. Agriculture is the second most significant source and accounted for 23% of the total emissions. Emissions from industrial processes contributed 17,3% of the total greenhouse gas emissions, waste sector – 4,6%.

Main contributors in energy sector are Energy industries and Transport sectors. In 2011 these sectors composed 37,6% and 37,9% of total GHG emisions from Energy sector respectively.

The composition of greenhouse gas emissions by sectors in 2011 is presented in Figure 1.

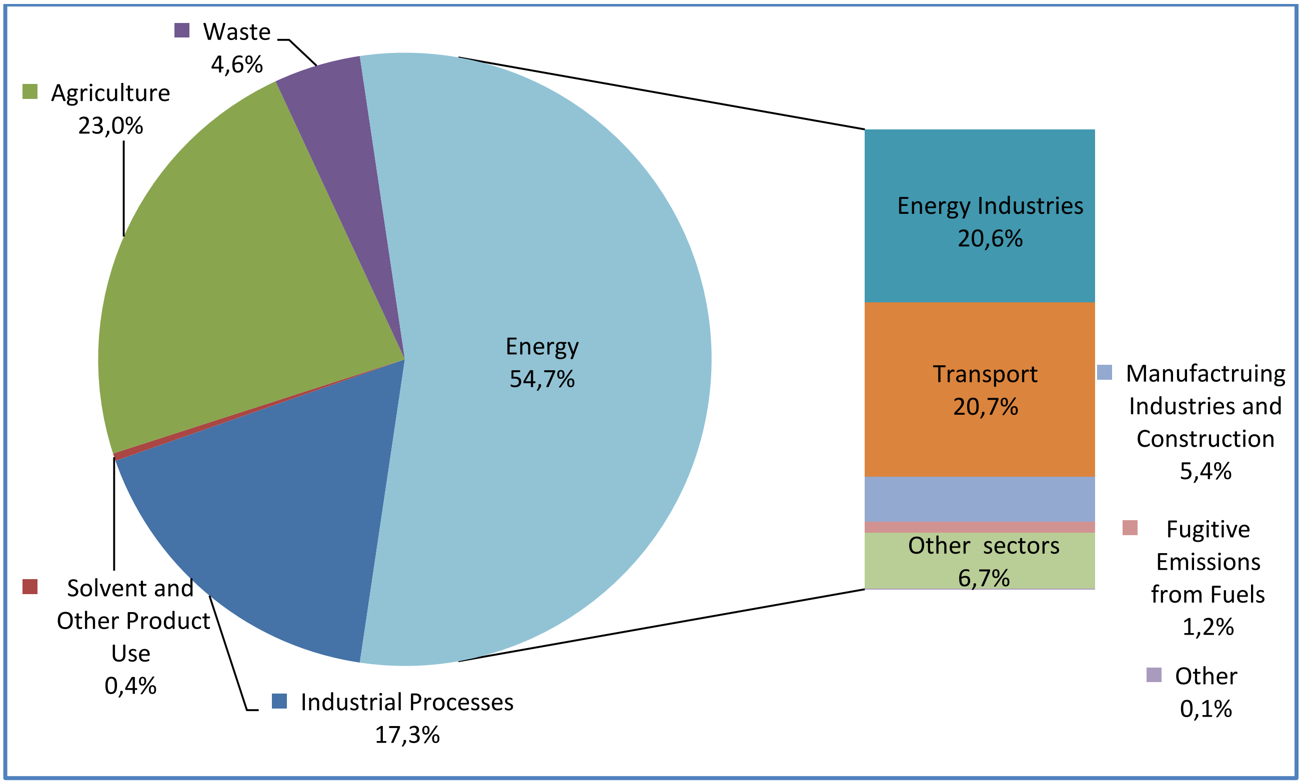


Figure 1. The composition of Lithuanian GHG emissions (CO_2 eq.) by sectors (excl. LULUCF) in 2011

The total GHG emission (excl. LULUCF) amounted to 21611,7 Gg CO_2 eq. in 2011. The emission have decreased by 55,7% comparing with the base year. The base year is 1990 for the greenhouse gases CO_2, CH_4, N_2O and 1995 for the F-gases HFC, PFC and SF_6.

The largest source of CO_2 emission is the *energy sector* accounting 80,6% of the total national CO_2 emission (excl. LULUCF) in 2011. The energy industries contribute 39,3% and the transport sector accounts for 39,4% of the CO_2 emission in energy section.

Comparing with 2010 CO_2 emission from energy sector in 2011 decreased by 7,3% wherein CO_2 emission from the energy industries and transport sector decreased by 16,4 and 1,8%, respectively. Decrease of emissions in the energy industries is related to changes in fuel consumption.

The most important GHG in 2011 is CO_2, it contributed 64,6% of the total national GHG emissions expressed in CO_2 eq., followed by N_2O (20,2%) and CH_4 (14,1%). HFCs and SF_6 together amounted 1,0% of the total GHG emissions (excl. LULUCF) in Lithuania.

Between 1990 and 2000 GHG emissions decreased significantly as a consequence of the decline in industrial production and associated fuel consumption. Once the economy started to grow again, emission rose but this was partly compensated by reductions achieved through energy efficiency and measures taken to reduce emissions.

Total GHG emissions in 2011 comparing with 2010 increased by 2,3% (excl. LULUCF) due to increase of energy consumption.

An overview of estimated GHG emissions is presented in Figure 2, which shows GHG emissions by gases, expressed in CO_2 eq. (excl. LULUCF) for the period 1990-2011.

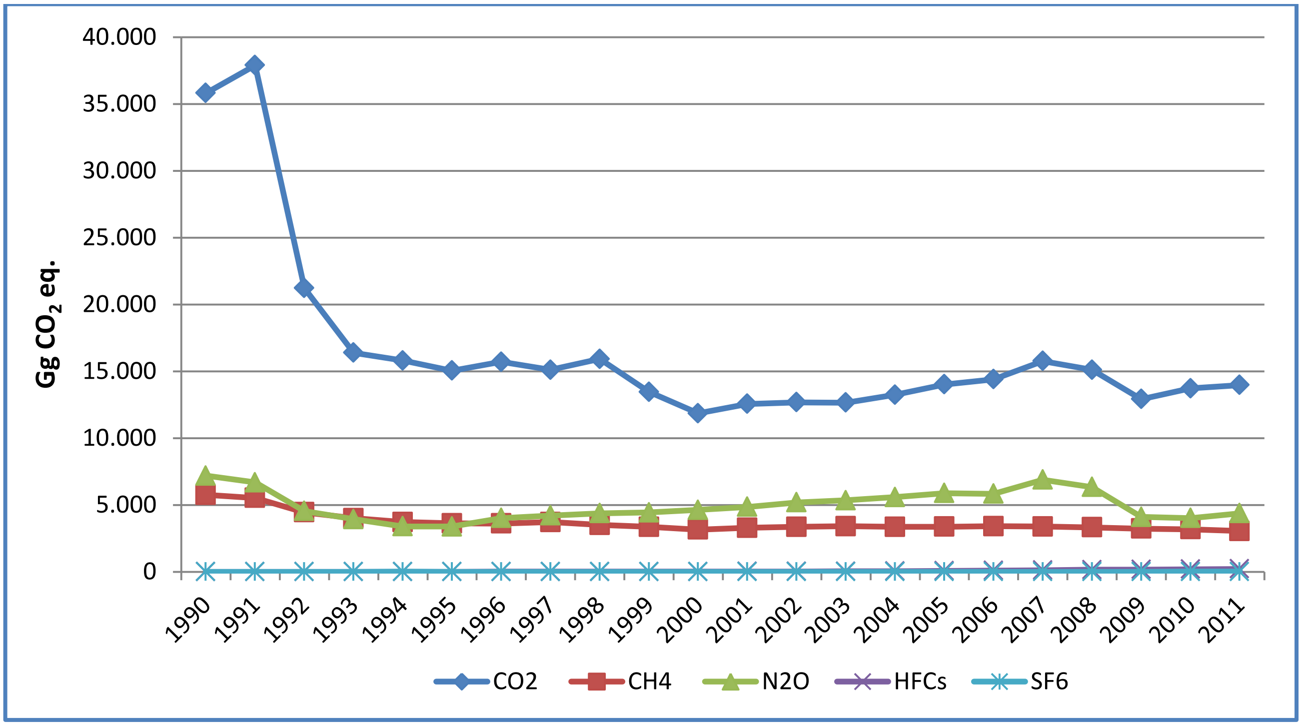


Figure 2. Trends of GHG emissions by gas in CO_2 eq., Gg (excl. LULUCF)

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

Energy sector is the most significant source of GHG emissions in Lithuania with 54,7% share of the total emissions (excl. LULUCF) in 2011. Emissions from energy include CO_2, CH_4, N_2O gases.

CO_2 emission from energy sector contained 80,6% of the total national CO_2 emissions (excl. LULUCF) in 2011. The main categories are energy industries and transport which contribute 31,6% and 31,7% to the total national CO_2 emission (excl. LULUCF), respectively. Comparing with 2010 CO_2 emissions from energy sector decreased by 7,3% wherein CO_2 emissions from energy industries and transport sector decreased by 16,4% and 1,8%, respectively. The emissions of CH_4 have decreased by 4,1% and N_2O emissions increased by 8,6%. The increase of N_2O emission was caused by increase of ammonia and nitric acid production.

The second important source of GHG emissions is agriculture sector accounting for 23% of the total GHG emissions (excl. LULUCF). This sector is the most significant source of CH_4 and N_2O emissions accounting for 54,8% and 75% of the total CH_4 and N_2O emissions, respectively. The main source of CH_4 emissions is enteric fermentation contributing 71,1% to the total agricultural CH_4 emissions. Agricultural soils are the most significant source of N_2O emissions accounting for 92% of the total agricultural N_2O emissions. Comparing with 2010 GHG emissions in agriculture sector in 2011 has not changed a lot with a small decrease of 0,2%.

Emissions from industrial processes amount to 17,3% of the total GHG emissions (excl. LULUCF) in 2011. The main categories are: ammonia production, nitric acid production and cement production. Ammonia production is the largest source of CO_2 emissions in industrial processes sector contributing 10,3% to the total national CO_2 emissions (excl. LULUCF) in 2011. Nitric acid production is the single source of N_2O emissions in industrial processes sector and accounts for 20% in the total national N_2O emissions (excl. LULUCF) in 2011. The GHG emissions in 2011 from industrial processes has increased by 67,6% comparing with 2010. The increase of GHG emission from industrial processes in 2011 was mainly due to increased ammonia and nitric acid production.

The use of solvents in industries and households contribute only 0,4% of the total GHG emissions (excl. LULUCF). The greenhouse gas emissions from this sector decreased by 1,7% in 2011 comparing with the previous year. This reduction was caused by population decrease.

Waste sector accounted for 4,6% of the total GHG emissions in 2011 (excl. LULUCF). The solid waste disposal on land is the second important source of CH_4 emissions. It contributes 26,5% to the total CH_4 emissions (excl. LULUCF). There was 8,6% decline in CH_4 emission from waste sector in 2011 caused by increased extraction of landfill gas from the biogas plants.

PART 1:
ANNUAL INVENTORY SUBMISSION

1 INTRODUCTION

1.1 Background information regarding greenhouse gas inventories and climate change

1.1.1 Background information about climate change

Lithuanian climate is formed affected by global factors and local geographical circumstances. Key features of the climate depend on the country's geographical location. The territory of Lithuania lies in the northern part of the temperate climate zone. The distance from the equator (6100 km) and from the North Pole (3900 km) determines general solar radiation flux and atmospheric circulation patterns over the country. According to the general classification of climate, almost the entire territory of Lithuania is assigned to the south-western sub-region of the continental forest region of the middle latitudes of the Atlantic Ocean, because its climate is close to that of Western Europe; while the Baltic coast is assigned to the South Baltic sub-region.

The character of climate variations in Lithuania greatly depends on the processes of atmospheric circulation, i.e., cyclonic and anticyclonic formations and air mass advection of a different nature. It was observed that a number of deep cyclones visiting Lithuania in cold seasons (November - March) was increasing, whereas a number of anticyclonic formations decreasing. The changing patterns of atmospheric circulation entailed changes in other climatic indices: changes in thermal season duration, decrease in seasonal differences of air temperature and precipitation amount, decline in snow cover indices.

Rapid increase in average annual temperature in Vilnius is observed in the last 30 years (Fig. 1-1).

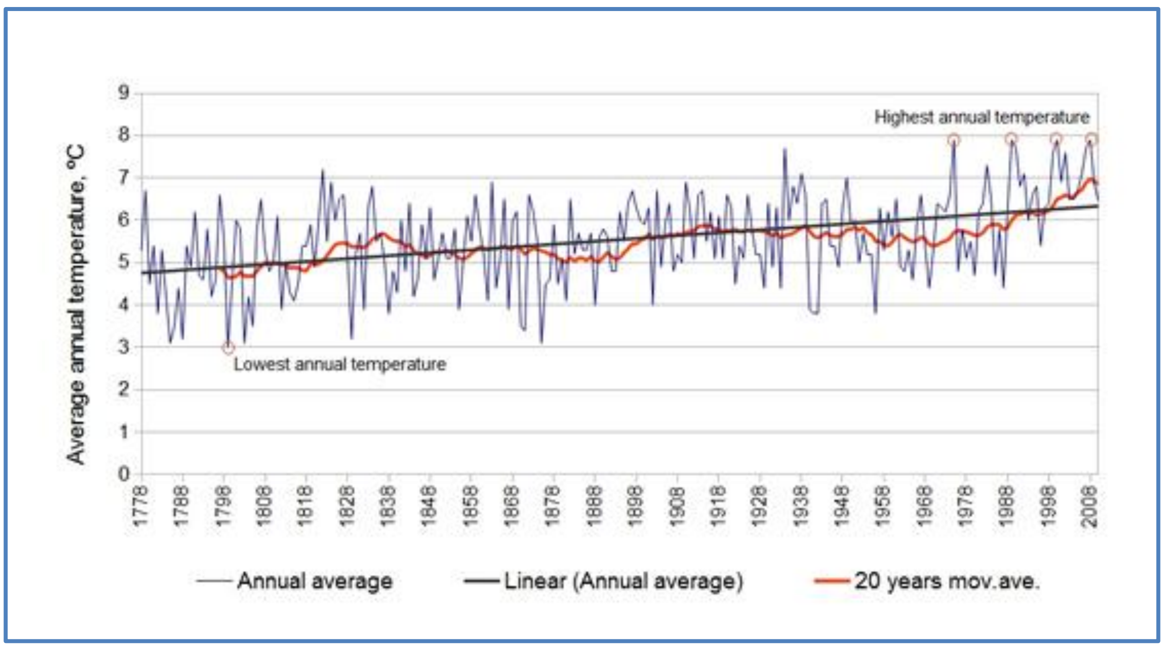


Figure 1-1. Average annual temperature in Vilnius, 1778-2010[1]

[1] Lithuanian Hydrometeorological Service under the Ministry of Environment. Available from: *http://www.meteo.lt/english/*

Average annual temperature, compared with the beginning of 20th century, has increased 0,7-0,9 °C which leads to more frequent droughts (for example 1992, 1994, 2002, 2006 summer seasons). Changes in precipitation patterns are not homogenous – in some parts of Lithuania it is increasing, in other – decreasing. However, these changes are not very significant. There is an observed tendency of precipitation increase during cold season and decrease during warm season. Liquid precipitation is becoming more frequent in cold season.

In Lithuania climate predictions are made by downscaling COSMO-CLM, HadCM3, ECHAM5 models output data. According to the modelling results, average maximum and minimal temperature in 21st century in Lithuania should increase. Highest changes are predicted during cold season. In Vilnius, average maximum and minimum temperature could increase by 4 °C in year 2100. During different months, however, this increase could be up to 7 °C.

In 21st century heat waves (days when maximum temperature ≥ 30 °C) will become more frequent. In 2061-2100 there could be 7 heat wave days per year more compared to 1971-2000. Cold spells, on the contrary, will become less frequent with most significant changes in January. Modelling experiments suggest that at the end of 21st century cold spells (days when minimal temperature ≤ -15 °C) will occur only during January-February.

In 21st century sunshine hours will increase during August – October, and will decrease during rest of the year. This will be caused by the higher cyclonic activity during cold season.

Studies made in Lithuania assumes that biggest changes in precipitation patterns will be during winter season and will not be so explicit in summer. Precipitation can double in Klaipėda – by the end of century precipitation amount can increase 16-22% compared to the end of 20th century. In Vilnius changes will be not so significant – projected increase is about 9-10%. Severe thundershowers will be more frequent on the coast (> 30 %).

Changes in temperature and precipitation patterns will affect different economical activities and natural ecosystems. Coastal region is one of the most vulnerable regions in Lithuania. Lithuanian coast is in the south-eastern region of Baltic Sea which will undergo biggest changes in 21st century, due to the sink of terrain and sea level rise. Pessimistic scenario suggests that water level in this region can rise by 0,5-1,0 m. In that case, there would be high risk of flooding urban areas in Klaipėda and Palanga. Also wind surge could disturb the port activities in Klaipėda more frequently.

All information about climate condition in Lithuania is observed from Lithuanian Hydrometeorological Service.

1.1.2 Background information on greenhouse gas inventories

This National Inventory Report (NIR) covering the inventory of GHG emissions of Lithuania is being submitted to the secretariat of the UNFCCC, in compliance with the decisions of the Conference of the Parties 3/CP.5 and 11/CP.4. It also was submitted to the European Commission and complies with Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community GHG emissions and for implementing the Kyoto Protocol.

Since 2004, inventory is prepared in common reporting format (CRF). From 2006 inventory is being prepared using CRF Reporter software, developed by UNFCCC secretariat. In 2006 for the first time complete time series 1990-2004 has been developed and submitted to the European Commission and the UNFCCC together with Lithuania's Initial Report under the Kyoto protocol.

The GHG inventory presented here contains information on anthropogenic emissions by sources and removals by sinks for the following direct (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) and indirect (CO, NOx, SO_2, NMVOCs,) greenhouse gases. This report contains detailed information about Lithuania's GHG inventory for the period 1990-2011. The NIR includes description of the methodologies and data sources used for emissions estimation by sources and removals by sinks, and discussion of their trends. The purpose of report is to ensure the transparency, consistency, comparability, completeness and accuracy of GHG inventory. For the preparation of inventory CRF Reporter v.3.6 software has been used.

The GHG inventory is prepared in accordance with the updated UNFCCC guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11 (FCCC/SBSTA/2006/9). Greenhouse gas inventory is compiled in accordance with the methodology recommended by the Intergovernmental Panel on Climate Change (IPCC) in its Revised 1996 Guidelines for National Greenhouse gas Inventories (IPCC, 1997), Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003) and Annotated outline of the National Inventory Report including elements under the Kyoto Protocol (UNFCCC secretariat, 2009), Guidelines for National Greenhouse Gas Inventories (IPCC, 2006).

1.2 Institutional Arrangement and Process for Inventory Preparation

1.2.1 Overview of institutional, legal and procedural arrangements for inventory preparation

National system for Lithuanian GHG inventory preparation have been changing over the time. Until the year 2011, GHG inventory preparation process was performed by contracting GHG compilers on the annual basis. Aiming to increase institutional capacity for inventory preparation and continuity of the inventory preparation process in compliance with Guidelines for National systems under Article 5 paragraph 1 of the Kyoto Protocol (decision 19/CMP.1) the Government of Lithuania and the Minister of Environment have issued a number of key regulatory legal acts and assigned responsible institutions for GHG inventory preparation. The main entities participating in GHG inventory process are:

- Ministry of Environment
- Environmental Protection Agency
- State Forest Service
- National Climate Change Committee
- Permanent GHG inventory working group
- Data providers
- External consultants

The principle scheme showing institutions responsibility in preparation of the GHG inventory in Lithuania and their interaction is shown in Figure 1-2.

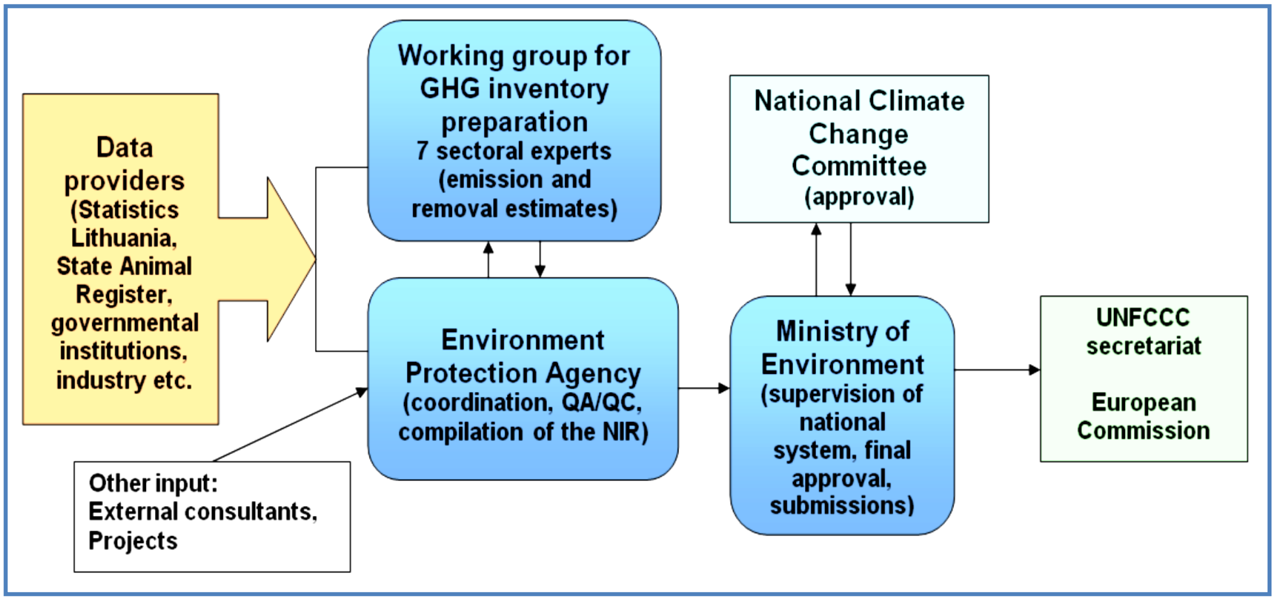


Figure 1-2. Institutional set-up for GHG inventory

Ministry of Environment

Ministry of Environment of the Republic of Lithuania is a National Focal Point to the UNFCCC. The Ministry of Environment is designated as *single national entity* responsible for the national GHG inventory. It has overall responsibility for the National System of greenhouse gas inventory and is in charge of the legal, institutional and procedural arrangements for the national system and the strategic development of the national inventory. Within the ministry, the Climate Change Policy Division of the Pollution Prevention Department administers this responsibility by supervising the national system. The Division will continue to supervise and coordinate the preparation of the National Inventory Report, including the final review of draft inventory reports. Among its responsibilities are the following:

- Overall coordination of GHG inventory process;
- Preparation of legal basis necessary for National System functioning;
- An official consideration and approval of GHG inventory;
- Approval of QA/QC plan and procedures;
- Timely submission of GHG inventory to UNFCCC Secretariat and European Commission;
- Coordination of the UNFCCC inventory reviews in Lithuania;
- Keeping of archive of official submissions to UNFCCC and European Commission;
- Informing the inventory compilers about relevant requirements for the national system.

Environmental Protection Agency

Lithuanian Environmental Protection Agency (EPA) under the Ministry of Environment starting from 2011 was nominated as an entity responsible for GHG inventory preparation by the Order of the Minister of Environment No D1-1017. Before this assignment EPA was one of the main activity data and other relevant information suppliers for GHG inventory's Waste sector and data on F-gases.

At present the EPA collects data on the use of water resources, discharges of waste water, waste generation and treatment, pollution of ambient air and surface water, chemicals and fluorinated gases; manages the available registers, e.g. the Ambient Air Quality, the European Pollutants Releases and Transfer Register and various databases. In 2012 Climate change division for GHG inventory preparation was established within the EPA, consisting of 5 officials.

As the coordinator of the GHG inventory preparation process, EPA has the following functions and responsibilities:

- Development and implementation of QA/QC plan and specific QA/QC procedures;
- Identification of data providers for specific information and collection of activity data and emission factors used to calculate emissions;
- Cooperate with sectoral experts on the selection of methods complying with IPCC Good Practice Guidance for calculation of emissions giving the priority to key categories and categories with high uncertainty;
- Checking and archiving of supplied input data, prepared inventory and used materials;
- Key categories analysis;
- Overall uncertainty assessment;
- Preparation of Common Reporting Format (CRF) tables and compilation of National Inventory Report (NIR);
- Maintaining the GHG inventory database;
- Providing the final inventory (CRF tables and NIR) for Ministry of Environment;
- Evaluating requirements for new data, based on internal and external reviews;
- Other activities.

The EPA establishes and operates GHG inventory database and archive, where archives of GHG inventory submissions and all supporting reference material is stored and maintained. Backups are prepared on regular basis following the EPA's information management procedures. The archive is managed according to the EPA Director's Order No. AV-152 concerning the approval of the National GHG inventory data archiving procedures (26^{th} June 2012). The main QA/QC procedures under responsabilities of EPA are performed according to the EPA Director's Order No. AV-191 concerning the approval of the National GHG inventory data quality assurance and quality control procedures (23^{th} July 2012).

State Forest Service

The State Forest Service (SFS) compiles the National Forest Inventory (NFI) and the forest information system, carries out monitoring of the status of the Lithuanian forests, collects and manages statistical data etc. The Service functions under the Ministry of Environment.

Since 2010 State Forest Service in the GHG inventory preparation process is responsible for calculations of emissions and removals of LULUCF (forestry part) sector and Kyoto Protocol activities under Art. 3 para. 3 and 4 following the order of the Minister of Environment 29 of July, 2010 No D1-666. SFS representative is also a member of permanent working group for GHG inventory preparation under the Government Resolution No 683. In this framework, the State Forest Service has the following responsibilities:

- Collection of activity data and emission factors used to calculate emissions and removals for LULUCF and KP-LULUCF sectors;
- Selection of methods (complying with IPCC Good Practice Guidance for LULUCF) for calculation of emissions and removals giving the priority to key categories and categories with a high uncertainty;
- Emission and removals estimates for LULUCF and KP-LULUCF sectors;
- Uncertainty assessment for LULUCF and KP-LULUCF sector;
- Checking and archiving of input data, prepared estimates and used materials;
- Preparation of Common Reporting Format (CRF) tables and National Inventory Report (NIR) parts for LULUCF and KP-LULUCF;
- Implementation of QA/QC plan and specific QA/QC procedures related to LULUCF and KP-LULUCF;
- Providing the final estimates (CRF tables and NIR part) for the Environmental Protection Agency;
- Evaluating requirements for new data, based on internal and external reviews.

In 2012 permanent staff of State Forest Service was complemented by 6 officials: 2 specialists were employed to work on data collection and GHG emissions and removals estimation from LULUCF and KP-LULUCF sectors and 4 specialists employed to conduct sampling of non-forest land of Lithuania's territory (necessary data collection for LULUCF and KP-LULUCF reporting).

National Climate Change Committee

Before final submission to the UNFCCC Secretariat and the European Commission, National Inventory Report is forwarded to the National Climate Change Committee for the comments and final approval. The National Committee on Climate Change was set up in 2001 in the first instance and renewed in Jannuary 2013. It consists of experts from government, academia and non-governmental organizations (NGOs) and has an advisory role. The main objective of the Committee is to ensure attainment of the goals related to the restriction of GHG emissions as set in the National Sustainable Development Strategy and implementation of the measures for attaining such goals. Also, the Committee has to coordinate the issues related to formulation and implementation of the national policy on climate change management, to advise on the implementation of the provisions of the UNFCCC and coordinate compliance with the requirements of the Kyoto Protocol and the EU legal acts related to the UNFCCC. Also, the Committee submits proposals regarding the annual priorities for the financing of climate change management measures under the Special Program for Climate Change, which is set up by the Law on Financial Instruments for Climate Change Management adopted on 7 July 2009.

Permanent GHG Inventory working group

Permanent GHG Inventory preparation working group is established by the Governmental Resolution No 683 (as amended on 28-03-2012 by Governmental Resolution No 334) and MoE Order No DI-538. According to the Governmental Resolution No 683, working group (commission) for the preparation of a greenhouse gas inventory report consists of representatives from:

- Ministry of Environment (Chairman of the Commission);
- Environmental Protection Agency (Deputy Chairman of the Commission);
- Institute of Physics of the Centre for Physical Sciences and Technology (energy, transport);
- Lithuanian Energy Institute (energy, except transport);
- Institute of Animal Science of the Lithuanian University of Health Sciences (agriculture);
- Lithuanian Research Centre for Agriculture and Forestry (LULUCF, except forestry);
- State Forest Service (LULUCF, forestry);
- Public body Centre for Environmental Policy (Industrial processes and waste).

Institutions, listed in the Governmental Resolution No 683, nominated experts, who have experience in areas related to GHG emissions accounting, and the personal composition of the permanent GHG inventory working group was approved by the MoE Order No DI-538.

Functions and responsibilities of the working group for GHG inventory preparation as a whole are defined as follows:

- Evaluation of requirements for new data based on internal and external reviews;
- Search and identification of specific data providers;
- Preparation of requests for new data;
- Identification, on the basis of the IPCC good practice guidelines, of methodologies for calculation of GHG emissions setting priority to key categories and categories with high uncertainty level;
- Determination of activity data;
- Determination of appropriate emission factors;
- Calculation of emissions;
- Data quality control;
- Filling CRF tables for corresponding sectors, drafting relevant NIR sectoral chapters;
- Preparation of comments and answers to the questions and comments received during the EC and UNFCCC reviews;
- Other activities.

The composition of the Working group for GHG inventory preparation as from 1st of July, 2011 (as approved by MoE Order No D1-538) is as follows:

- Mr. Vitalijus Auglys (Ministry of Environment) – Chairman of the working group;
- Dr. Mindaugas Gudas (Environment Protection Agency) – Deputy Chairman of the working group;
- Dr. Inga Konstantinavičiūtė (Lithuanian Energy Institute) – energy sector (except transport);
- Dr. Steigvilė Byčenkienė (Institute of Physics) – energy sector (transport);
- Dr. Simonas Valatka (Centre for Environmental Policy) – industry sector (industrial processes, solvents and other products use);
- Dr. Remigijus Juška (Institute of Animal Science) – agriculture sector;
- Representatives of Lithuanian Research Centre for Agriculture and Forestry, Vokė branch – LULUCF (land use other than forestry);
- Dr. Ričardas Beniušis (State Forest Service) – LULUCF (forestry);
- Dr. Romualdas Lenkaitis (Centre for Environmental Policy) – waste sector.

Data providers

Data providers are responsible for:

- collection of activity data,
- applying QC procedures (documentation in checklists to be provided to EPA),
- evaluation of uncertainties of the initial data.

The most important data providers for the Lithuanian GHG inventory preparation are: Statistics Lithuania, the Environmental Protection Agency, the State Forest Service, the Lithuanian Forest Research Institute, the Institute of Physics, the Agricultural Information and Rural Business Centre of the Ministry of Agriculture, the Geological Survey of Lithuania, the National Land Service under the Ministry of Agriculture, the Institute of Animal Science, industry companies etc.

The main providers of the data for the Lithuania's GHG inventory are:

- Statistics Lithuania publishes Lithuanian annual statistical publications (annual statistical data on energy balance, agriculture, production and commodities);
- State Forest Service under the Ministry of Environment publishes annual statistical data on forestry (*Lithuanian Statistical Yearbook of Forestry (2001-2011)*; *Lithuanian Country Report on Global Forest Resources Assessment (2005, 2010));*
- The National Land Service under the Ministry of Agriculture provides data of the Lithuanian Land Fund including data on forest land area;
- Environmental Protection Agency collects data and maintains database on wastewater and waste, F-gases;
- Industrial companies (AB Achema (ammonia, nitric acid production data and natural gas consumption data), AB „Orlen Lietuva" (CO_2 EFs for fuel combustion), AB „Akmenes cementas" (activity data and CaO/MgO content), AB „Naujasis Kalcitas" (limestone composition data), glass production companies (data on dolomite, soda ash, potash and chalk use), UAB „Paroc" (rock wool production data, etc.));
- Institute of Physics is annually calculating precursors (NO_x, SO_2, CO, NMVOC) emissions under the UNECE Convention on Long-range Transboundary Air Pollution;
- Agricultural Information and Rural Business Centre of Ministry of Agriculture (data on livestock population);
- State Medicines Control Agency (data on metered dose inhalers, N_2O use in medicine);
- Annual EU Emissions Trading System (ETS) data reports by the operators.

Aiming to set up the system to ensure better data collection for the preparation of NIR, the amendment No 1540 of the Government Resolution No 388 of 7 April 2004 was adopted on 3 November 2010. The Government Resolution determines responsibilities of other ministries and their subordinated institutions, as well as other institutions and the state science research institutes to provide data which they collect and possess and are required for the inventory compilation (Table 1-1). In the Government Resolution each ministry is assigned to collect more precise information from institutions and agencies within their jurisdiction and provide all this information to Ministry of Environment and its authorised institution - Environmental Protection Agency. The state science research institutes are authorised to perform new scientific researches, necessary for the improvement of data collection in the sectors where lack of data is identified, and to provide information required for the preparation of the NIR.

Table 1-1. Summary of institutions responsibilities to provide data under the amendment No 1540 to the Government Resolution No 388

Institution	Data
Ministry of Agriculture and it's subordinates	Information on land use and land use change areas and other relevant information Information on cattle population, age and other relevant information required for inventory's Agriculture sector's estimates preparation
Ministry of Energy and it's subordinates	All the available information required for GHG inventory's Energy sector's estimates preparation
Statistics Lithuania	All the available information required for GHG inventory preparation, including energy and fuel balance, economical development indicators, e.g. GDP, etc.
State science research institutes	All the available information required for GHG inventory preparation possessed by the Lithuanian Energy Institute, Agriculture Institute, Institute of Agrarian Economics, Institute of Animal Science, Institute of Physics, etc.
State Road Transport Inspectorate under the Ministry of Transport and Communications	Information on average CO_2 emission from different type of vehicles
Ministry of Interior and it's subordinates	Information on annually registered number of vehicles, their models, types, engine capacity and fuels used

External consultants

External experts, independent specialists providing data for the GHG inventory (data providers) may also be involved during the inventory process in preparation and upgrading of methodologies, data review and evaluation, they can also perform expertise of the whole inventory or of its separate parts. External experts can be contracted annually in the areas where specific expertise is needed and the experience and knowledge of the working group member's is not enough.

In 2013 Lithuania was selected as one of the ten countries to participate in EU support project "Assistance to MS with KP reporting". This project is a valuable help to MS enabling to improve their reporting of GHG inventory. Lithuania has identified general issues that requires improvments:

- Industrial processes – improvement in collection of activity data for F-gases;
- Agriculture sector – improvement in emission estimation form agricultural soils;
- LULUCF/KP-LULUCF – improvements in estimation of carbon stocks;
- Cross-cutting issues – improvement in estimation of uncertainties and key categories.

The support is provided by experience exchange between Lithuanian sectorial and project experts. The main form of support is wiki forum which is a convenient form of communication for all MS participating in this project. This forum is also helpful as more detailed issues can be discussed, not only those listed above. The support via wiki forum is being held during February-April. The other form of support that will be provided in April-June is workshops (one day visits to MS). These workshops will be applied to deal with the most problematic issues of GHG reporting. The workshops will be organized by mutual agreement of support experts and Lithuanian experts.

Some outcomes of the support project are already reflected in this submission, mainly in cross-cutting issues:

- Improvements in calculation of key categories using a higher approach (Tier 2);
- Improvements in uncertainty evaluation using combined uncertainty analysis.

Other improvements will be generalized and provided in next submission.

Norway Grants partnership project "Cooperation on GHG inventory" between Lithuania and Norway under the programme No 25 „Capacity-building and institutional cooperation between beneficiary state and Norwegian public institutions, local and regional authorities" is delayed and planned to be started in 2013. The partner of this programme will be Norwegian Climate and Pollution Agency (Klif), which is the national entity responsible for GHG inventory preparation in Norway.

The objective of this partnership project is capacity building and improvement of the Lithuania's National system for the preparation of GHG inventory to comply with the relevant UNFCCC and Kyoto protocol reporting requirements. Expected outcomes of the project are:

- A training programme for Lithuanian inventory experts to raise the technical competence of experts involved in the GHG inventory and projections development process. Lithuanian experts lack knowledge related to general as well as specific sectoral GHG emissions and projections reporting requirements. This became very important when permanent working group for GHG inventory was newly established and some of the experts have limited experience with reporting of GHG estimates.
- The development of Quality assurance/Quality control (QA/QC) procedures as well as documenting, archiving system improvement.
- Implementation of studies to fill in the reporting gaps in several GHG inventory areas:
    - Study for evaluation of carbon stocks in forest and non-forest land in soil and forest litter. This study will cover the sampling of soil and litter on the national forest inventory sample plots and analysis of these samples.
    - Study for evaluation of carbon stocks in soil and forest litter of forests that were afforested on non-forest land. The study will include determination of sample plots and sampling, analysis of samples.
    - Study for evaluation of carbon stock in dead organic matter (dead wood) analyzing various degrees of dead wood decomposition rates. The study will cover determination of sample plots and sampling, analysis of samples.
    - Study for development of the harvested wood products (HWP) accounting system and preparation of accounting methodology. This study should cover analysis of legal regulation, practices of neighboring countries and accounting principles of harvested wood products in Lithuania.
    - Study on proposals of effective implementation of Regulation of European Parliament and European Council on a mechanism for monitoring and reporting GHG emissions.

- Assistance in development of national system for GHG projections reporting. Proposals for fulfillment of relevant EU and UNFCCC GHG projections reporting requirements and modeling tools and methodologies use.

Project will be implemented during the years 2013-2014 and the budget allocated for this project amounts to 772 500 Eur.

<u>A number of studies aiming to improve GHG inventory estimates were initiated and implemented in 2012:</u>

National emission factors for energy sector development study. For calculation of emissions from the fuel combustion, some emission factors based on study conducted in 1997 are used, some EF were developed in 2010 based on research data from the Lithuanian oil refinery and the rest are default IPCC emission factors. Given that emissions from combustion of fuels are among the most important key categories, a study to develop country specific EFs was complited which accurately reflect the carbon content and other physical properties of fossil fuel consumed in country. The study was completed in 2012. The results of the study are applied for GHG calculations in this submission.

Study to determine the quantity of fluorinated gases (HFCs, PFCs and SF_6) use in Lithuania, development of the methods for emissions calculations and recommendations to improve F-gases data collection system. Lithuania's emission inventory for consumption of F-gases is based on a survey which was conducted in 2008. The scope of the survey was insufficient as only commercial and industrial refrigeration and air conditioning were covered, therefore further analysis was needed in order to complement GHG inventory and collect more detailed information on F-gases use in Lithuania during 1990-2010. This study was completed and implemented in 2012. The results of the study were applied for GHG calculations in this submission.

Study on research and evaluation of methane producing capacity and nitrous oxide in Lithuanian manure management systems. The study was developed and results are presented in this submission.

Study on research and analyses of methane emissions from waste-water and sludge. The study was required as data is not sufficient for the proper calculation of GHG emissions from waste sector. The study was completed in 2012 and results are applied in this submission.

1.3 Overview of the inventory preparation process

Lithuania prepares National Inventory Report and CRF tables annually according to requirements of the UNFCCC, the Kyoto Protocol and the EU greenhouse gas monitoring mechanism decision No 280/2004/EC. The organisation of the preparation and reporting of Lithuania's GHG inventory and the responsibilities of its different institutions are described in previous section.

The annual GHG inventories preparation follows the Work schedule for reporting. Work schedule for preparation and submission of National GHG inventory 2013 is presented in Table 1-2. Lithuania has to submit GHG inventory to the European Commission **by 15 January** and update estimates by **15 March** annually. GHG inventory to the UNFCCC shall be submitted **by 15 April** annually.

Table 1-2. Work plan for preparation and submission of National GHG inventory 2013

Activity	Responsible institutions	Deadlines
Updated QA/QC plan 2012-2013	EPA, MoE	August 2012
Data collection - sending of official letters to data providers; Methods development; QC procedures, data archiving	EPA, WG sectoral experts	September-October 2012
Meetings of all involved institutions for defining specific areas for improvements and recalculations	MoE, EPA, SFS, WG sectoral experts	September 2012
Sectoral experts input results to EPA	WG sectoral experts	October-November 2012
Filling CRF Reporter database, QC procedures, data archiving	EPA	November 2012
Prepare CRF tables and NIR part on LULUCF and KP-LULUCF and sending to EPA, data archiving	SFS	November 2012
Prepare draft NIR and send to MoE and other institutions for comments	EPA	By December 2012
Comments from MoE and others to EPA	MoE	By 15 December 2012
Submission of CRF tables, xml file and elements of the NIR to European Commission	MoE	By 15 January 2013
Possible CRF and NIR updates and final approval by MoE	EPA, MoE	By March 2013
Sending NIR to NCCC for comments and final approval, QA procedures	MoE	By 15 March 2013
Submission of updated CRF tables, xml file and NIR to European Commission	MoE	By 15 March 2013
Submission of CRF tables, xml file and NIR to UNFCCC secretariat	MoE	By 15 April 2013

This schedule does not include timeframe for the EU inventory consistency checks, UNFCCC reviews and Lithuania's responses though the Work Plan may be updated during the year. Possible legislation improvements for a proper National System functioning are also not included in this scheme, but will be considered during the year and will be drafted by the Ministry of Environment, if necessary.

1.4 Brief general description of methodologies and data sources used

1.4.1 Main Principles for GHG inventory

The main principles which Lithuania's GHG inventory should follow are set up in Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11 (FCCC/SBSTA/2006/9). GHG inventory should be transparent, consistent, comparable, complete and accurate. Inventory should be prepared using comparable methodologies agreed upon by the Conference of the Parties (COP4).

Transparency means that the assumptions and methodologies used for an inventory should be clearly explained to facilitate replication and assessment of the inventory by users of the reported information. The transparency of inventories is fundamental to the success of the process for the communication and consideration of information;

Consistency means that an inventory should be internally consistent in all its elements with inventories of other years. An inventory is consistent if the same methodologies are used for the base and all subsequent years and if consistent data sets are used to estimate emissions or removals from sources or sinks. An inventory using different methodologies for different years can be considered to be consistent if it has been recalculated in a transparent manner, in accordance with the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and Good Practice Guidance for Land Use, Land-Use Change and Forestry;

Comparability means that estimates of emissions and removals reported in inventory should be comparable among Annex I Parties. For this purpose, the methodologies and formats agreed by the COP for estimating and reporting inventories Annex I Parties should be used. The allocation of different source/sink categories should follow the split of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, and the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry, at the level of its summary and sectoral tables;

Completeness means that an inventory covers all sources and sinks, as well as all gases, included in the IPCC Guidelines as well as other existing relevant source/sink categories which are specific and, therefore, may not be included in the IPCC Guidelines. Completeness also means full geographic coverage of sources and sinks;

Accuracy is a relative measure of the exactness of an emission or removal estimate. Estimates should be accurate in the sense that they are systematically neither over nor under true emissions or removals, as far as can be judged, and that uncertainties are reduced as far as practicable. Appropriate methodologies should be used, in accordance with the IPCC good practice guidance, to promote accuracy in inventories.

1.4.2 Methodologies used for preparation of GHG inventory

GHG inventory contains information on the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6). Information is provided on the following indirect greenhouse gases:

carbon monoxide (CO), nitrogen oxides (NOx) and non-methane volatile organic compounds (NMVOCs), as well as sulphur oxides (SO_x).
The GHG inventory is prepared in accordance with the methodology recommended by the IPPC in its publications:

- Revised 1996 Guidelines for National Greenhouse Gas Inventories, IPPC, 1997;
- Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, IPPC, 2000;
- Good Practice Guidance for Land Use, Land-Use Change and Forestry, IPPC, 2003;
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories, IPPC, 2006.

GHG inventory is prepared also taking into account requirements, provided in the following EU legislation:

- Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol (OJ 2004 special edition, Chapter 15, Volume 8, p. 57);
- Commission Decision No 2005/166/EC of 10 February 2005 laying down rules implementing Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol (OJ 2005 L 55, p. 57)

Simple equations that combine activity data with emission factors are used. Different sources in the transport, agriculture and LULUCF sectors necessitate the use of more complicated equations and models. Table 1-3 summarises the most important data sources used in the inventory.

Table 1-3. Main data sources used in the greenhouse gas inventory

Sector	**Main data sources**
1.A Energy: Fuel Combustion	Energy Statistics database (Statistics Lithuania) EU ETS emission data
1.B Energy: Fugitive Emissions	Energy Statistics database (Statistics Lithuania) Lithuanian Geological Service Individual companies
2. Industrial Processes	Individual production plants EU ETS emission data Industrial statistics database (Statistics Lithuania) F-gases database (EPA)
3. Solvents and Other Product Use	Statistics Lithuania database Published literature
4. Agriculture	The Register of Agricultural Information and Rural Business Centre of Ministry of Agriculture Agricultural Statistics database (Statistics Lithuania) Published literature
5. LULUCF	NFI (National Forest Inventory) State Forest inventory Lithuanian Statistical Yearbook of Forestry Published literature

6. Waste	Waste database (EPA) Regional Waste Management Centres

A detailed description of methodologies and data sources used in the preparation of the emission inventory for each sector is outlined in the relevant chapters.

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

1.5.1 GHG inventory (including and excluding LULUCF)

Key source categories analyses for the GHG inventory were performed according to the *IPCC 2000 Good Practice Guidance* and *IPCC GPG LULUCF 2003*. Tier 1 level and trend assessment of the key source categories including and excluding LULUCF were conducted for all years for which inventory estimates are available and Tier 2 level and trend assessment with uncertainties including and excluding LULUCF was performed in inventory for the first time. This approach covered the whole time period. LU_{xt} and TU_{xt} were calculated using Tier 1 uncertainty analysis (Annex II).

The base year for the analysis is 1990 for the greenhouse gases CO_2, CH_4, N_2O and 1995 for the F-gases HFC, PFC and SF_6. Any source category that met the 95% threshold was identified as a key source category.

In 2013 the level of disaggregation used for the key category analysis was performed by taking into account country-specific issues, specifically, in energy and agriculture sectors key categories were broken down into sub-source categories in order to reflect the level at which the EFs were applied and in order to focus efforts towards methodological improvements on these most significant sub-source categories.

Energy Sector is the main source of the GHG emissions accounting for 67,2% in 1990 and 54,7% in 2011 of the total emissions (excl. LULUCF). The second important sector is Agriculture Sector accounting for 21,1% in the base year and 23% in 2011 of the total GHG emissions (excl. LULUCF).

Tier 1 key category with a highest contribution to national total emission in 2011 is 1.AA.3.B Road transportation - diesel fuel (CO_2) accounting for 12,7% of the total emission (excl. LULUCF) whereas the key category with the highest contribution in the base year was 1.AA.1A Public electricity and heat production – liquid fuels (CO_2) accounting for 12,4% of the total emission (excl. LULUCF). The second most important source of greenhouse gas emissions in 2011 and 1990 is 1.AA.1.A Public electricity and heat production - gaseous fuel (CO_2). Its contribution to national total is 12,3% in 2011 and 11,9% in the base year.

Tier 2 key category with a highest contribution to national total emission in 2011 is 6.A. Solid Waste Disposal on Land (CH_4) and 4.D.3. Indirect Soil Emissions (N_2O) in 1990 excluding LULUCF.

Including LULUCF Tier 1 for both 2011 and 1990 5.A.1. Forest Land remaining Forest Land (CO_2) had the highest contribution to national total emission, while in Tier 2 highest contribution had 5.B Cropland (CO_2).

Under Tier 1 analysis all key categories except for 1.AA.4.C Agriculture/Forestry/Fisheries (CO_2) and 2.A.2. Lime Production (CO_2) of 2010 were identified as key in this year's submission too.

Under Tier 2 analysis only 1.AA.3.C Railways (CO_2) were identified as new key sources in 2011. Except for 1.AA.3.B Road transportation LPG (CO_2) all key categories of 2010 were identified as key in this year's submission too.

Comparing Tier 1 and Tier 2 assessment few new key categories were identified in this submission:

- 1.AA.3 Transport, N_2O
- 1.AA.4 Other sectors, N_2O
- 3. Solvent and Other Product Use, CO_2
- 3. Solvent and Other Product Use, N_2O
- 4.D.1.3. Direct Soil Emissions N-fixing crops, N_2O
- 5.A.1. Forest Land remaining Forest Land, N_2O
- 5.D. Wetlands, CO_2
- 6.B. Waste-water Handling, CH_4
- 6.B. Waste-water Handling, N_2O

Results of the Tier 1 and Tier 2 Level and Trend key categories analysis are provided in Table 1-4. More detailed information on key categories calculations is provided in the Annex I.

Table 1-4. Key sources categories analysis by Level and by Trend (years 1990, 2011, 1990-2011)

KEY category	GHG	Level without LULUCF 1990	Level with LULUCF 1990	Level without LULUCF 2011	Level with LULUCF 2011	Trend (1990-2011) without LULUCF	Trend (1990-2011) with LULUCF	Approach used
1.AA.1.A Public electricity and heat production, gaseous fuel	CO_2	X	X	X	X	X	X	Tier 1 Tier 2
1.AA.1.A Public electricity and heat production, liquid fuel	CO_2	X	X	X	X	X	X	Tier 1 Tier 2
1.AA.1.B Petroleum refining, liquid fuel	CO_2	X	X	X	X	X	X	Tier 1 Tier 2
1.AA.2 Manufacturing industries and construction, gaseous fuels	CO_2	X	X	X	X	X	X	Tier 1 Tier 2
1.AA.2 Manufacturing industries and construction, liquid fuels	CO_2	X	X			X	X	Tier 1 Tier 2
1.AA.2 Manufacturing industries and construction, solid fuels	CO_2			X	X	X	X	Tier 1 Tier 2
1.AA.3 Transport	N_2O			X	X			Tier 2

1.AA.3.B Road transportation, diesel	CO_2	X	X	X	X	X	X	Tier 1 Tier 2
1.AA.3.B Road transportation, gasoline	CO_2	X	X	X	X	X	X	Tier 1 Tier 2
1.AA.3.B Road transportation, LPG	CO_2			X	X	X	X	Tier 1
1.AA.3.C Railways	CO_2	X		X				Tier 1 Tier 2
1.AA.3.E Off-road vehicles and machinery	CO_2	X	X	X		X	X	Tier 1 Tier 2
1.AA.4 Other sectors, biomass	CH_4			X	X	X	X	Tier 1 Tier 2
1.AA.4 Other sectors	N_2O			X				Tier 2
1.AA.4.A Commercial/Institutional	CO_2	X	X	X	X	X	X	Tier 1 Tier 2
1.AA.4.B Residential	CO_2	X	X	X	X	X	X	Tier 1 Tier 2
1.AA.4.C Agriculture/Forestry/Fisheries	CO_2	X						Tier 1
1.B Fugitive Emissions from Fuels	CH_4	X	X	X	X	X	X	Tier 1 Tier 2
2.A.1 Cement Production	CO_2	X	X	X	X	X	X	Tier 1 Tier 2
2.A.7 Bricks and tiles	CO_2					X		Tier 1
2.B.1 Ammonia Production	CO_2	X	X	X	X	X	X	Tier 1 Tier 2
2.B.2 Nitric Acid Production	N_2O	X	X	X	X	X	X	Tier 1 Tier 2
2.F.1 Refrigeration and Air Conditioning Equipment	HFC			X	X	X	X	Tier 1 Tier 2
3. Solvent and Other Product Use	CO_2	X		X	X	X		Tier 2
3. Solvent and Other Product Use	N_2O	X				X	X	Tier 2
4.A Enteric Fermentation, cattle	CH_4	X	X	X	X	X	X	Tier 1 Tier 2
4.B Manure Management	N_2O	X	X	X	X	X	X	Tier 1 Tier 2
4.B Manure Management, cattle	CH_4	X	X	X	X	X		Tier 1 Tier 2
4.B Manure Management, swine	CH_4	X	X	X	X	X	X	Tier 1 Tier 2
4.D.1.1 Direct Soil Emissions, Synthetic N fertilizers	N_2O	X	X	X	X	X		Tier 1 Tier 2

4.D.1.2 Direct Soil Emissions, manure fertilizers	N_2O	X	X	X	X	X	X	Tier 1 Tier 2
4.D.1.3. Direct Soil Emissions N-fixing crops	N_2O	X	X	X	X	X	X	Tier 2
4.D.1.4 Direct Soil Emissions, Crop residues	N_2O	X	X	X	X	X	X	Tier 1 Tier 2
4.D.1.5. Direct Soil Emissions Cultivation of histosols	N_2O	X	X	X	X	X	X	Tier 1 Tier 2
4.D.2 Pasture Range and Paddock Manure	N_2O	X	X	X	X	X	X	Tier 1 Tier 2
4.D.3 Indirect Emissions	N_2O	X	X	X	X	X	X	Tier 1 Tier 2
5.A.1 Forest Land remaining Forest Land	CO_2		X		X		X	Tier 1 Tier 2
5.A.1 Forest Land remaining Forest Land	N_2O				X			Tier 2
5.A.2 Land converted to Forest Land	CO_2		X		X		X	Tier 1 Tier 2
5.B Cropland	CO_2		X		X		X	Tier 1 Tier 2
5.C Grassland	CO_2		X		X		X	Tier 1 Tier 2
5.D Wetland	CO_2		X		X			Tier 2
6.A Solid Waste Disposal on Land	CH_4	X	X	X	X	X	X	Tier 1 Tier 2
6.B Waste-water handling	CH_4	X	X	X	X	X		Tier 2
6.B Waste-water handling	N_2O	X	X	X	X	X		Tier 2

1.5.2 KP-LULUCF

Key category analysis for KP-LULUCF was developed according to the section 5.4 of the *IPCC 2003* GPG for LULUCF. Categories under Articles 3.3 and 3.4 were considered as key if their contribution was greater than the smallest category considered key in the UNFCCC inventory (including LULUCF). The results are presented in Table 1-5.

Table 1-5. Key categories for KP Article 3.3 and 3.4. activities

Key categories of emissions and removals	**Gas**	**Criteria used for key category identification**	
		Associated category in UNFCCC inventory is key	**Category contribution is greater than the smallest category considered key in the UNFCCC inventory (including LULUCF)**
Forest Management	CO_2	Forest land remaining forest land	Yes

1.6 Information on the QA/QC plan including verification and treatment of confidentiality issues where relevant

1.6.1 QA/QC plan

The overall aim of the quality system is to maintain and improve the quality in all stages of the inventory work, in accordance with decision 19/CMP.1. The quality objectives of the QA/QC plan and its application are an essential requirement in the GHG inventory and submission processes in order to ensure and improve the inventory principles: transparency, consistency, comparability, completeness, accuracy, timeliness and confidence in the national emissions and removals estimates for the purposes of meeting Lithuania's reporting commitments under the UNFCCC and the Kyoto protocol. In addition, one of the objectives of the quality system is to determine short-term and long-term activities for the GHG inventory improvement plan.

QA/QC plan was updated in 2012. The Ministry of Environment and the Environment Protection Agency was responsible for the development of the updated QA/QC Plan. The EPA is responsible for the coordination and implementation of the Plan with a supervision performed by the MoE.

The QA/QC Plan describes the quality objectives of the GHG inventory, the national system for inventory preparation, tasks and responsibilities. A description is provided of various formal procedures already implemented in the development of the GHG inventory and of planned improvements.

As defined in *IPCC GPG 2000*, quality control is a system of routine technical activities, to measure and control the quality of the inventory as it is being developed. A basic quality control system should provide routine checks to ensure data integrity, correctness, and completeness and identify errors or omissions. In addition, procedures for documentation and archiving of inventory material and recording of all quality control activity data should be developed.

Quality Assurance (QA) activities include planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process to verify that data quality objectives were met, ensure that the inventory represents the best possible estimate of emissions and sinks given the current state of scientific knowledge and data available, and support the effectiveness of the quality control (QC) program.

1.6.2 Quality control

EPA, as the coordinator of the GHG inventory and QA/QC Manager, has the following functions and responsibilities:

- Checking and archiving supplied input data;
- Checking assumptions and data selection criteria;
- Checking data inputs and references;
- Checking data processing procedures and emission calculations;
- Checking units, conversion and adjustment factors, etc.;
- Ensuring adequate documentation;
- Checking consistency of data between source categories;
- Checking data aggregation and transcription;

- Coordinating QA/QC activities, preparing QC and QA procedures;
- Providing the final inventory (CRF tables and NIR) for the MoE.

Quality control involves the following:
Evaluation of the data collection procedure, to establish whether:

- the necessary methods, activity data and emission factors (i.e. those in conformity with the IPCC Good Practice Guidance) have been used;
- the calculations have been made correctly;
- all time series data has been provided and calculated;
- the data and results for the current year have been compared with the data and results of the previous years;
- the notes and comments contain all necessary information on the data sources, calculation methods, etc.

Evaluation of the emission calculation, to establish:

- consistency of the emission factors used;
- correctness of the emission parameters, units, conversion factors used;
- correctness of the data transferred from spreadsheets to CRF tables;
- correctness of repeat calculations.

Evaluation of the preparation of respective chapters of the NIR, to establish:

- integrity of the structures of the inventory data;
- completeness of the inventory;
- consistency of time series;
- whether the emission estimates have been compared with previous estimates;
- whether the data tables of the National Inventory Report correspond to the text;
- whether all necessary information on the data sources, assumptions and calculation methodology have been provided.

Results of the checks are recorded in a quality control protocols. After a check, the protocol is given back to the sectoral experts who respond to the comments of the QC Manager and, if necessary, correct the data, calculation methodology or the report (NIR) accordingly.

In addition to routine quality checks (Tier 1), source specific quality control procedures were applied, focusing on key categories and on categories with higher uncertainty. Source-specific QA/QC details are discussed in the relevant sections (Energy, Industrial processes, Agriculture and Waste) of the NIR.

The main QA/QC procedures under responsabilities of EPA are performed according to the EPA Director's Order No. AV-191 concerning the approval of the National GHG inventory data quality assurance and quality control procedures (23th July 2012).

Archiving

The proper archiving and reporting of the documentation related to inventory compilation process is also part of the QA/QC activities. Inventory documentation must be sufficiently comprehensive, clear and sufficient for all present and future experts to be able to obtain and review the references used and reproduce the inventory calculations.

The main archives of the GHG inventory are placed within the Environmental Protection Agency. GHG inventory archive was transmitted to EPA from the Ministry of Environment for the further enhancement and completion. In 2011 EPA prepared GHG inventory archive improvement plan. The main tasks outlined in the plan are: to develop documentation checklists for each CRF category; to complete GHG inventory archive with the documentation provided by the sectoral experts; to develop a manual describing a common archiving procedures (archive data structure, timing, data security etc.) The manual describing common archiving procedures of Lithuania's GHG inventory (archive data structure, timing, data security etc.) was approved on 26th June 2012 and published as EPA Director's Order No. AV-152 concerning the approval of the National GHG inventory data archiving procedures. The document describes general archiving principles, timing and outlines the structure of the Lithuania's GHG inventory archive. National GHG inventory archive is located in the EPA server and contains 5 main folders:

- General information (related legislation, IPCC methodologies, QA/QC plans and checklists forms, information sources or links and other useful information for report preparation);
- GHG data (subfolders grouped by years and by sectors – calculation sheets, emission factors, activity data, references, draft NIR, communication with sectoral experts etc.);
- Submissions (official submissions grouped by year and date – NIR, CRF, SEF, XML, cross-cutting information);
- Inventory Reviews (EC and UNFCCC review information, questions, answers, communication, review reports etc.);
- Backup (backup files of CRF).

In order to fill the gaps in archive, EPA developed checklists and documentation quality protocols for each CRF category and performed comprehensive quality checks over the each CRF category to identify missing references and documentation in the existing GHG inventory archive. According to the checklists results, sectoral experts provided missing references and documentation to the EPA, though all relevant GHG inventory material was collected, systematized, compiled and arranged according to the archive management system. Archive information includes:

- Disaggregated EFs used, including references to the IPCC document for default factors or to published references or other documentation.
- Activity data or sufficient information to enable activity data to be traced to the referenced source.
- Worksheets and interim calculations for source category estimates and aggregated estimates and any recalculations of previous estimates.
- QA/QC plans and outcomes of QA/QC procedures (external and internal reviews, checklists, documentation quality protocols).
- Data on key source identification, uncertainty assessment.
- Official Lithuania's GHG inventory submissions.

In addition to the main archive, sectoral experts have archives located in their own facilities. Original National Forest Inventory data is archived in the State Forest Service.

1.6.3 Quality Assurance

Quality assurance includes an objective review to assess the quality of the inventory, and also to identify areas where improvements could be made. The objective in QA implementation is to involve reviewers that can conduct an unbiased review of the inventory. In general, reviewers that have not been involved in preparing the inventory should be used. Preferably these reviewers would be independent experts from other agencies or a national or international expert or group not closely connected with national inventory compilation.

As the coordinating institution, EPA is also responsible for establishing a quality assurance system comprising review procedures which are conducted by personnel not directly involved in the inventory compilation/development. Its responsibilities include:

- Identification and prioritization of sets of data for review based on key category and uncertainty analysis,
- Identification of review personnel,
- Conclusions and corrective actions based on the review results.

A basic review of the draft GHG emission and removal estimates and the draft report takes place before the final submissions to the EC and UNFCCC secretariat (January to March) by the involved institutions on GHG inventory preparation process: the final draft of the NIR is coordinated with the Climate Change Policy Division at MoE, National Climate Change Committee, the relevant departments of the Ministry of Environment (e.g. Department of Waste, Department of Water, Department of Forestry and others) and it's subordinated institutions (e. g. Environmental Protection Agency, Lithuanian Environmental Investment Fund who is administrator of the National GHG Registry, etc.) before the submission to the European Commission and the UNFCCC secretariat. Received corrections are incorporated into the NIR.

Each year, the European Commission performs quality checks of the EU member states GHG inventories. The corrections are elaborated in Lithuania's GHG inventory in response to EC quality checks and comments. In 2012 technical review of the GHG emission inventory of Lithuania took place to support the determination of annual emission allocations under EU Decision 406/2009/EC. The technical review of the 2012 GHG inventory estimates of Lithuania for the years 2005, 2008, 2009 and 2010 was performed by a Technical Expert Review Team (TERT) under service contract to the Directorate General for Climate Action of the European Commission. Number of TERT recommendations were taken into account and resulting recalculations were performed in 2012 as well as 2013 GHG inventory submissions: estimation of emissions from lime production in the sugar factories, recalculation of emissions from N-fixing crops taking into account data on lucerne and clover, revision of emissions estimates associated with the Crop residues category, recalculation of emissions of F-gases.

UNFCCC reviews performed by the ERTs help to fulfill requirements of the Quality Assurance of the Lithuania's GHG inventory. UNFCCC review reports indicate issues where inventory needs improvements. GHG Inventory Expert team shall take into consideration recommendations provided by the ERT to ensure that all estimates or explanations as indicated by the ERT are corrected and included into NIR the next submissions.

1.7 General uncertainty evaluation, including data on the overall uncertainty for the inventory totals

Uncertainty estimation was performed using Tier 1 approach of *IPCC 2000*. Quantitative uncertainties assessment was carried out for the emission level 2011 and for 1990-2011 (1995-2011 for F-gases) trend in emissions for all source categories comprising emissions of CO_2, CH_4, N_2O, HFC and SF_6 gases (in CO_2 equivalents). The GHG uncertainty estimates do not take into account the uncertainty of the Global Warming Potential (GWP) factors. The sources included in the uncertainty estimate cover 99,9% of the total greenhouse gas emission.

Uncertainties were estimated using combination of available default factors proposed in *IPCC Good Practice Guidance* with uncertainties based on expert judgment, consultation with statistical office. Tier 1 uncertainty evaluation analysis (including and excluding LULUCF) is presented in Annex II table 1a, 1b.

Uncertainty categories are reported in line with key categories analysis and they are used for Tier 2 key categories analysis.

In response to ERT recommendations 2012 uncertainty analysis additionally was performed for each sector for all gases combined on purpose to have more detailed information for inventory improvements planning. Uncertainties of activity data of different gases and uncertainties of emission factor from the same sectors were combined using GPG 2000 equation 6.3. Results of combined uncertainty analysis including and excluding LULUCF are sorted descending to identify the biggest sectorial uncertainty in the inventory (Annex II table 2a, 2b).

Excluding LULUCF five first subcategories with the biggest sectorial uncertainty were:

1. 6A Solid Waste
2. 4D1 Direct Soil Emissions
3. 4D2 Pasture Range and Paddock
4. 4D3 Indirect Soil Emissions
5. 6C Waste incineration

Including LULUCF five first subcategories with the biggest sectorial uncertainty were:

1. 6A Solid Waste
2. 4D1 Direct Soil Emissions
3. 4D2 Pasture Range and Paddock
4. 4D3 Indirect Soil Emissions
5. 5.C. Grassland

Detailed information about uncertainty assessment is described under each sub-sector in the relevant NIR chapter.

Overall uncertainty

The total national GHG emission including LULUCF in the year 2011 is estimated with an uncertainty of ±53,2% and the trend of GHG emission 1990-2011 has been estimated to be ±9,9%.

The total national GHG emission excluding LULUCF in the year 2011 is estimated with an uncertainty of ±11,4% and the trend of GHG emission 1990-2011 has been estimated to be ±2,4%.

Comparing to the previous submission uncertainties have increased. Changes of uncertainties are related to revaluated uncertainties on the scope of implemented studies in energy sector, consumption of halocarbons and SF_6, agriculture sector, LULUCF and waste sectors. To achieve more reliable results, it is necessary to gather more relevant uncertainty data concerning both the activity data and the emission factors. As soon as more precise uncertainty estimates appear, they will be included in to calculations.

1.8 Completeness and Time-Series Consistency

Lithuania's GHG emission inventory includes all the major emission sources identified by the IPCC Good Practice Guidance 2000 with some exceptions reported as "not estimated" (NE) (see Table 1-6), which suppose to have a minor effect on the total GHG emissions. Emissions are not estimated mainly due to lack of available IPCC methodologies and/or lack of activity data.

Activity data and emission factors/parameters used for estimations are consistent and adequate through the 1990-2011. 1995 was taken as the base year for estimating emissions of F-gases.

Table 1-6. Summary of completeness of GHG inventory

IPCC source and sink categories	CO_2	CH_4	N_2O	HFCs	PFC	SF_6
1 Energy						
A Fuel combustion	√	√	√			
1 Energy industries	√	√	√			
2 Manufacturing industries and construction	√	√	√			
3 Transport	√	√	√			
4 Other sectors	√	√	√			
5 Other	√/IE/NE/NO	√/IE/NE/NO	√/IE/NE/NO			
B Fugitive emissions from fuels						
1 Solid fuels	NO	NO	NO			
2 Oil and natural gas	√	√	√			
C Memo items						
1 International Bunkers	√	√	√			
2 Multilateral Operations	NO	NO	NO			
3 CO_2 emissions from biomass	√					
2 Industrial processes						
A Mineral products	√	NA/NE/NO	NA/NE/NO			
B Chemical industry	√	√	√	NO	NO	NO
C Metal production	√	NO	NO	NO	NO	NO
D Other production	√					

	E Production of halocarbons and SF_6				NO	NO	NO
	F Consumption of halocarbons and SF_6				√	NA/NO	√
	G Other production	NA	NA	NA	NA	NA	NA
3	**Solvent and other product use**	√		√			
4	**Agriculture**						
	A Enteric fermentation		√				
	B Manure management		√	√			
	C Rice cultivation		NO				
	D Agricultural soils		NA/NE	√			
	E Prescribed burning of savannas		NO	NO			
	F Field burning of agricultural residues		NO	NO			
	G Other		NO	NO			
5	**Land use, land use change and forestry**						
	A Forest land	√	√	√			
	B Cropland	√	√	√			
	C Grassland	√	√	√			
	D Wetlands	√	NE/NO	√			
	E Settlements	√/NE/NO	NE	NE			
	F Other land	√/NE/NO	NE/NO	NE/NO			
	G Other	NE	NE	NE			
6	**Waste**						
	A Solid waste disposal on land	NA	√				
	B Wastewater handling		√	√			
	C Waste incineration	√	NA	√			
	D Other	NA	NA	NA			
7	**Other**	NA	NA	NA	NA	NA	NA

√ – Emissions of the gas are covered under the source category
NA – Emissions of the gas not applicable to the source category
NO – Emissions of the gas does not occur in Lithuania for the source category
NE – Emissions on the gas not estimated for the source category
IE – Included elsewhere

2 TRENDS IN GREENHOUSE GAS EMISSIONS

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

Total GHG emissions amounted to 21611,7 Gg CO_2 eq. excluding LULUCF and 11128,2 Gg CO_2 eq. including LULUCF in 2011. The greenhouse gases include CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. The emissions of GHG expressed in Gg CO_2 equivalent in 2011 have decreased by 55,7% comparing to the base year excluding LULUCF and by 75% including LULUCF. Figure 2-1 shows the estimated total greenhouse gas emissions in CO_2 eq. from 1990 to 2011.

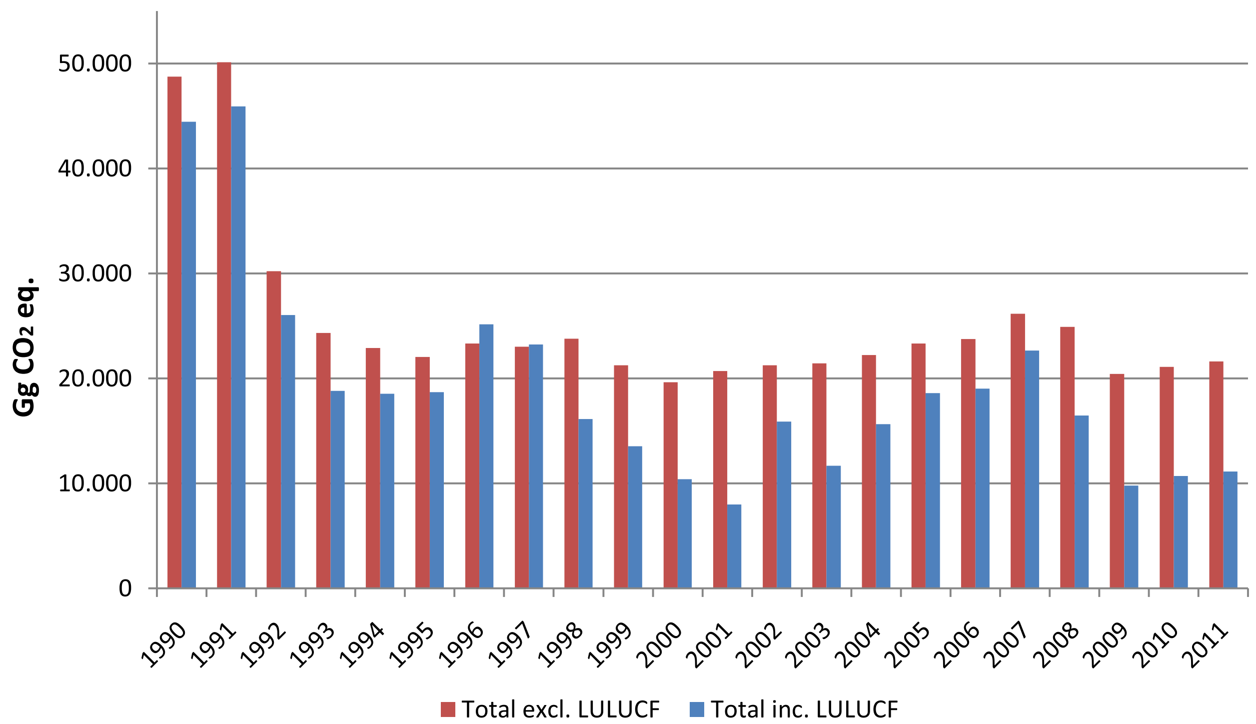


Figure 2-1. Emission trends for aggregated greenhouse gases in 1990-2011 (Gg CO_2 eq.)

The most important greenhouse gas is CO_2, it contributed 64,6% to the total national GHG emissions expressed in CO_2 eq. in 2011, followed by N_2O (20,2%) and CH_4 (14,1%). PFCs, HFCs and SF_6 amounted together to 1% of the total greenhouse gas emissions (excl. LULUCF) in the Lithuania.

Upon its independence from the Soviet Union in 1990, after 50 years of annexation, Lithuania inherited an economy with high energy intensity. A blockade of resources, imposed by USSR during 1991–1993 led to a sharp fall in economic activity, as reflected by the decrease of the Gross Domestic Product (GDP) in the beginning of nineties. The economic situation improved in the middle of the last decade and GDP has been increasing until 1999 (during 1999-2000, GDP decreased due to the economic crisis in Russia) and GDP continued increasing from 2001 to 2008. In 2009 GDP decreased due to the world economical crisis and the slight growth of GDP in 2011 was observed 5,9. These fluctuations were reflected in the country's emissions of greenhouse gases.

2.2 Description and interpretation of emission trends by gas

Carbon dioxide

The most important greenhouse gas in Lithuania is carbon dioxide. The share of CO_2 from the total greenhouse gas emissions (excl. LULUCF) is varieng from 59% to 75% during the time-period. CO_2 emissions have decreased by 61% since 1990. In 2011, the actual CO_2 emission (incl. LULUCF) was 89,1% lower than the emission in 1990. Between 1990 and 2000 greenhouse gas emissions decreased significantly as a consequence of the decline in industrial production and associated fuel consumption. Once the economy start grow again, emission rose but this was in part compensated by reductions achieved through energy efficiency and measures taken to reduce emissions. Comparing with 2010 CO_2 emissions increased by 4,7% including LULUCF or 1,8% excluding LULUCF.

The largest source of CO_2 emissions is energy sector which contributes around 80,6% of all CO_2 emissions. Compared to 2010 CO_2 emissions from energy sector decresed by 7,3%.

Figure 2-2 shows the distribution of CO_2 emissions in 2011 by the main sectors and subsectors.

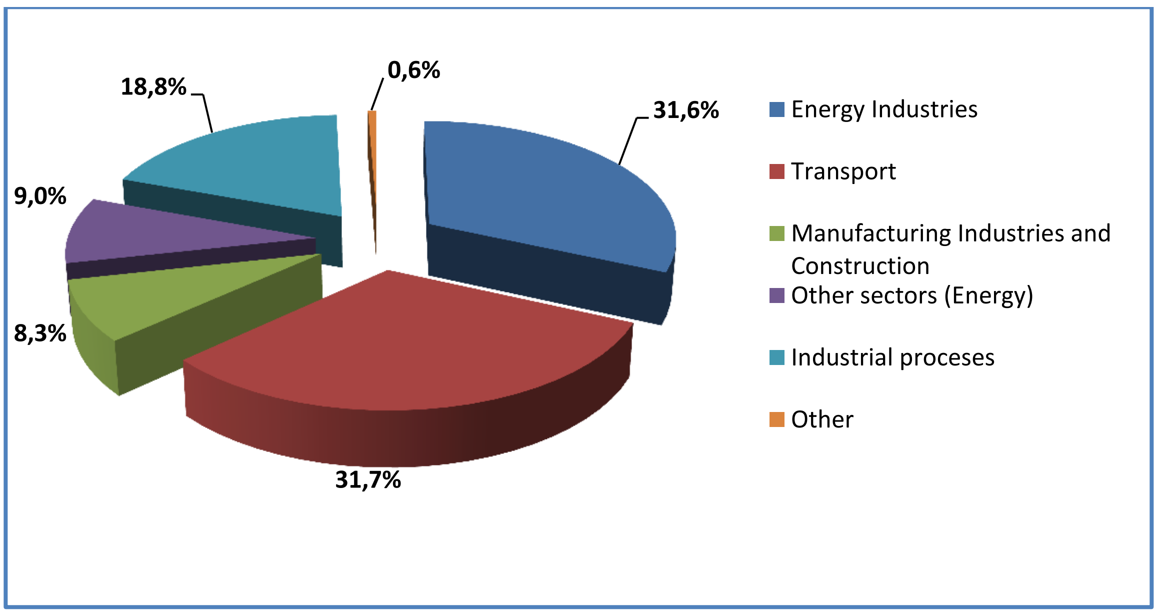


Figure 2-2. Distribution of CO_2 emissions by the main sectors and subsectors in 2011 (%)

Nitrous oxide

Nitrous oxide is the second most important GHG accounting for 20,2% in the total national greenhouse gas emissions (excl. LULUCF). Agriculture is the main source of N_2O emissions which contributed 75,7% to the total N_2O emissions in 2011. Particularly these are emissions from agricultural soils – contributing for 69,6% of the total N_2O emisions, and manure management which accounts for 6,1% in the total national GHG emissions.

N_2O emission from agriculture sector have increased by 1,4% comparing with 2010. The increase was in agricultural soils subsector as emissions from application of sewage sludge were identified.

The second significant source of N_2O emissions is nitric acid production. It contributes 20% to the total N_2O emissions. N_2O emissions had been increasing since 1995 and reached its peak in 2007. After the installation of the secondary catalyst in nitric acid production enterprise in 2008 the emissions dropped drastically and continue to decrease. Figure 2-3 shows the distribution of N_2O emissions in 2011 by the main sectors and subsectors.

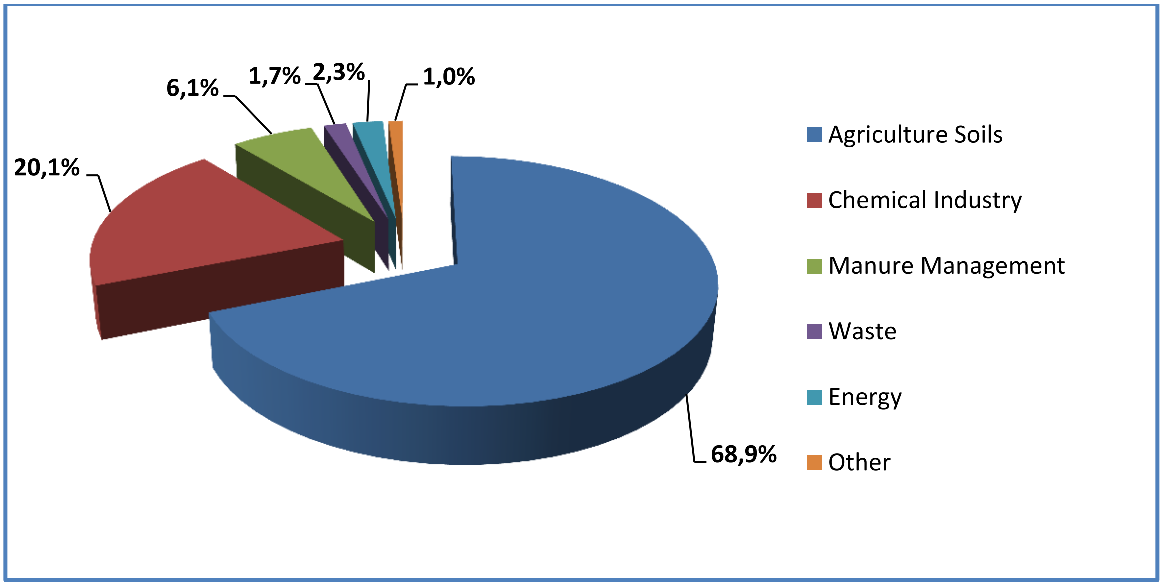


Figure 2-3. Distribution of N_2O emissions by the main sectors and subsectors in 2011 (%)

Methane

The largest sources of methane emissions are: agriculture sector, contributing with 54,9% in 2011, waste sector – 26,5% and oil and natural gas sector – 8,6% (Figure 2-4). The emission from agriculture derives from enteric fermentation and manure management contributing with 38,9% and 15,9% of the total national CH_4 emission (excl. LULUCF).

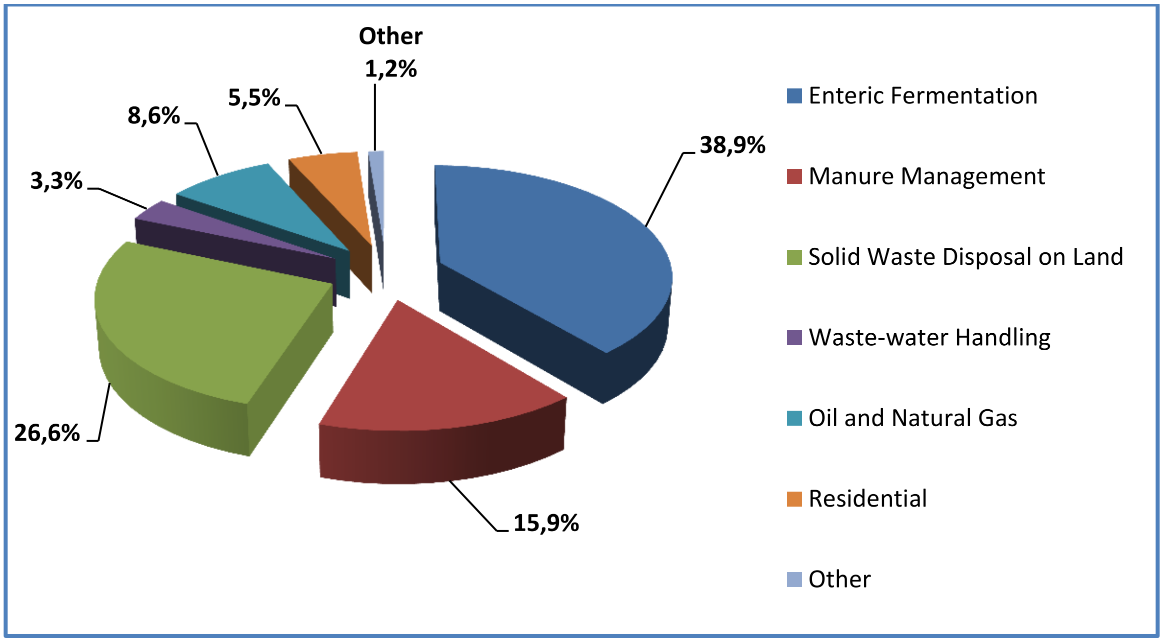


Figure 2-4. Distribution of CH_4 emissions by the main sectors and subsectors in 2011 (%)

The emission of CH_4 has decreased by 47% from 1990 to 2011 (excl. LULUCF). The emissions of CH_4 mainly decreased due to reduction of livestock population.

HFCs and SF_6

The F-gases contribute 1% to the total national greenhouse gas emissions. The emissions of F-gases have increased during 1995-2011. A key driver behind the trend has been the substitution of ozone depleting substances (ODS) by F-gases in many applications. Figure 2-5 shows the trend of F-gases emissions during the period 1995-2011.

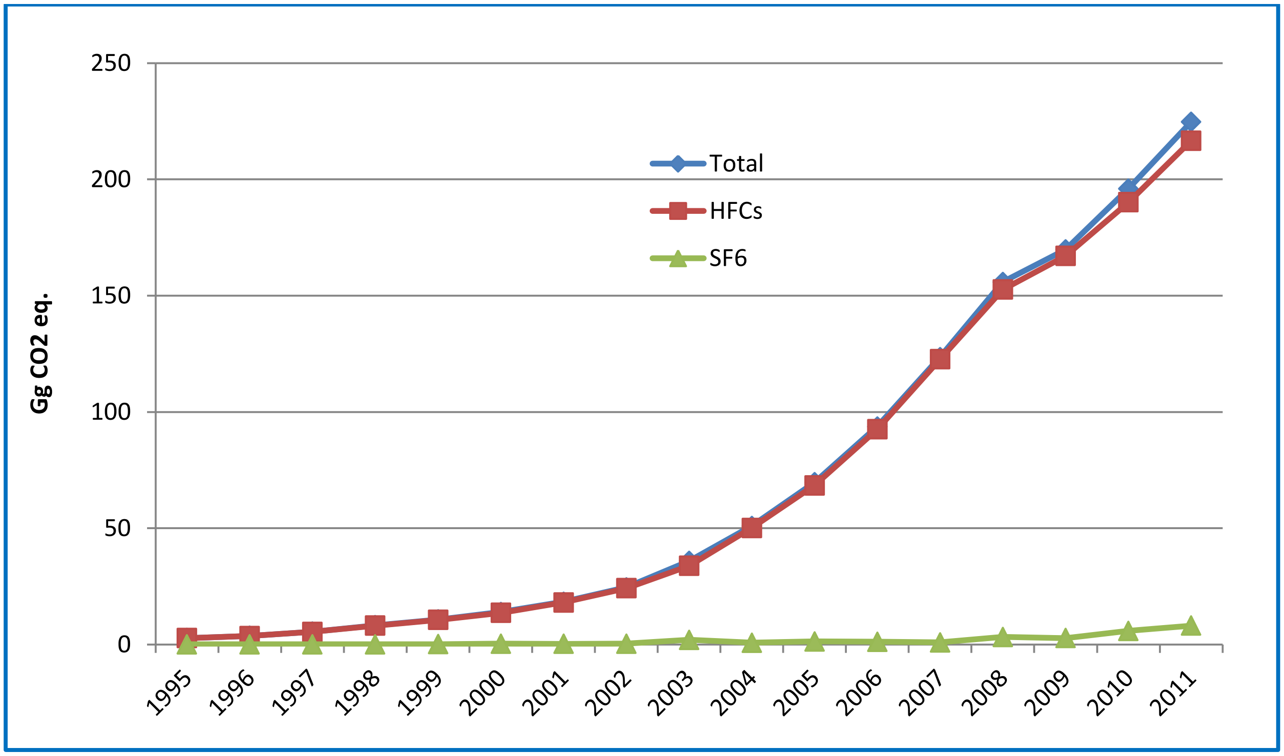


Figure 2-5. Emission trends for F-gases for the period 1995-2011 (Gg CO_2 eg.)

2.3 Description and interpretation of emission trends by category

The trends of greenhouse gas emissions by sectors are presented in Table 1 showing greenhouse gas emissions by sectors, expressed in CO_2 equivalent and taking into account greenhouse gas emissions/removals from LULUCF sector.

Energy

The energy sector is the most significant source of greenhouse gas emissions in Lithuania with 54,7% share of the total emissions (excl. LULUCF) in 2011. The emissions from energy include CO_2, CH_4 and N_2O emissions.

Emissions of total greenhouse gases from the energy sector have decreased by 2,8 times from 32744,95 Gg CO_2 eq. in 1990 to 11820,46 Gg CO_2 eq. in 2011 (Figure 2-6). Significant decrease of emissions was mainly due to economic slump in the period 1991-1994. During the fast economic growth over the period 2000-2008 greenhouse gas emission in energy sector was increasing about 2,3% per annum. The global economic recession has impact on greenhouse gas reduction in energy sector by 9,7% in 2009. The closure of Ignalina NPP and GDP increase had impact on greenhouse gas increase by 7,6% in 2010.

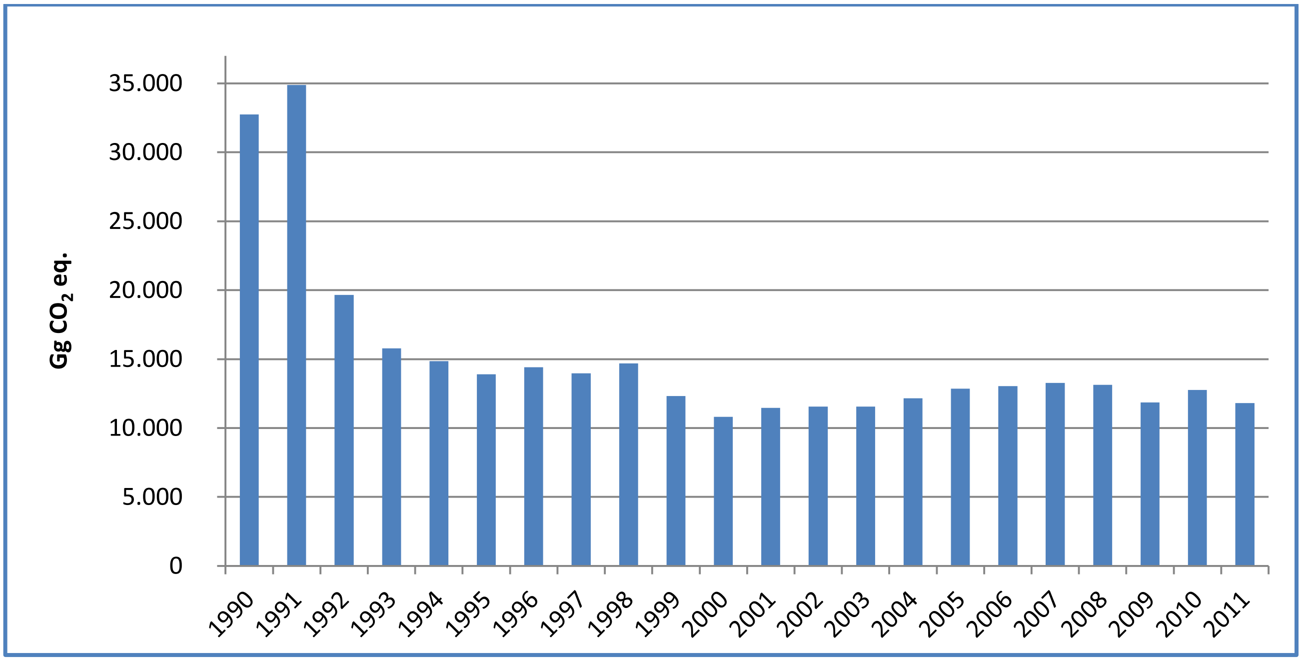


Figure 2-6. Trend of greenhouse gas emissions in energy sector during the period 1990-2011 (Gg CO_2 eq.)

During the period 1990-2011 the share of transport sector significantly increased. In 1990, transport sector accounted for 23,1% of total greenhouse gas emission in energy sector whereas in 2011 – 37,9%. This growth is influenced by the rapid increase of the density of transport routes and the number of road vehicles.

The increase of greenhouse gas emissions from fugitive is mainly caused by the increase of CH_4 emissions from natural gas distribution, reflecting the increase of the length of natural gas pipelines. Since 1990 greenhouse gas emissions from this subsector was increasing by average 3% per annum.

Industrial processes

The emissions from industrial processes (referred to as non-energy related ones) amount to 17,3% of the total emissions (excl. LULUCF) in 2011. The emissions from industrial processes includes CO_2, N_2O and F-gases emissions. Emissions of total greenhouse gases from the industrial processes sector have decreased by 1,2 times from 4396,79 Gg CO_2 eq. in 1990 to 3735,01 Gg CO_2 eq. in 2011 (Figure 2-7).

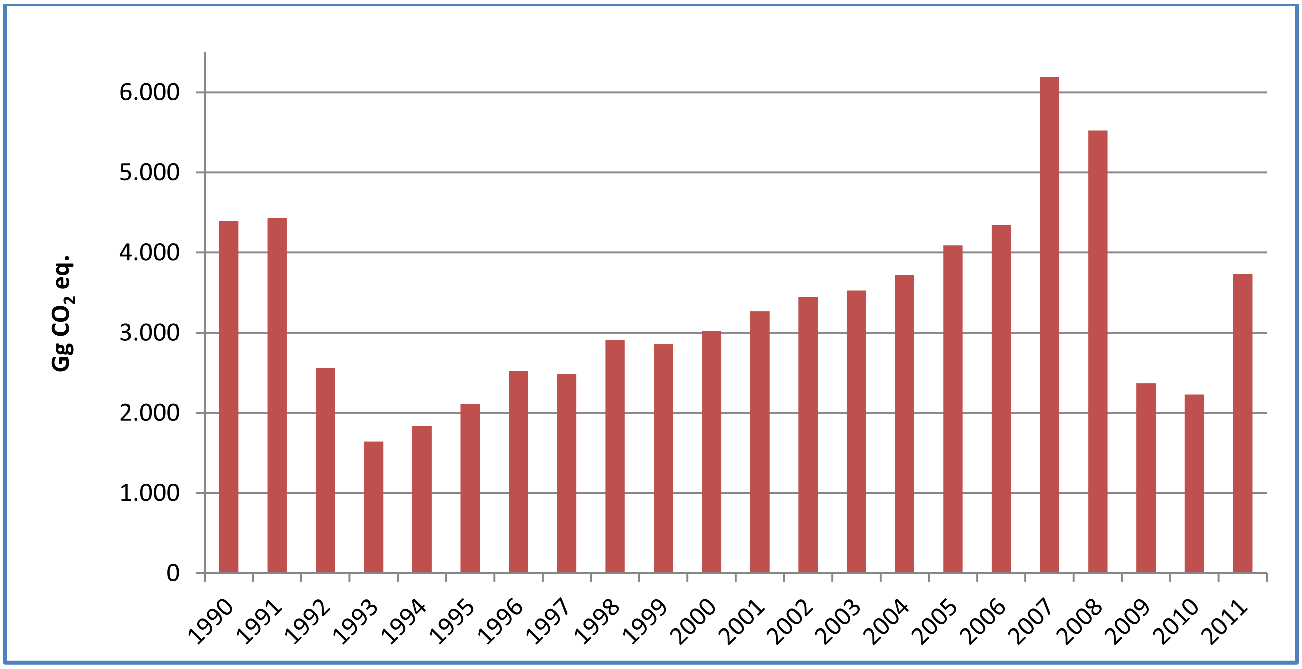


Figure 2-7. Trend of greenhouse gas emissions in industrial processes sector during the period 1990-2011 (Gg CO_2 eq.)

CO_2 emissions from ammonia production contributing 10,3% to the total GHG national emissions (excl. LULUCF). The lowest emission of CO_2 was in 1993 due to decrease of the ammonia production and the peak of CO_2 emissions was in 2007 when the ammonia production increased. In 2011 ammonia and nitric acid production capacity have increased again causing an increase in the total GHG emissions.

Nitric acid production is the single source of N_2O emissions in industrial processes sector and accounts for 4,1% in the total GHG emission (excl. LULUCF). N_2O emissions had been increasing since 1995 and reached its peak in 2007. After the installation of the secondary catalyst in nitric acid production enterprise in 2008 the emissions of N_2O dropped drastically till 2010 and started to increase. Comparing with 2010 these emissions increased by 53,1%

Solvents and other product use

The use of solvents in industries and households contribute 0,4% of the total greenhouse gas emission (excl. LULUCF). The emissions from solvents and other product use in 2011 include CO_2 and N_2O emissions. The emissions of total GHG from the solvents and other product use sector have decreased by more than 2 times from 197,52 Gg CO_2 eq. in 1990 to 85,95 Gg CO_2 eq. in 2011 (Figure 2-8). The reduction is due to the population decrease. The main source of CO_2 emissions is paint application contributing 49,4% to the total solvent and other product use CO_2 emissions. Domestic solvent use is the second important source of CO_2 emissions (19,8%).

Figure 2-8. Trend of greenhouse gas emissions in solvents and other product use sector during the period 1990-2011 (Gg CO_2 eq.)

Agriculture

Agriculture sector is the second most important source of greenhouse gas emissions in Lithuania contributing 23% to the total GHG emission (excl. LULUCF). The emissions from agriculture sector in 2011 include CH_4 and N_2O emissions. Emissions of total greenhouse gases from the agriculture sector have decreased by 2 times from 10292,09 Gg CO_2 eq. in 1990 to 4979,97 Gg CO_2 eq. in 2011 (Figure 2-9).

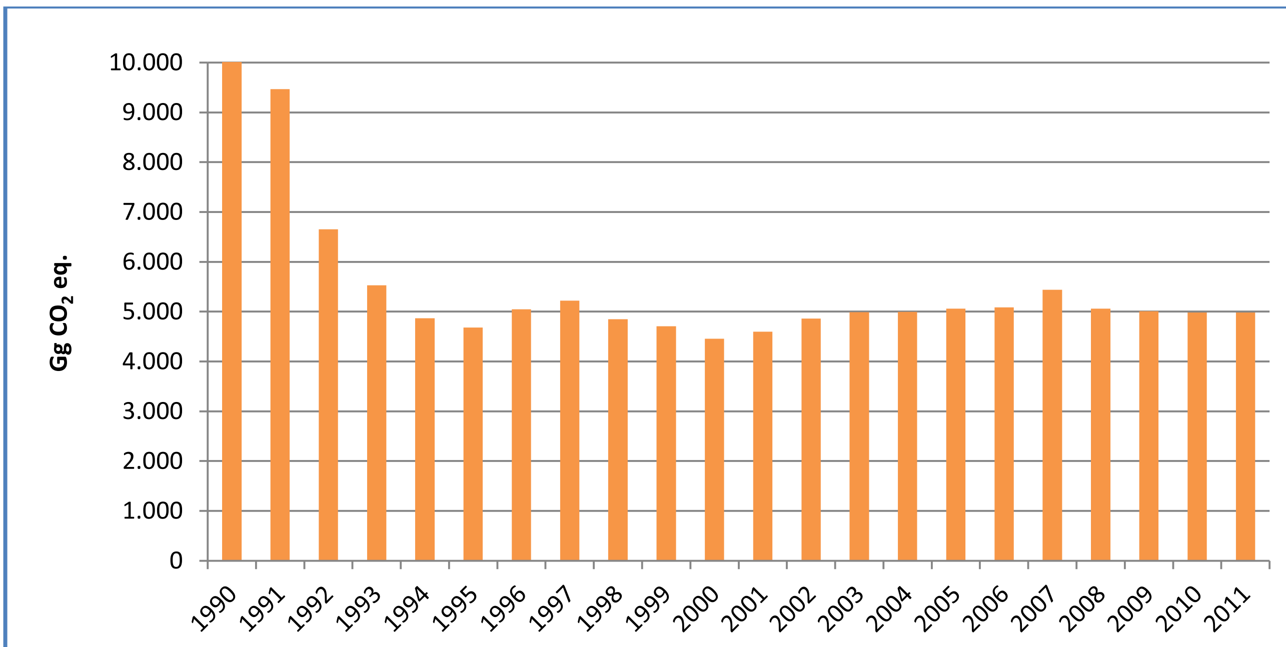


Figure 2-9. Trend of greenhouse gas emissions in agriculture sector during the period 1990-2011 (Gg CO_2 eq.)

Agriculture sector is the most significant source of the CH_4 and N_2O emissions accounting for 54,9% and 75,7% in the total CH_4 and N_2O emissions, respectively. The emissions of CH_4 and N_2O from agriculture sector decreased by 61,3% and 44,6% compare to the base year, respectively.

The major part of the agricultural CH_4 emission originates from digestive processes. Enteric fermentation contributes 38,9%, manure management – 15,9% to the total national CH_4 emissions. The reduction of CH_4 emissions is caused by the decrease in total number of livestock population.

Agricultural soils are the most significant source of N_2O emissions accounting for 69,6% in the total national N_2O emissions. N_2O emission from atmospheric deposition and nitrogen leaching and run-off in 2011 decreased by 53,1% and 49,6% respectively compare to the 1990 due to decrease of consumption of synthetic fertilizers and number of livestock population.

LULUCF

The Land Use, Land-Use Change and Forestry (LULUCF) sector for 1990-2011 as a whole acted as a CO_2 sink except in 1996 and 1997 when emission constituted to 1823,18 Gg and 207,24 Gg of CO_2 (Figure 2-10). That is explained by sudden spruce dieback that caused huge loses in trees volume, in Lithuania`s spruce stands, which has direct impact on biomass calculations and on CO_2 balance from this sector.

The LULUCF sector during the period 2007-2011 removed from nearly 22,3% to 76% of the total CO_2 emissions in Lithuania. Largely this should be contributed to forest land.

For the calculation and reporting of emissions and removals from the LULUCF sector, the IPCC Good Practice Guidance on Land Use, Land-Use Change and Forestry (*IPCC* 2003) have been used. According to the *IPCC 2003*, Lithuanian land area is divided into six land-use categories such as: forest land, cropland, grassland, wetlands, settlements and other land, and into the relevant subcategories: "land remaining in the same land-use category for the last 20 years" and "land converted to present land use during the past 20 years".

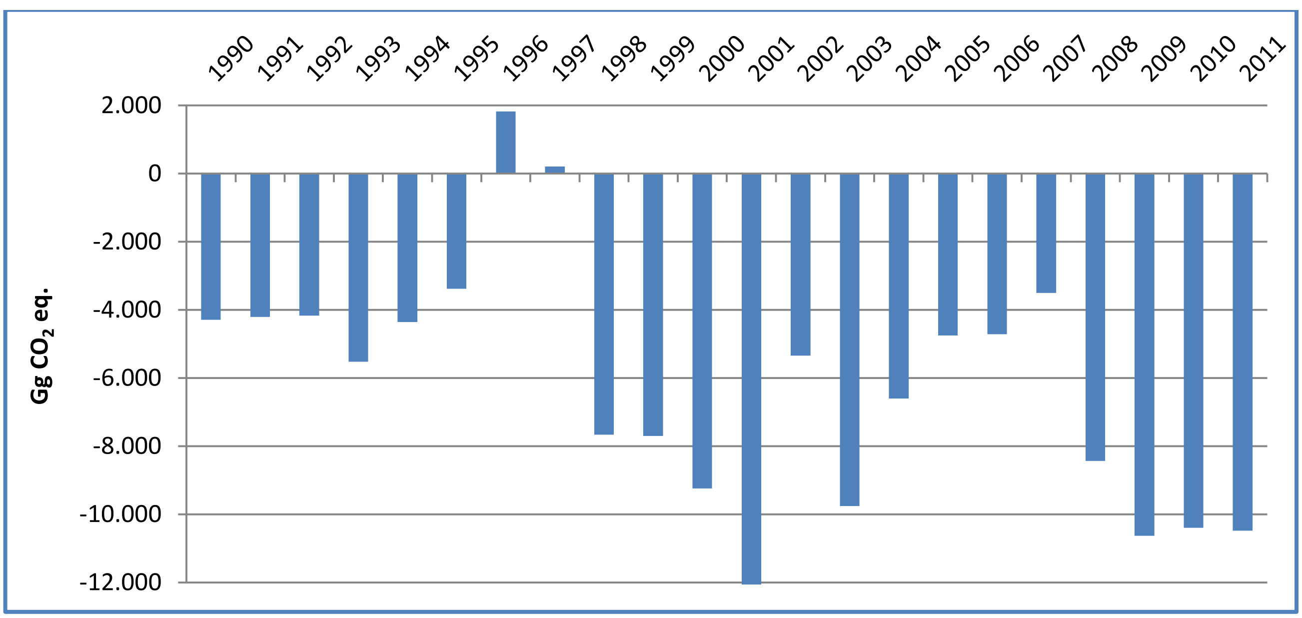


Figure 2-10. Lithuanian total greenhouse gases removals from LULUCF sector for the period 1990-2011 (Gg CO_2 eq.)

Waste

The waste sectors accounted for 4,6% of the total greenhouse gas emissions in 2011 (excl. LULUCF). The emissions from waste sector in 2011 include CO_2, CH_4 and N_2O emissions. Emissions of the total greenhouse gases from waste sector have decreased from 1122,51 Gg CO_2 eq. in 1990 to 990,31 Gg CO_2 eq. in 2011 (Figure 2-11).

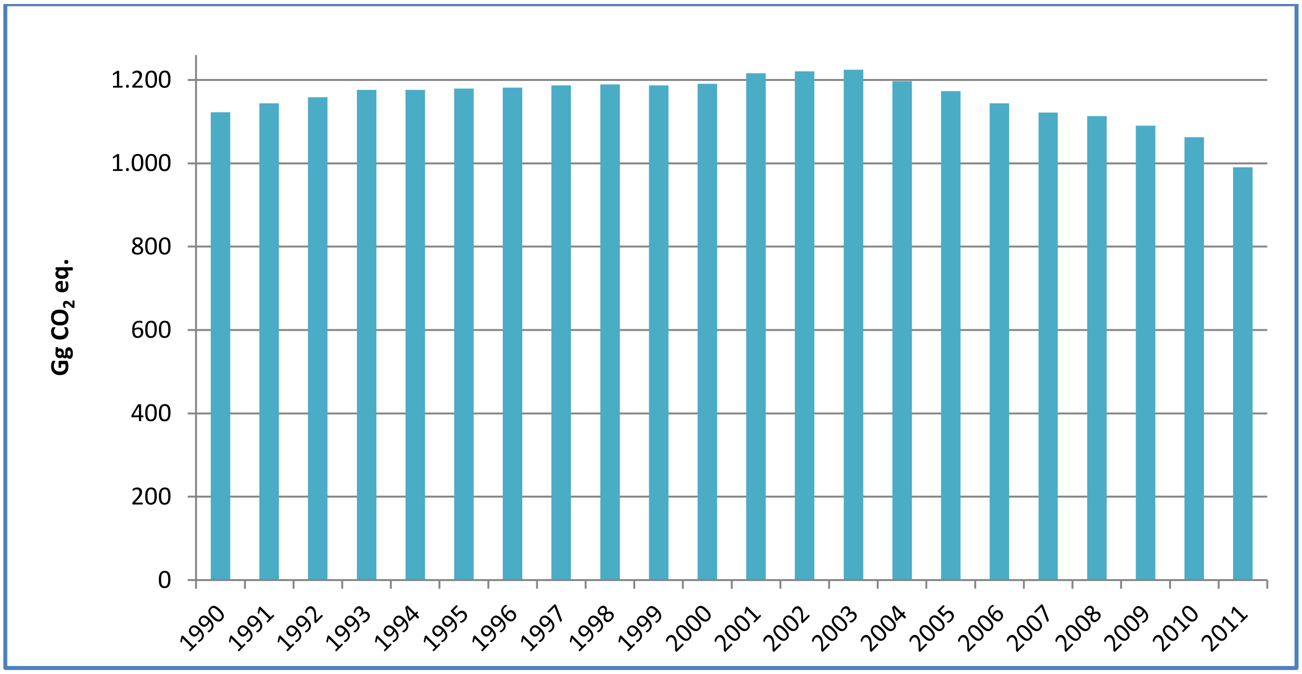


Figure 2-11. Trend of greenhouse gas emissions in waste sector during the period 1990-2011 (Gg CO_2 eq.)

Solid waste disposal on land, including disposal of sewage sludge, was the most important source contributing from average 80,5% of the total greenhouse gas emissions in waste sector. The increase of emissions was observed from 2001 to 2004 and was caused mainly by disposal of large amounts of organic sugar production waste. In later years the producers managed to hand over this waste to farmers for use in agriculture and greenhouse gas emissions have declined.

Total GHG emissions decreased approximately by 56% excluding LULUCF and by 75% including LULUCF compared to the base year. The trends of GHG emissions by sectors are presented in Table 1, expressed in CO_2 equivalent and taking into account GHG emissions/removals from LULUCF.

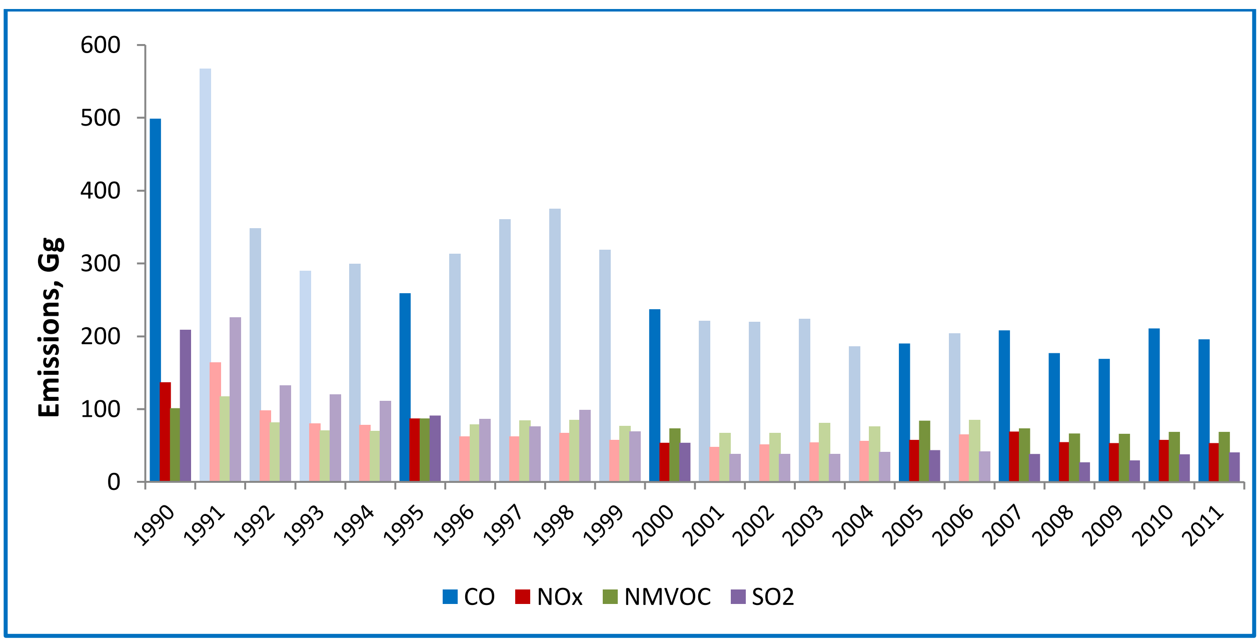
2.4 Description and interpretation of emission trends for indirect greenhouse gases and sulfur oxides

Nitrogen oxides ($NO_x = NO + NO_2$), non-methane volatile organic compounds (NMVOC) and carbon monoxide (CO) are not greenhouse gases, but they have an indirect effect on the climate throught the formation of ozone and their effects on the lifetime of the methane emission in the atmosphere. CO via its effects on hydroxyl radical (•OH), can help to promote abundance of methane in the atmosphere as well as increase ozone formation. NO_x influence climate by their impact on other greenhouse gases. NMVOCs have some short lived direct radiative forcing properties, primarily influence climate via promotion of ozone formation and production of organic aerosols . Sulphur dioxide (SO_2) also has an indirect impact on climate, as it increases the level of aerosols with a subsequent cooling effect. Therefore, emissions of these gases are to some extent included in the inventory.

Lithuania joined the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP) in 1994. As a party to the CLRTAP Lithuania is bound annually report data on emissions of air pollutants covered in the Convention and its Protocols using the Guidelines for Estimating and Reporting Emission Data under the Convention on Long-range Transboundary Air Pollution (EB.AIR/GE.1/2002/7). To be able to meet this reporting requirement Lithuania compiles and updates an air emission inventory of SO_2, NO_x, NMVOC, CO and NH_3, particulate matter, various heavy metals and POPs and projection.

The Informative Inventory Report (IIR) covering the inventory of air pollutant emissions from Lithuania are the source of data in this report (Figure 2-12). The report contains information on Lithuanian's inventories for 1990, 1995, 2000, 2005, 2007-2011 years (for remaining years data was interpolated or partially calculated (transparent columns)). Air emission inventory is based mainly on statistics published by Statistics Lithuania (Statistical Yearbooks of Lithuania, sectoral yearbooks on energy balance, agriculture, commodities production etc.), Institute of Road Transport, Registry of Transport (State enterprise "Regitra"), emission data collected by Environment Protection Agency and other.

A large decrease in all indirect GHG emissions was caused by the structural changes in the economy after 1990 when political independence of Lithuania was restored (Figure 2-12). This led to lower emissions in energy and industrial production and to an overall decrease in the emissions from industrial processes between 1990 and 1995. In 1996 the economy began to recover and production increased. In 1994, the GDP dropped to 54% of the 1989 level but later started to increase again.



* source LRTAP submission 2013

Figure 2-12. Development of non GHG gas and SO_2 emissions, 1990-2011

A rapid decrease of indirect emissions followed the decline of the country economy in the 1990s. Since 2000, the GDP has been growing continuously. Tables 2-1 and Table 2-2 present results from the Level Assessment of the key source for 1990 and 2011.

Table 2-1. Key source analysis for the main pollutants in 1990

Component	Key categories (Sorted from high to low and from left to right)								Total (%)
SO_x	1 A 1 a Public electricity and heat production	1 A 2 f ii Mobile Combustion in manufacturing industries and construction	1 A 4 a i Commercial / institutional: Stationary	1 A 4 b i Residential: Stationary plants					**84.5**
	37.5%	22.5%	14.0%	10.5%					
NO_x	1 A 1 a Public electricity and heat production	1 A 3 b iii Road transport: Heavy duty vehicles	1 A 4 c ii Agriculture/ Forestry/Fishing: Off-road vehicles and oth. machinery	1 A 3 b i Road transport: Passenger cars	1 A 2 f ii Mobile Combustion in manufacturing industries and construction	1 A 4 a i Commercial ; institutional: Stationary			**83.5**
	25.2%	24.1%	12.6%	11.5%	5.9%	4.2%			
NMVOC	3 A 2 Industrial coating application	1 A 3 b i Road transport: Passenger cars	1 A 4 c ii Agriculture/ Forestry/Fishing: Off-road vehicles and oth. machinery	1 A 3 b iii Road transport: Heavy duty vehicles	1 A 4 b i Residential: Stationary plants	3 D 2 Domestic solvent use	1 B 2 a v Distribution of oil products	2 D 2 Food and drink	**79.7**
	17.8%	17.4%	11.0%	7.8%	7.7%	7.1%	5.7	5.2	
CO	1 A 3 b i Road transport: Passenger cars	1 A 4 b i Residential: Stationary plants	1 A 3 b iv Road transport: Mopeds & motorcycles	1 A 4 a i Commercial / institutional: Stationary					**83.0**
	40.7%	23.9%	10.8%	7.6%					

Table 2-2. Key source analysis for the main pollutants in 2011

Component	**Key categories (Sorted from high to low and from left to right)**								**Total (%)**
SO_x	1 B 2a iv Refining / storage	1 A 2f ii Mobile Combustion in manufacturing industries and construction	1 A 4 b i Residential: Stationary plants	1 A 1 a Public electricity and heat production	1 A 4 a i Commercial/ institutional: Stationary				**86.0**
	25.8%	18.5%	17.5%	15.4%	8.8%				
NO_x	1 A3b iii Road transport: Heavy duty vehicles	1 A 1 a Public electricity and heat production	1 A 3 b i Road transport: Passenger cars	1 A 3 c Railways	1 A 2 f ii Mobile Combustion in manufacturing industries and construction	1 A 4 b i Residential: Stationary plants	1 A 4 c ii Agriculture/ Forestry/Fishing: Off-road vehicles and other machinery		**82.1**
	38.9%	13.1%	11.4%	5.8%	5.1%	4.1%	3.8%		
NMVOC	3 A 2 Industrial coating application	1 A 4 b i Residential: Stationary plants	1 B2a iv Refining / storage	3 D 2 Domestic solvent use	2 D 2 Food and drink	3 D 3 Other product use	3 B 1 Degreasing	1 A 3 b i Road transport: Passenger cars	**83.7**
	21.0%	20.9%	11.2%	8.4%	6.7 %	5.8%	3,1%	4.2%	
CO	1 A 4 b i Residential: Stationary plants	1 A 3 b i Road transport: Passenger cars							**81.9**
	67.3%	14.6%							

During the period 1990-2011, the emissions of sulphur dioxide has decreased by about 82%, conditioned by decline in energy production mainly due to substantial reduction of liquid fuel consumption. Oil products are very important fuels in Lithuania. However, their share in the primary energy balance has decreased steadily — from 42,4% in 1994 to 30,5% in 2001. This is related mostly to a reduction in the consumption of heavy fuel oil for producing electricity and district heat. The share of natural gas, the most attractive fuel over the long term, has increased. The role of coal has decreased throughout the period — from 3,7% in 1990 to 0,9% in 2001. In 1990, the most significant sectoral source of SO_x emissions was Electricity and heat production (37,5%), followed by emissions occurring from Manufacturing Industry & Construction (22,5 %) and in the Commercial, institutional and households (14,0%) sectors (Table 2-1). A combination of measures has led to the reductions in SO_x emissions. This includes fuel-switching from high-sulphur solid (e.g. coal) and liquid (e.g. heavy fuel oil) fuels to low sulphur fuels (such as natural gas) for power and heat production purposes within the energy, industry and domestic sectors, improvements in energy efficiency, and the installation of flue gas desulphurisation equipment in new and existing industrial facilities. The implementation of several directives within the EU limiting the sulphur content of fuel quality has also contributed to the decrease (UNECE, 2011). Electricity and heat production sector now contributes 15,4% of Lithuanian's total emissions in 2011. Emissions are mostly comprised of emissions from activities related to Combustion in manufacturing industries and construction (18,5%) and Residential combustion (17,5%) sectors (Table 2-2).

Emissions of NO_x have decreased by 2,5 times between 1990 and 2011. The Road transport (1A3bi-iii) and Energy industry (1A1) sectors are main sources of nitrogen oxides emissions ~50% in 1990 and 2011. The largest reduction of emissions in absolute terms since 1990 has occurred in the road transport sector. The reduction was observed mainly due to decrease of energy production and fuel consumption in transport sector during the period of 1990-1994 (the consumption of gasoline by road transport reduced by 56% and diesel by 57%). Due to less effective implementation of the Euro Standarts Lithuania report an increase in NO_x emissions till 2007. The reductions from 2007 have been achieved despite the general increase in activity within this sector and have primarily been achieved as a result of fitting three-way catalysts to petrol fuelled vehicles (the effect of catalytic degradation in newer cars was taken into account). In the electricity/energy production sector reductions have also occurred, in these instances as a result of measures such as the introduction of combustion modification technologies, however, the amounts of NO_x jumped considerably in 1A1a sector, which was due to a larger use of gas in power plants following INNP closure.

In 2011, the most significant sources of NMVOC emissions were Solvent and product use (21,0%), followed by Residential: Stationary plants (20,9%). The decline in emissions since 1990 has primarily been due to reductions achieved in the road transport sector due to the introduction of vehicle three-way catalytic converters (oxidation-reduction) and carbon canisters on petrol cars, for evaporative emission control driven by tighter vehicle emission standards, combined with limits on the maximum volatility of petrol that can be sold in EU Member States, as specified in fuel quality directives. The second reason of this change was decrease in use of motor fuel in transport sector and increase in a share of used diesel fuel compared to gasoline.

The CO emission trend shows decrease of emissions for period 1990 – 2011 by 2,5 times. Carbon monoxide emissions, total 196 Gg (2011), originates generally from the Energy sector. Residential sector generated the biggest part of the total CO emissions – 67,3% (2011).

3 ENERGY (CRF 1)

3.1 Overview of the sector

Sudden political upheaval, after the collapse of the Former Soviet Union, was followed by deep and complicated changes in all sectors of the Lithuanian economy, including Energy sector. Economic slump in Lithuania was comparatively large: at the end of 1994 Lithuanian Gross Domestic Product (GDP) dropped to 56,1% of the 1990 level. Since 1995 country's economy has been gradually recovering (Figure 3-1). Lithuanian GDP decreased by 1,1% in 1999 due to the financial and economic crisis in Russia. The year 2000 was a turning point because since this year the national economy has been recovering very fast. During the period 2000-2007 the average growth rate of GDP was 8,0% per annum (Statistics Lithuania, 2008). The impact of global economic recession was dramatic in Lithuania. The global economic crisis had an effect on Lithuanian GDP already in 2008, but GDP growth rate in 2008 was still positive (2,9%). In 2009, GDP decreased by 14,8%. Since 2010 Lithuania's GDP has grown slightly by 1,4% in 2010 and 5,9% in 2011. Export has been the main driver of increased GDP during 2010–2011 (Statistics Lithuania, 2012).

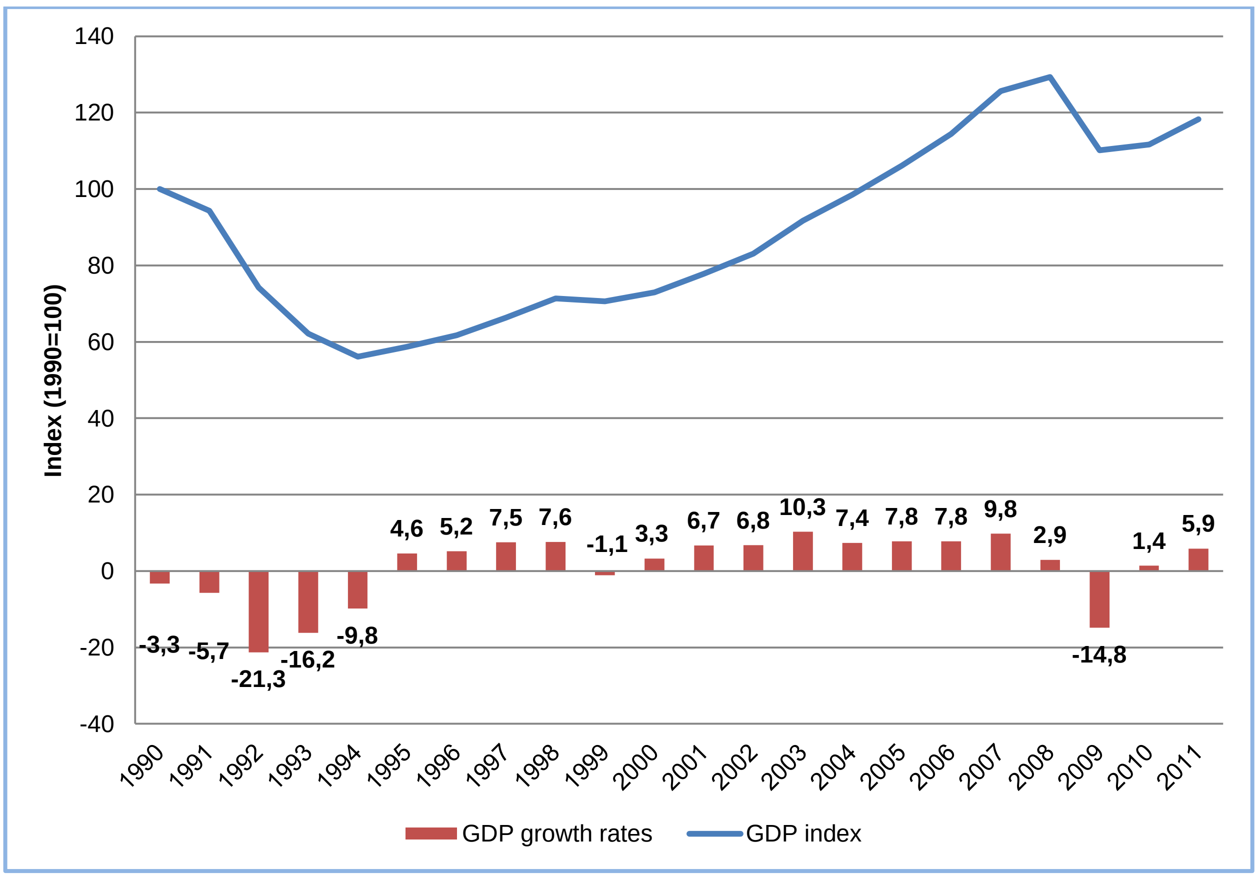


Figure 3-1. Changes of GDP annual growth rates and index in Lithuania

Dynamics of primary energy consumption in Lithuania during 1990-2011 is presented in Figure 3-2. Total primary energy consumption in 1990 amounted to 675,87 PJ (16,14 Mtoe) and in 2011 – 304,58 PJ (7,27 Mtoe). Oil and oil products were the most important fuel in Lithuania over previous decade. However, since 2000 their share in the primary energy balance has been fluctuating about

30% with the smallest portion of 23,9% in 2003 and the largest share of 38,9% in 2010. The major factors influencing changes in the role of oil products were decreasing consumption of heavy oil products for production of electricity and district heat and growing consumption of motor fuels in the transport sector. In 2009, due to significant reduction of motor fuel consumption, share of oil products decreased to 27,8%, but in 2010 due to closure of Ignalina Nuclear Power Plant (NPP) the share of oil products increased to 39,1%. With reference to data of 2011, the share of oil and oil products was 36,3%.

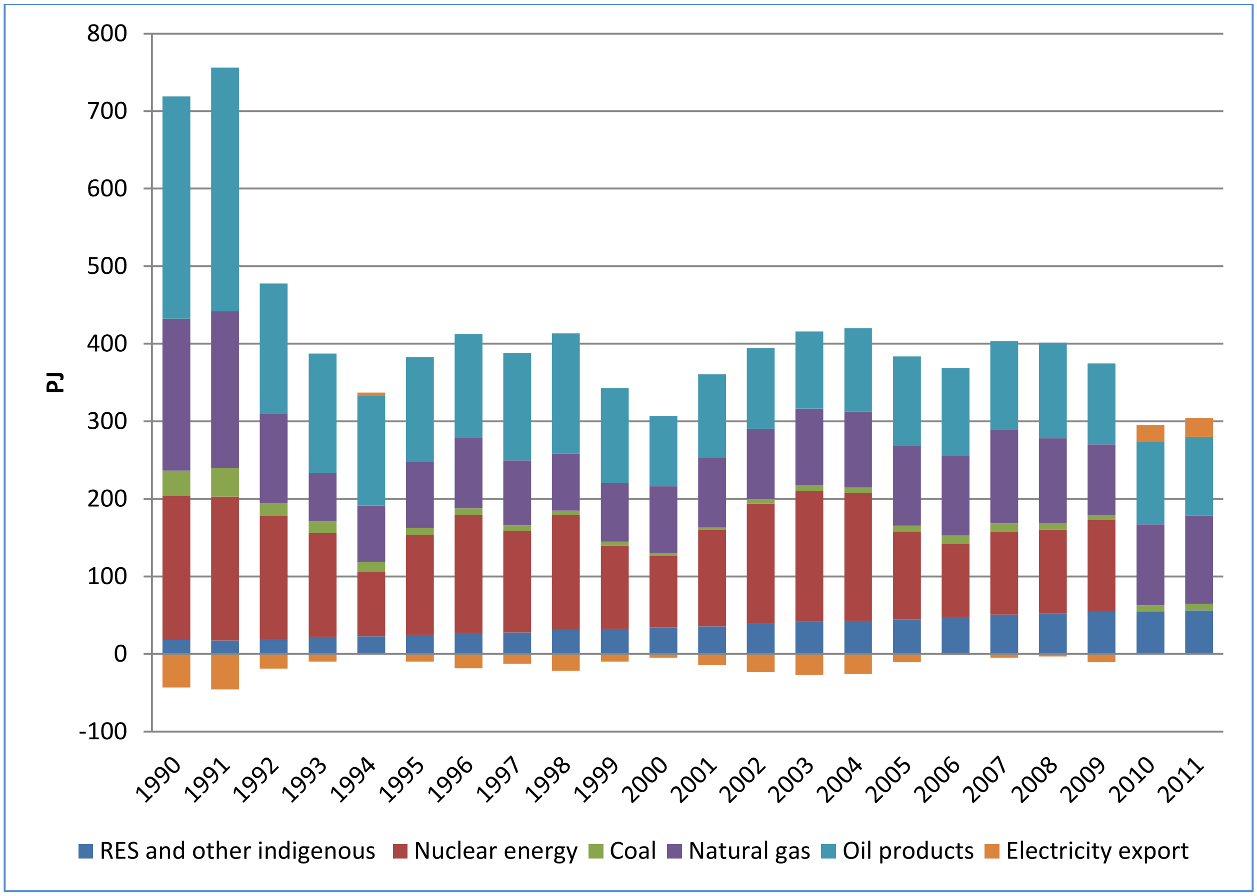


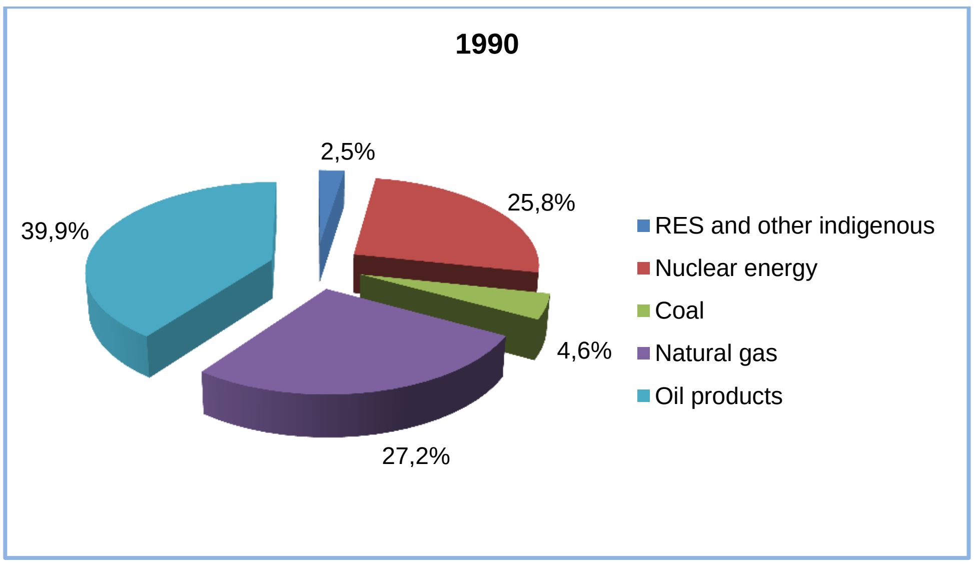
Figure 3-2. Primary energy consumption in Lithuania

At present natural gas is the most important fuel in the Lithuanian primary energy balance. The share of natural gas was fluctuating about 26% over the period 2000-2009 with the lowest contribution of 23,0% in 2002 and the largest share of 30,0% in 2007. Total consumption of natural gas was decreasing owing to reduction of its use for non-energy needs in 2008 and 2009. Consumption of gas for production of mineral fertilizers in 2009 was by 1,9 times less than in 2007. Since the beginning of Lithuanian economy recovery after the global crisis, the share of natural gas increased by 13 percentage points, i.e. from 24.4% in 2009 till 37.4% in 2011.

During the last decade the share of nuclear energy was very high and fluctuated about 30% with the lowest value of 25,6% in 2006 and the highest value of 40,6% in 2003. The role of nuclear fuel was very important in Lithuania. Nuclear fuel helped to increase the security of the primary energy supply, especially in the power sector. During the process of accession into the EU, one of the country's obligations was decision on the early closure of Ignalina Nuclear Power Plant (NPP). It was agreed that Unit 1 of this power plant would be closed before 2005 and Unit 2 in 2009. Ignalina NPP was the main source of electricity generation during the period 1988-2009, and even after the closure of Unit 1 it was producing more than 70% of electricity generated by Lithuanian power plants. The share of nuclear energy in the primary energy balance in the year 2009 (year of final closure of Ignalina NPP) was 31,6%. It is important to note that a large portion of electricity generated by this power plant was exported. Lithuania during the last decade was a net exporter of electricity and for instance in 2004 more than 37% of electricity generated by Ignalina NPP was exported to neighbouring countries. In 2011, share of electricity generated by all Lithuanian power plants was about 42% in the balance of gross consumption and 58% of electricity necessary to meet internal requirements was covered by electricity import, mostly from Russia.

Over the period 2000-2011 the share of coal in the primary energy balance was fluctuating about 2,0%, and in 2011 contribution of this fuel was 2,9%.

Comparison of the primary energy consumption structure in 1990 and in 2011 is presented in Figure 3-3.



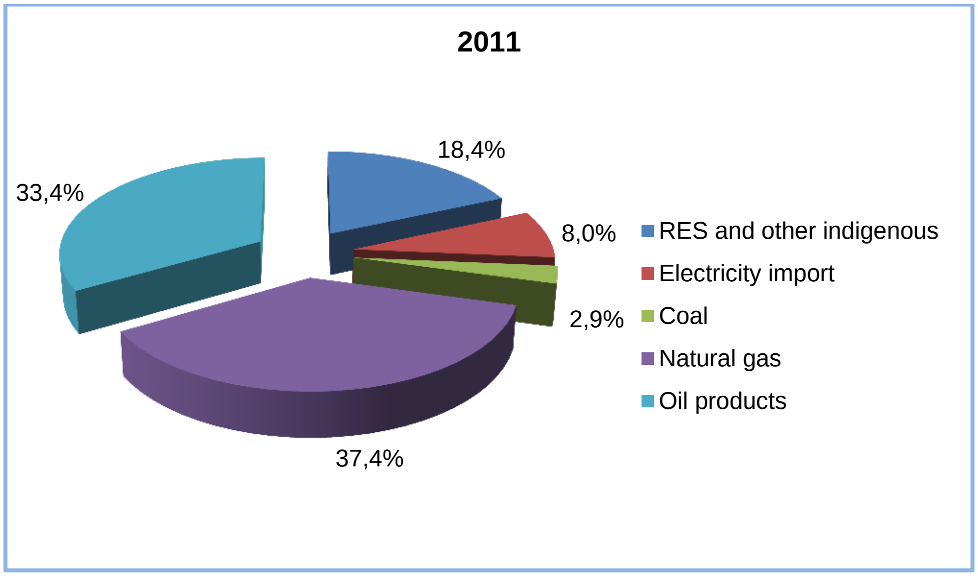


Figure 3-3. Structure of primary energy consumption in Lithuania

Indigenous energy resources in Lithuania are rather scarce. Certain contribution into balance of indigenous resources is originated from local oil, peat and energy of chemical processes. Nevertheless contribution of renewable energy sources into the country's primary energy balance during the period 1990-2011 was increasing (Statistics Lithuania, 2004, 2006-2011). During the period 1990-2011 primary energy supply from renewable sources increased by 3,2 times with an average annual growth of 5,9%. Primary supply from renewable energy sources reduced by 0,9% in 2011 due to consumption reduction of wood and agricultural waste, bioethanol, hydro and geothermal energy. The consumption of renewable energy sources by energy forms are presented in Figure 3-4. Currently the main domestic energy resource is solid biomass. Solid biomass accounts for 86,5% in the balance of renewable energy sources. The second largest renewable energy source is liquid biomass. In 2011, a share of bioethanol and biodiesel was 4,4%. Hydro power is fluctuating and currently provides 3,9% in the balance of renewable energy sources.

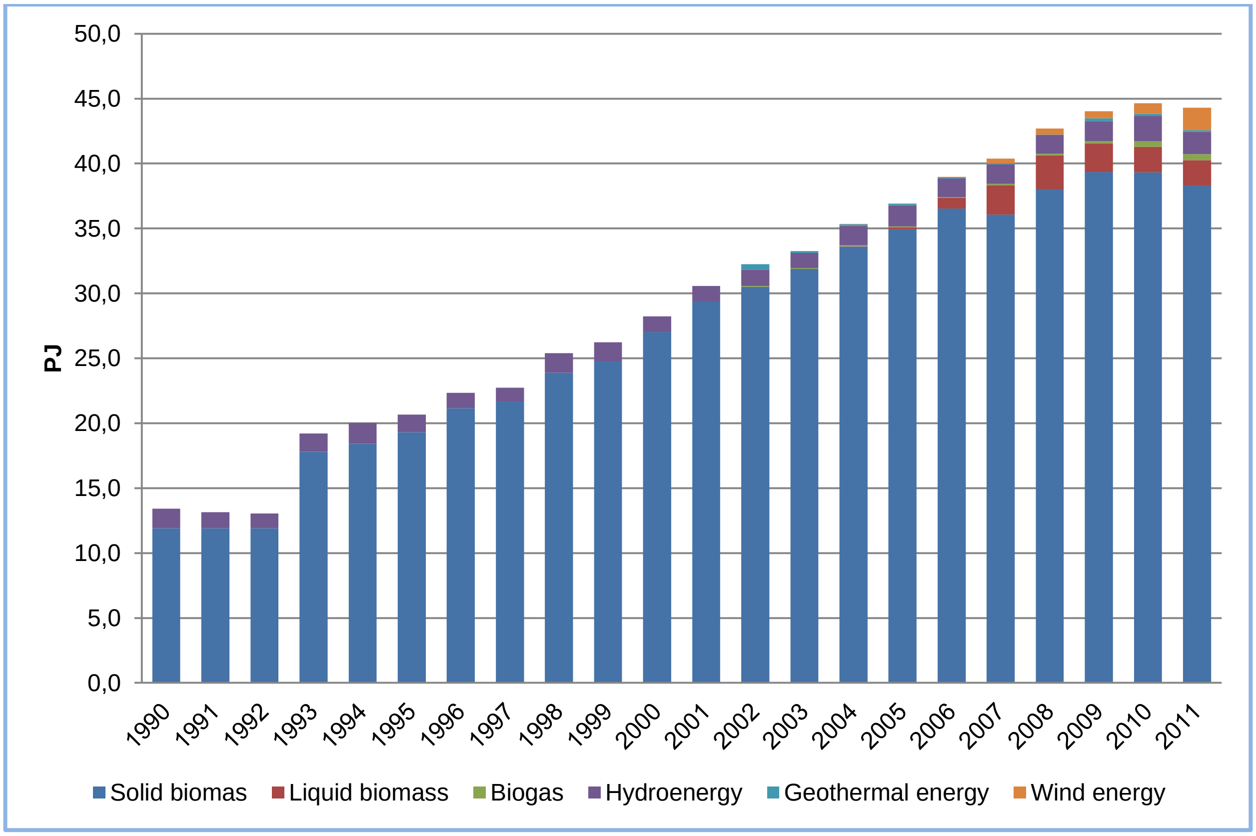


Figure 3-4. Consumption of renewable energy sources in Lithuania

Ignalina NPP played a key role in the Lithuanian energy sector producing up to 70-80% of the electricity. Even after the closure of Unit 1 at the end of 2004 this power plant was dominating in the electricity market – its share in the balance of gross electricity generation in 2009 has been almost 71%. Therefore the most important internal changes in the Lithuanian energy sector in 2010 are related with the final closure of Ignalina NPP (Figure 3-5). After the closure of Ignalina NPP Lithuanian Thermal Power Plant (Lithuanian TPP) is the major electricity generation source. Lithuanian TPP can cover up to 50-60% of the gross internal consumption. But in this case the country's dependence on primary energy import would be very high. After closure of Ignalina NPP energy sector dependent very much on supply of primary energy sources from one country (the country depends on Russia for 100% of its natural gas, and for more than 90% of its crude oil and almost 100% of coal requirements). In addition cost of electricity production at this power plant is high due to high price of natural gas. Thus, currently more than half of required electricity is imported from neighbouring countries (mostly from Russia).

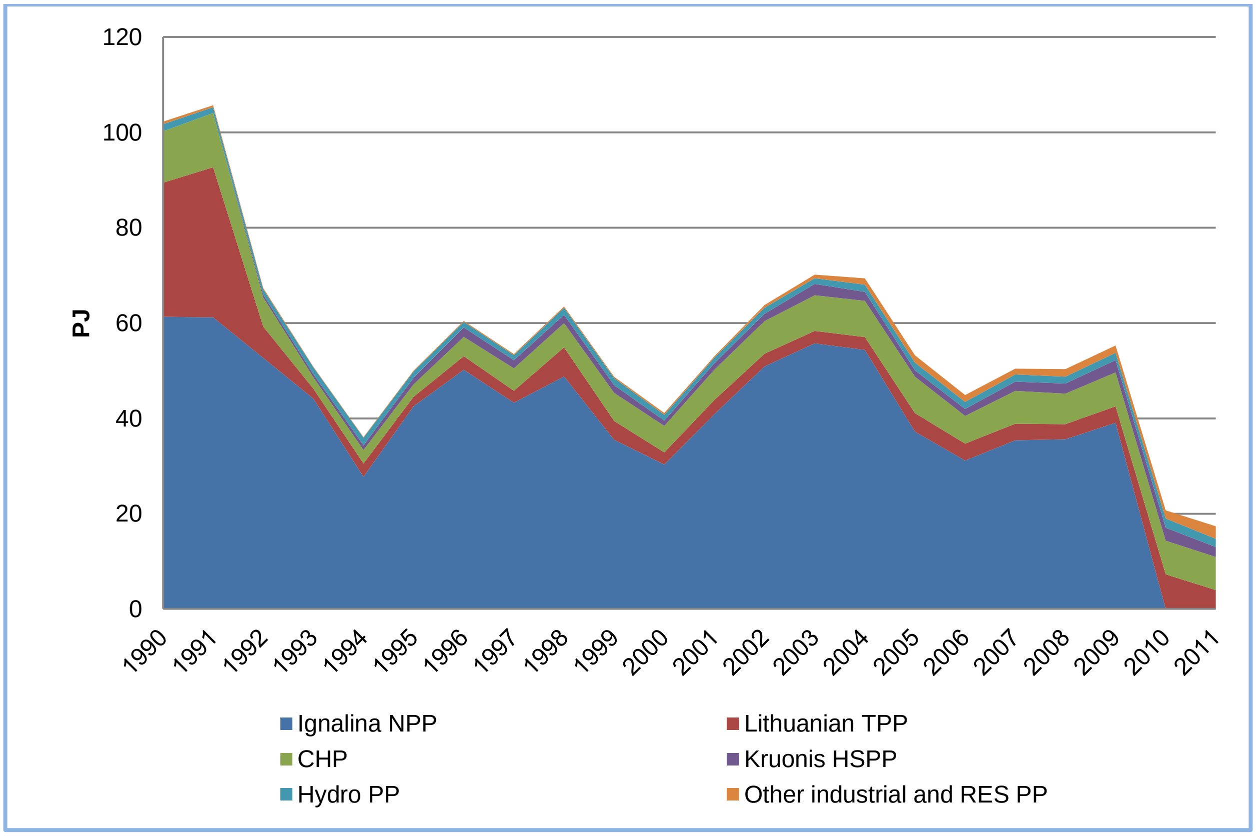


Figure 3-5. Structure of electricity generation in Lithuania

Taking into consideration absence of interconnections with the Western energy systems, the country's energy policy is focused on gradual increase of consumption of renewable energy resources and increase of energy efficiency.

Green electricity generation has been almost stable and fully dominated by hydropower in Lithuania during the period 1990-2000 (Figure 3-6). Since 2000 green electricity generation was increasing on average by 11,2% per year. Current electricity generation from renewable energy sources is still dominated by hydropower, generating about 43,4% of RES-E in 2011 and wind power, producing 43,1% of RES-E in 2011.

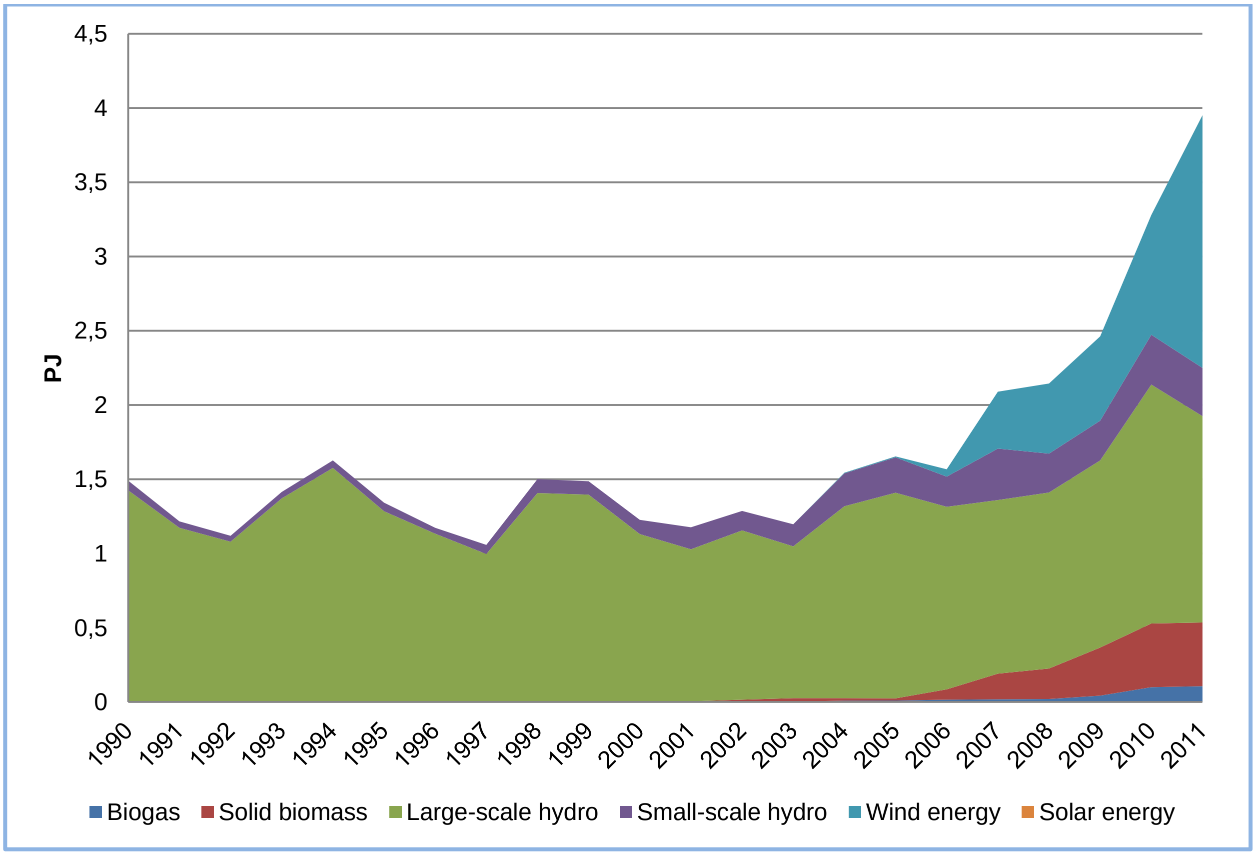


Figure 3-6. Green electricity production in Lithuania

Since 2006 the role of new renewable energy sources is growing rapidly in the Lithuanian electricity market. In 2011, about 43,1% of green electricity was covered by wind energy, 10,9% by biomass and about 2,7% by biogas. With reference of data 2011, there was produced 0,274 TJ (75,99 GWh) of solar electricity. Solar electricity contribution to the structure of RES-E was minor – 0,01% in 2011.

Many factors had influence on changes of energy consumption: deep economic slump in 1991-1994, fast economic growth over the period 2000-2008, dramatic reduction of economic activities in all branches of the national economy and the closure of Ignalina NPP in 2009, a significant increase of energy prices, an increase of energy efficiency and other reasons.

Total final energy consumption (excluding non-energy use) in 1990 amounted to 405,26 PJ (9,68 Mtoe). In 1991-1994 final energy consumption decreased approximately by 2,1 times (Figure 3-7). The final energy consumption was increasing during the period 2000-2008 by 4,0% per annum, and in 2008 it was 215,41 PJ (5,14 Mtoe) (Statistics Lithuania, 2004, 2006, 2010). During this period the final energy consumption was increasing in all sectors of the national economy.

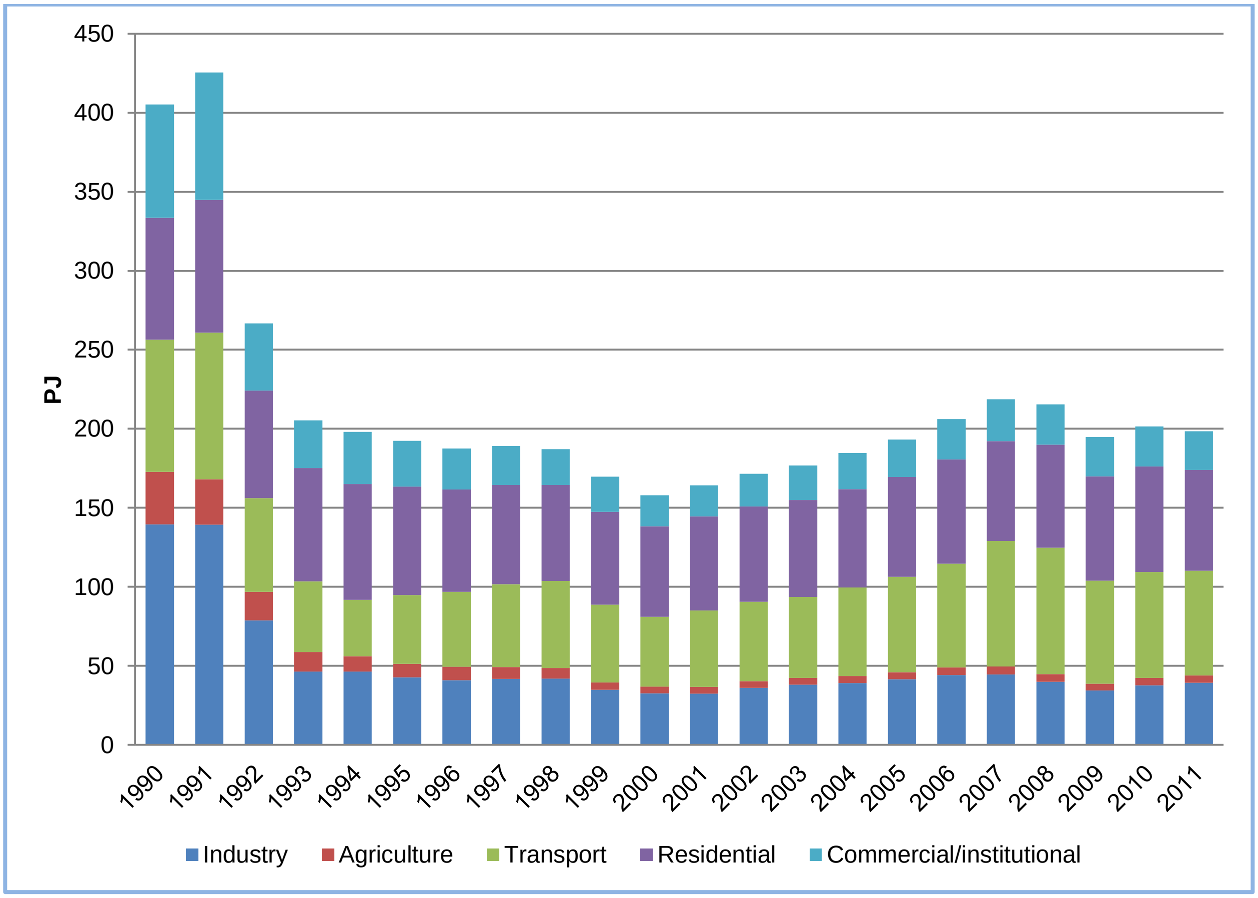


Figure 3-7. Final energy consumption in Lithuania

In 2009, total final energy consumption was by 9,6% less than in the previous year, and the most severe impact of the economic recession was in the construction sector where energy consumption decreased by 35%. Energy consumption decreased in the transport sector by 18,4%. As a result of recovering Lithuanian economy, final energy consumption increased by 3,4% in 2010. However, in 2011 the final energy consumption reduced by 1,5% and amounted to 198,44 PJ (4,74 Mtoe). This decrease was mainly caused by reduced energy consumption in transport, residential and commercial/institutional sectors. Final energy consumption in industry increased by 4,6% in 2011 due to growing activities of Lithuanian manufacturing sector.

Several emission sources in the Energy Sector are key categories. Key categories in 2011 by level (L) and trend (T), excluding LULUCF are listed in Table 3-1.

Table 3-1. Key category from Energy Sector in 2011 by Level and Trend excluding LULUCF

IPCC source categoty	Gas	Identification criteria	Approach used
1.AA.1.A Public electricity and heat production, gaseous fuel	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1
1.AA.1.A Public electricity and heat production, liquid fuel	CO_2	Level	Tier 1
		Trend	Tier 1 / Tier 2

1.AA.1.B Petroleum refining, liquid fuel	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
1.AA.2 Manufacturing industries and construction, gaseous fuels	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
1.AA.2 Manufacturing industries and construction, liquid fuels	CO_2	Level	-
		Trend	Tier 1 / Tier 2
1.AA.2 Manufacturing industries and construction, solid fuels	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
1.AA.3 Transport	N_2O	Level	Tier 2
		Trend	-
1.AA.3.B Road transportation, diesel	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
1.AA.3.B Road transportation, gasoline	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
1.AA.3.B Road transportation, LPG	CO_2	Level	Tier 1
		Trend	Tier 1
1.AA.3.C Railways	CO_2	Level	Tier 1 / Tier 2
		Trend	-
1.AA.3.E Off-road vehicles and machinery	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
1.AA.4 Other sectors, biomass	CH_4	Level	Tier 2
		Trend	Tier 1 / Tier 2
1.AA.4 Other sectors	N_2O	Level	Tier 2
		Trend	-
1.AA.4.A Commercial/Institutional	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
1.AA.4.B Residential	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
1.B. Fugitive Emissions from Fuels	CH_4	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2

3.2 Fuel combustion (CRF 1.A)

Fuel Combustion category (CRF 1.A) comprises following sources:

- Fuel Combustion – Sectoral Approach (CRF 1.A.A)
  - o Energy Industries (CRF 1.A.A.1)
  - o Manufacturing Industries and Construction (CRF 1.A.A.2)
  - o Transport (CRF 1.A.A.3)
  - o Other Sectors (CRF 1.A.A.4)
  - o Other (CRF 1.A.A.5)
- Fuel Combustion – Reference Approach (CRF 1.A.B.)
- Difference - Reference and Sectoral Approach (CRF 1.A.C)
- Feedstocks and non-energy use of fuels (CRF 1.A.D)

This chapter gives an overview of emissions and key sources of fuel combustion activities, includes information on completeness, QA/QC, planned improvements as well as on emissions, emission trends and methodologies applied (including emission factors). Furthermore, information on sectoral/reference approach and feedstocks/non-energy use of fuels is given in this sector. Additionally to information provided in this Chapter, Annex III includes information on the activity data used for emissions estimation, i.e. national energy balance data are presented and Annex IV includes summary of study on "Determination of national GHG emission factors for energy sectors" (fuel combustion) performed by Lithuanian Energy Institute in August 2012.

In the Energy sector emissions of CO_2 contribute about 95% of total greenhouse gas emissions CO_2 eq. in 2011. Trends of total GHG emissions calculated as CO_2 equivalents from the energy sector are presented in Figure 3-8. Total greenhouse gases (GHG) from the energy sector have decreased by almost 2,8 times from 32745,0 Gg CO_2 eq. in 1990 to 11820,5 Gg CO_2 eq. in 2011. Significant decrease of emissions was mainly due to economic slump in 1991-1994 period. During the fast economic growth over the period 2000-2008 GHG emission in Energy sector was increasing about 2,2% per annum. The global economic recession had impact on GHG reduction in energy sector by 10,0% in 2009. The closure of Ignalina NPP and GDP increase had impact on GHG increase by 7,9% in 2010. In 2011, total GHG emissions in Energy sector decreased by 7,6%. This trend was stipulated by almost 16,4% decrease of GHG emissions in public electricity and heat production sector due to increased share of electricity import from neighbouring countries, increased use of renewable energy sources and natural gas.

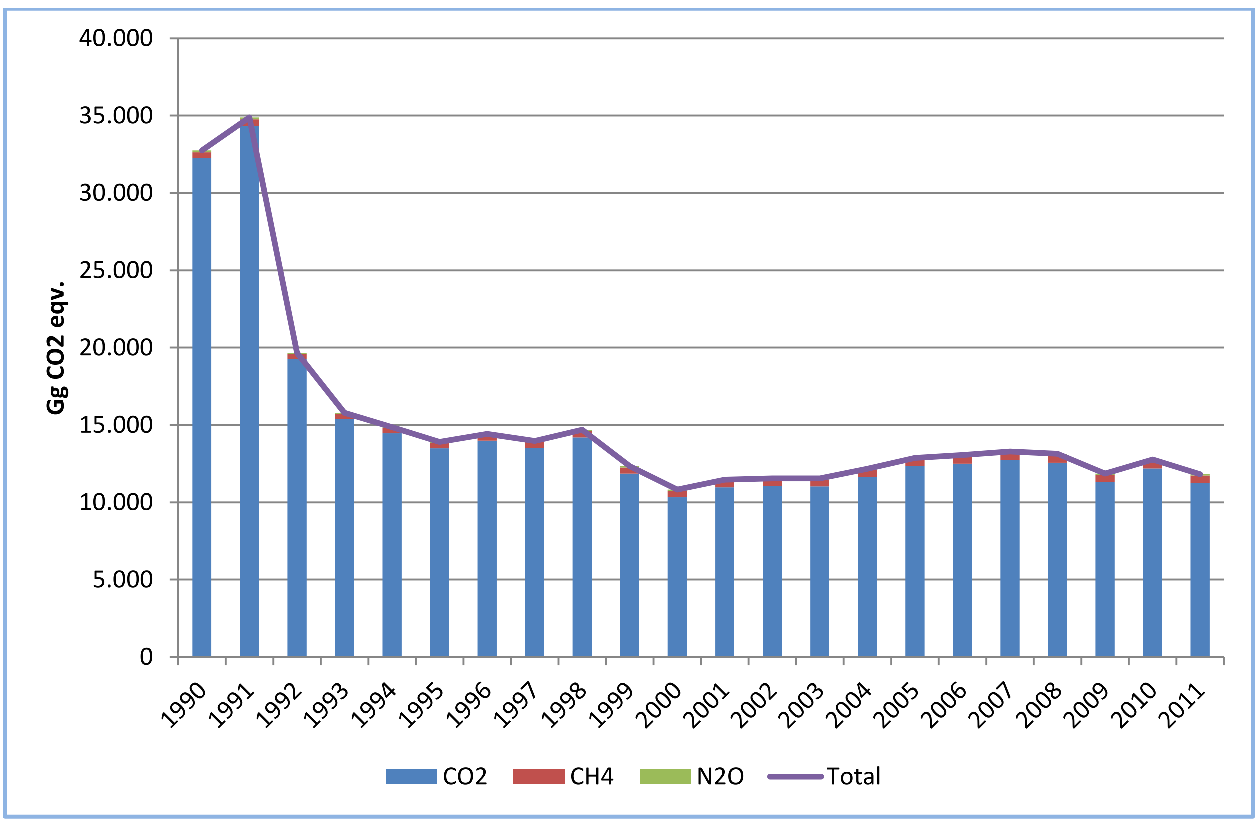
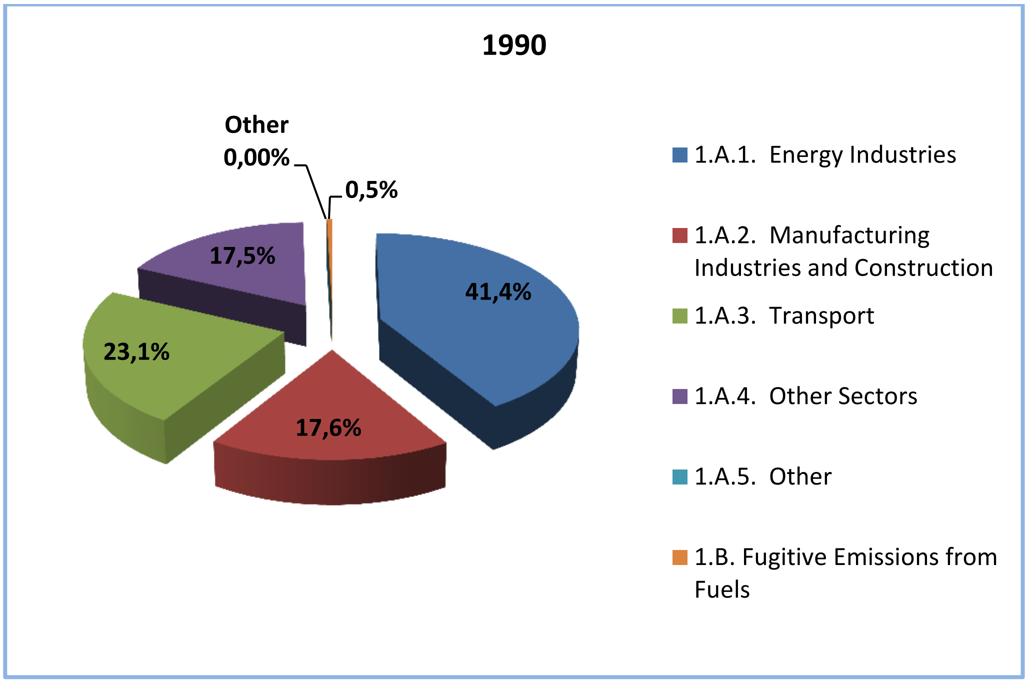


Figure 3-8. Total GHG emission from the Energy Sector (CRF 1), Gg CO_2 eq.

Changes in structure of GHG emissions in energy sector showed in Figure 3-9. The 1.A.1 Energy industries accounts for the largest share of GHG emission from Energy Sector. In 2011 this source category amounted about 37,6% of total GHG emission from energy sector. During the period 1990-2011 significantly increased share of the transport sector. In 1990 transport sector accounted for 23,1% of total GHG emission from Energy Sector and in 2011 - 37,9%.



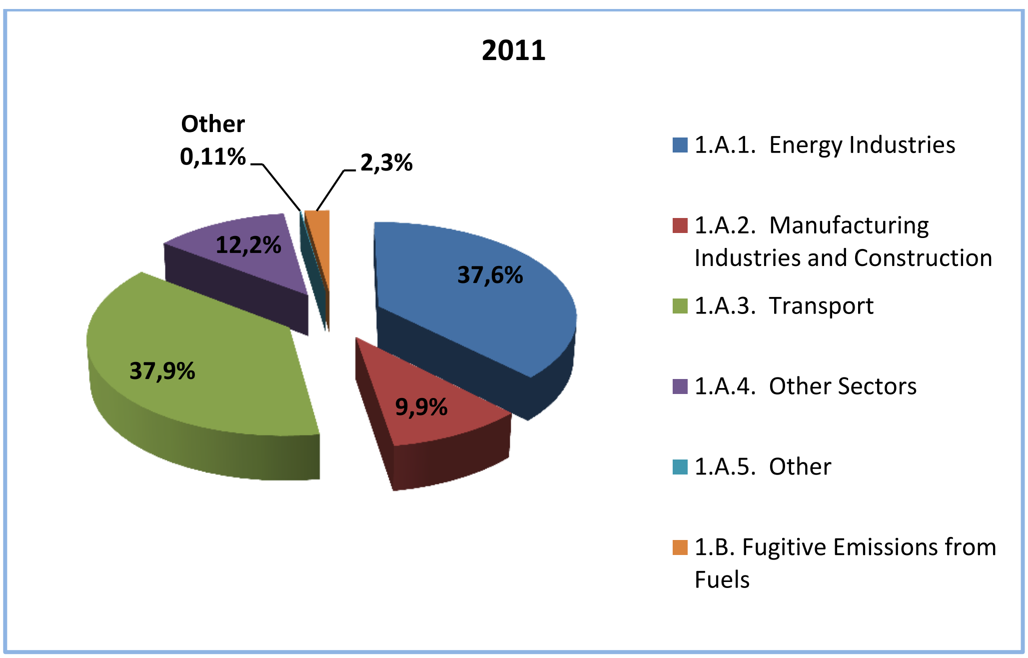


Figure 3-9. Structure of GHG emission from Energy Sector in 1990 and 2011

The trends of GHG emissions calculated as CO_2 equivalent from different subsectors within the Energy Sector are presented in Figure 3-10. The most important subsector regarding total emission in the base year was Energy industries (1.A.1) and it remains to be one of the most important. The closure of Ignalina NPP in 2010 had impact on GHG emission increase in this subsector. In 2010 GHG emissions increased by approximately 10,5% in energy industries. In 2011 GHG emissions in energy industries reduced by almost 16,4%. Growing activities in the Manufacturing industries and construction sector stipulated increase in GHG emissions during 2009-2011. GHG emissions from Transport sector in 2011 decreased by 1,8%. An increase took place in Other sectors (1.A.4). Since 2000 GHG emissions in this subsector was growing about 2,2% per annum. Such increase is mainly stipulated by significant growth of natural gas and coal consumption in residential and commercial/institutional subsectors.

Increase of GHG emissions from 1.B Fugitive emissions from fuels is mainly caused by the increase of CH_4 emissions from natural gas distribution, reflecting the increase of the length of natural gas pipelines. Since 1990 GHG emissions from this subsector was increasing by 2,7% per annum. In 2011 fugitive emissions accounted 269,8 Gg CO2 eqv.

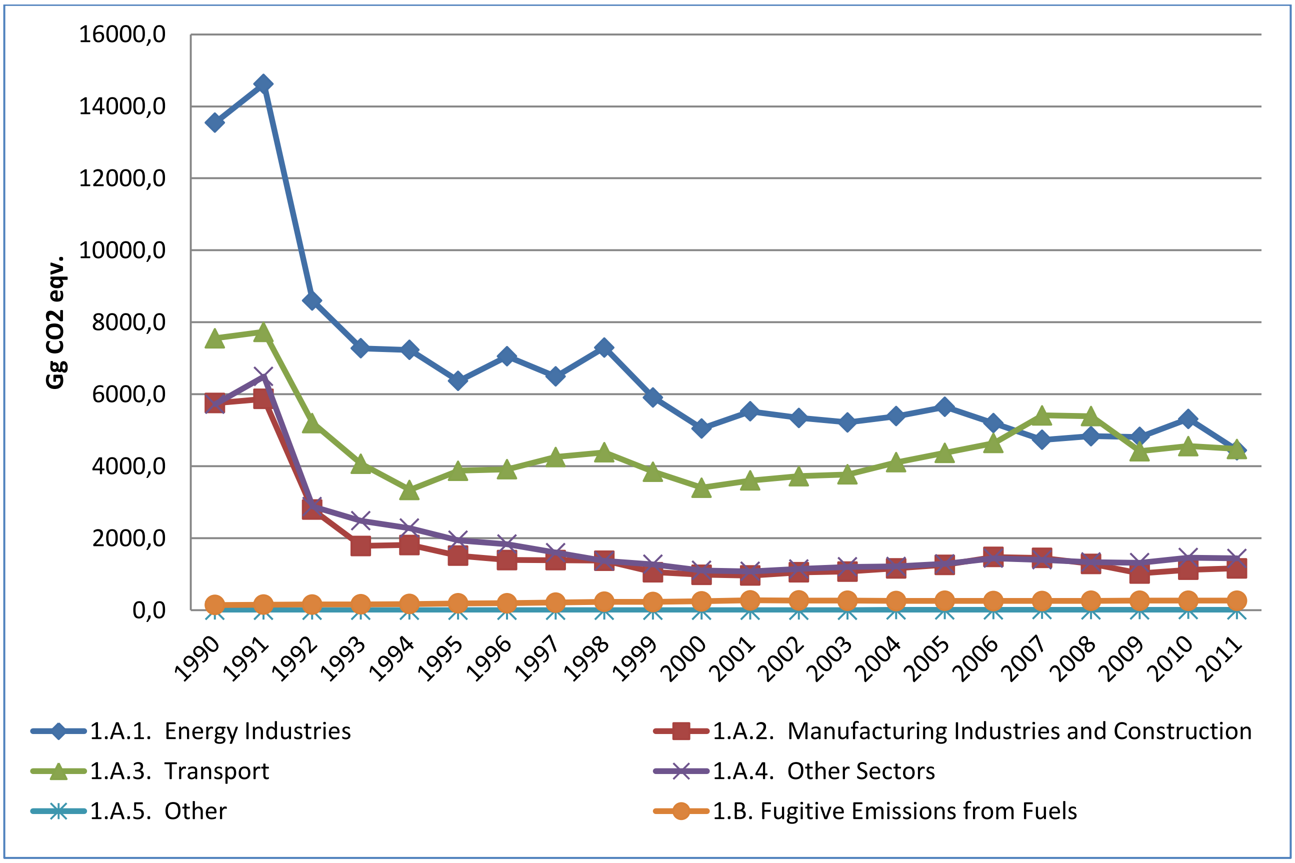


Figure 3-10. Total GHG emissions from the different subsectors within the Energy Sector, (CRF 1), Gg CO_2 eq.

3.2.1 Comparison of sectoral approach with the reference approach

CO_2 emissions from energy sector were calculated using both sectoral and reference approaches. Reference approach is accounting for carbon, based mainly on supply of primary fuels and the net quantities of secondary fuels brought into the country.

Differences between sectoral and reference approach were estimated for fuel consumption and CO_2 emissions. Figure 3-11 shows comparison of CO_2 emissions estimates for the two approaches for the period 1990–2011.

Table 3-2 presents CO_2 emissions of sectoral and reference approach.

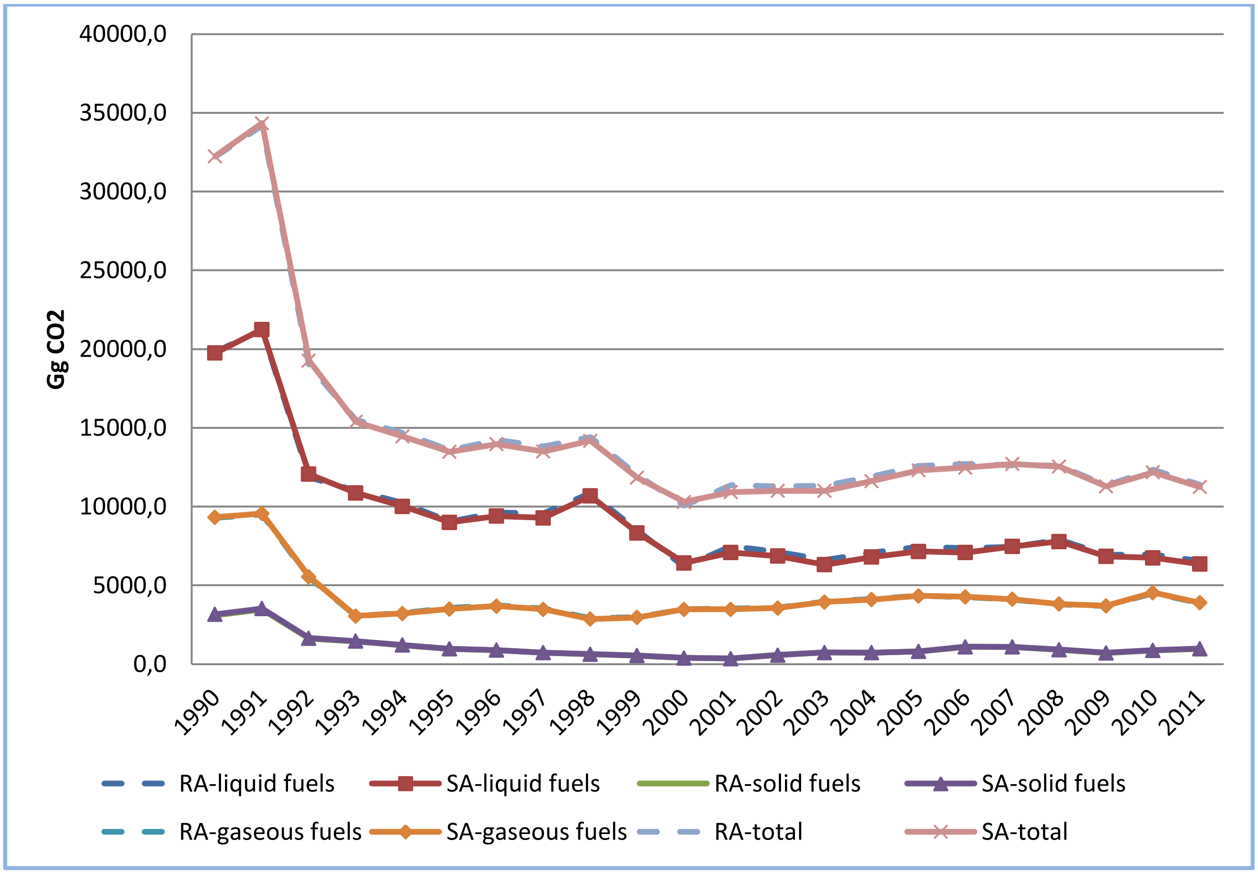


Figure 3-11. Comparison of CO_2 emissions between sectoral and reference approach

Figure 3-11 shows that the differences for CO_2 emissions are very closely correlated.

Table 3-2. Values of CO_2 emissions from sectoral and reference approach

Year	Reference approach				Sectoral approach			
	Liquid, Gg CO_2	Solid, Gg CO_2	Gaseous, Gg CO_2	Total, Gg CO_2	Liquid, Gg CO_2	Solid, Gg CO_2	Gaseous, Gg CO_2	Total, Gg CO_2
1990	19828	3102	9283	32213	19757	3164	9324	32246
1991	21219	3466	9499	34183	21250	3535	9559	34344
1992	11851	1626	5489	18965	12061	1653	5549	19264
1993	11015	1435	3051	15501	10868	1461	3054	15384
1994	10219	1195	3248	14662	10019	1215	3215	14450
1995	9058	959	3559	13576	9005	974	3505	13484
1996	9622	882	3728	14232	9393	891	3678	13963

1997	9567	723	3522	13812	9282	734	3482	13497
1998	10858	631	2910	14400	10676	642	2858	14176
1999	8487	535	2975	11998	8334	544	2960	11838
2000	6190	390	3484	10063	6428	395	3479	10303
2001	7487	351	3516	11354	7083	356	3478	10916
2002	7124	573	3577	11274	6865	581	3561	11007
2003	6604	736	3977	11317	6312	743	3943	10998
2004	7076	715	4127	11918	6795	726	4099	11620
2005	7454	799	4334	12586	7155	813	4334	12301
2006	7361	1083	4250	12694	7086	1103	4269	12477
2007	7445	1080	4101	12625	7471	1097	4122	12711
2008	7897	908	3798	12603	7784	924	3819	12546
2009	6944	706	3686	11336	6844	718	3706	11284
2010	6966	864	4507	12337	6748	880	4531	12176
2011	6548	968	3871	11387	6348	985	3892	11247

Table 3-3 presents percentage differences of CO_2 emissions between reference and sectoral approach. Statistical differences of energy balances contribute to some share of differences between these two methods especially for liquid fuels. The differences of CO_2 emissions between these two methods arise also due to fuel transformation and distribution losses, which are not considered in the sectoral approach. In reference approach CO_2 emissions from diesel are fully accounted as fossil emissions while in sectoral the share of biofuels is accounted under liquid biomass (as biofuel).

Table 3-3. Difference of CO_2 emissions by fuel type, %

Year	Liquid fuels, %	Solid fuels, %	Gaseous fuels,%	Total, %
1990	0,36	-1,95	-0,45	-0,10
1991	-0,15	-1,95	-0,63	-0,47
1992	-1,74	-1,68	-1,09	-1,55
1993	1,35	-1,82	-0,09	0,76
1994	2,00	-1,67	1,02	1,47
1995	0,58	-1,56	1,55	0,68
1996	2,43	-1,02	1,34	1,93
1997	3,07	-1,43	1,17	2,33
1998	1,70	-1,69	1,82	1,57
1999	1,84	-1,59	0,51	1,35
2000	-3,72	-1,39	0,14	-2,33
2001	5,70	-1,52	1,12	4,01
2002	3,76	-1,26	0,46	2,43
2003	4,63	-0,99	0,88	2,90
2004	4,13	-1,49	0,67	2,56

2005	4,18	-1,74	0,01	2,32
2006	3,87	-1,76	-0,45	1,74
2007	-0,36	-1,56	-0,51	-0,68
2008	1,46	-1,81	-0,54	0,45
2009	1,47	-1,71	-0,54	0,46
2010	3,24	-1,78	-0,53	1,32
2011	3,14	-1,79	-0,53	1,25

In reference approach emissions are estimated by subtracting carbon stored in the final products from the total carbon content calculated from the apparent consumption. Feedstocks and non energy consumption has been accounted according to the energy balances based on information provided in the Lithuanian Statistics database (http://www.stat.gov.lt/lt/).

During the review ERT noticed differences between the IAE data and the reference approach data which are provided by the Lithuanian Statistics and recommended explain these differences in the NIR. Following this recommendation Lithuania investigated that the differences in natural gas consumption between the IEA data and the reference approach are due to the use of different types of calorific values: Lithuanian Statistics uses a net calorific value whereas the IAE data are based on a gross calorific value. The difference between net calorific value (NCV) and gross calorific value (GCV) is: 1 NCV = 0.9 GCV (IEA, 2005).

Representatives of Lithuanian Statistics explained that differences of refinery feedstock imports and refinery stocks between the IAE data and the reference approach are due to different aggregation level. The Lithuanian Statistics for refinery feedstock aggregates: refinery feedstock, semi-finished products of oil refining and additives/oxygenates. In the IEA database, refinery feedstock aggregates: refinery feedstock and semi-finished products of oil refining. Additives/oxygenates is provided separately in the IEA database.

It was investigated that crude oil import data for 1991-1994, 2000 and crude oil stock for 1990 between the IAE data and the Lithuanian statistics differ only in TJ, but are the same in specific unit (tons). This shows that these differences are due to the use of different types of calorific values.
It is necessary to mentioned, that GHG emission estimates in the sectoral approach and in the reference approach are based on activity data which are provided by the Lithuanian Statistics using the same NCV.

3.2.2 International bunker fuels

GHG emissions and activity data from navigation assigned to international bunkers are presented in the following Table 3-4.

Table 3-4. GHG emissions and activity from 1.C1.B International bunkers-marine 1990-2011

Year	CO_2, Gg	CH_4, Gg	N_2O, Gg	Activity data, TJ
1990	302,2	0,019	0,002	3894
1991	498,3	0,032	0,004	6422
1992	925,1	0,060	0,007	11921

1993	510,8	0,033	0,004	6583
1994	482,8	0,031	0,004	6222
1995	448,5	0,029	0,003	5780
1996	417,4	0,027	0,003	5379
1997	192,3	0,012	0,001	2496
1998	158,1	0,010	0,001	2094
1999	229,5	0,015	0,002	3019
2000	292,6	0,019	0,002	3828
2001	314,9	0,021	0,002	4112
2002	348,9	0,023	0,003	4554
2003	348,2	0,023	0,003	4532
2004	360,1	0,023	0,003	4692
2005	456,8	0,030	0,004	5933
2006	437,8	0,028	0,003	5681
2007	380,7	0,025	0,003	4944
2008	285,9	0,019	0,002	3722
2009	406,9	0,026	0,003	5285
2010	445,0	0,029	0,003	5781
2011	452,4	0,029	0,004	5883

Tier 2 is used for CO_2 emissions estimates and Tier 1 for CH_4 and N_2O for International bunkers. The Statistics Lithuania provides data on marine bunkers in Energy Balances (see Annex III). Emissions factors used to estimate CO_2, CH_4 and N_2O emissions are presented in Table 3-5. Country specific CO_2 emission factor and IPCC default values of CH_4 and N_2O has been used.

Table 3-5. Emission factors used for International bunkers - marine

	CO_2, t/TJ	CH_4, t/TJ	N_2O, t/TJ
Gas/diesel oil	72,89	0,005	0,0006
Residual fuel oil	77,60	0,005	0,0006

GHG emissions and activity data from aviation assigned to international bunkers are presented in the following Table 3-6.

Table 3-6. GHG emissions and activity from 1.C1.A International bunkers aviation 1990–2011

Year	CO_2, Gg	CH_4, Gg	N_2O, Gg	Activity data, TJ
1990	399,3	0,0	0,0	5527
1991	480,5	0,0	0,0	6652
1992	194,7	0,0	0,0	2695
1993	107,9	0,0	0,0	1494
1994	114,6	0,0	0,0	1586
1995	118,0	0,0	0,0	1634
1996	96,7	0,0	0,0	1338

1997	90,8	0,0	0,0	1257
1998	81,8	0,0	0,0	1133
1999	76,1	0,0	0,0	1053
2000	73,4	0,0	0,0	1016
2001	98,2	0,0	0,0	1360
2002	83,4	0,0	0,0	1155
2003	93,5	0,0	0,0	1294
2004	105,9	0,0	0,0	1466
2005	139,1	0,0	0,0	1926
2006	158,1	0,0	0,0	2189
2007	198,1	0,0	0,0	2742
2008	229,4	0,0	0,0	3176
2009	109,9	0,0	0,0	1522
2010	145,3	0,0	0,0	2012
2011	166,9	0,0	0,0	2311

Statistical data on use of three types of aviation fuel are collected by the Statistics Lithuania: aviation gasoline, gasoline type jet fuel and kerosene type jet fuel since 2001. Since 2001 Statistics Lithuania distinguishes aviation fuel consumption between domestic and international flights, however for 1990-2000 period only total fuel consumption data are available. Taking into consideration IPCC good practise guidelines activity data were extrapolated and following advice from experts during 2004 review it was distinguished in such a way that all aviation gasoline is used for domestic purposes and thus all the rest (gasoline type jet fuel and kerosene type jet fuel) is used for international flights – the latter could therefore be considered as aviation bunkers. More information on AD extrapolation is provided in chapter 3.4.1. Emissions factors used to estimate CO_2, CH_4 and N_2O emissions for aviation are presented in Table 3-7.

Table 3-7. Emission factors used for International bunkers - aviation

	CO_2, t/TJ	CH_4, t/TJ	N_2O, t/TJ
Jet kerosene	72,24	0,0005	0,002

In this category following recalculations has been done:

- correction of country specific CO_2 emission factor for residual fuel oil based on study on "Determination of national GHG emission factors for energy sector (fuel combustion) performed by Lithuanian Energy Institute;
- correction of CH_4 emission factors for jet kerosene, gas/diesel oil and residual fuel oil based on default values provided in 1996 IPCC;
- correction of N_2O emission factor for jet kerosene based on default values provided in 1996 IPCC.

Impact of these recalculations is presented in Table 3-8.

Table 3-8. Impact of recalculation on GHG emissions from 1.C1 International bunkers

Year	Submission 2012, Gg CO2 eq.	Submission 2013, Gg CO2 eq.	Absolute difference, Gg CO2 eq.	Relative difference, %
1990	720,7	706,1	-14,7	-2,0
1991	1009,0	985,0	-24,1	-2,4
1992	1168,7	1124,9	-43,8	-3,7
1993	645,8	621,6	-24,1	-3,7
1994	623,0	600,2	-22,8	-3,7
1995	590,5	569,3	-21,2	-3,6
1996	536,2	516,5	-19,7	-3,7
1997	292,7	284,6	-8,1	-2,8
1998	245,5	241,3	-4,3	-1,7
1999	314,4	307,1	-7,3	-2,3
2000	378,3	367,8	-10,6	-2,8
2001	427,0	415,2	-11,8	-2,8
2002	447,6	434,4	-13,2	-3,0
2003	457,7	443,8	-13,9	-3,0
2004	482,3	468,2	-14,1	-2,9
2005	617,8	598,8	-19,0	-3,1
2006	617,6	599,0	-18,6	-3,0
2007	598,0	582,0	-16,0	-2,7
2008	530,0	518,4	-11,6	-2,2
2009	536,1	519,3	-16,8	-3,1
2010	611,8	593,3	-18,5	-3,0

3.2.3 Feedstocks and non-energy use of fuels

In this submission the data on feedstocks and non-energy use of fuels are updated based on information provided by the Statistics Lithuania. Feedstocks and non-energy use of fuel are included in national Energy balances (see Annex III). Use of fuels for feedstocks and non-energy use is dominated by natural gas (Figure 3-12). In 2011, natural gas amounted about 61% and refinery feedstocks - 28% in the structure of feedstocks and non-energy use of fuels.

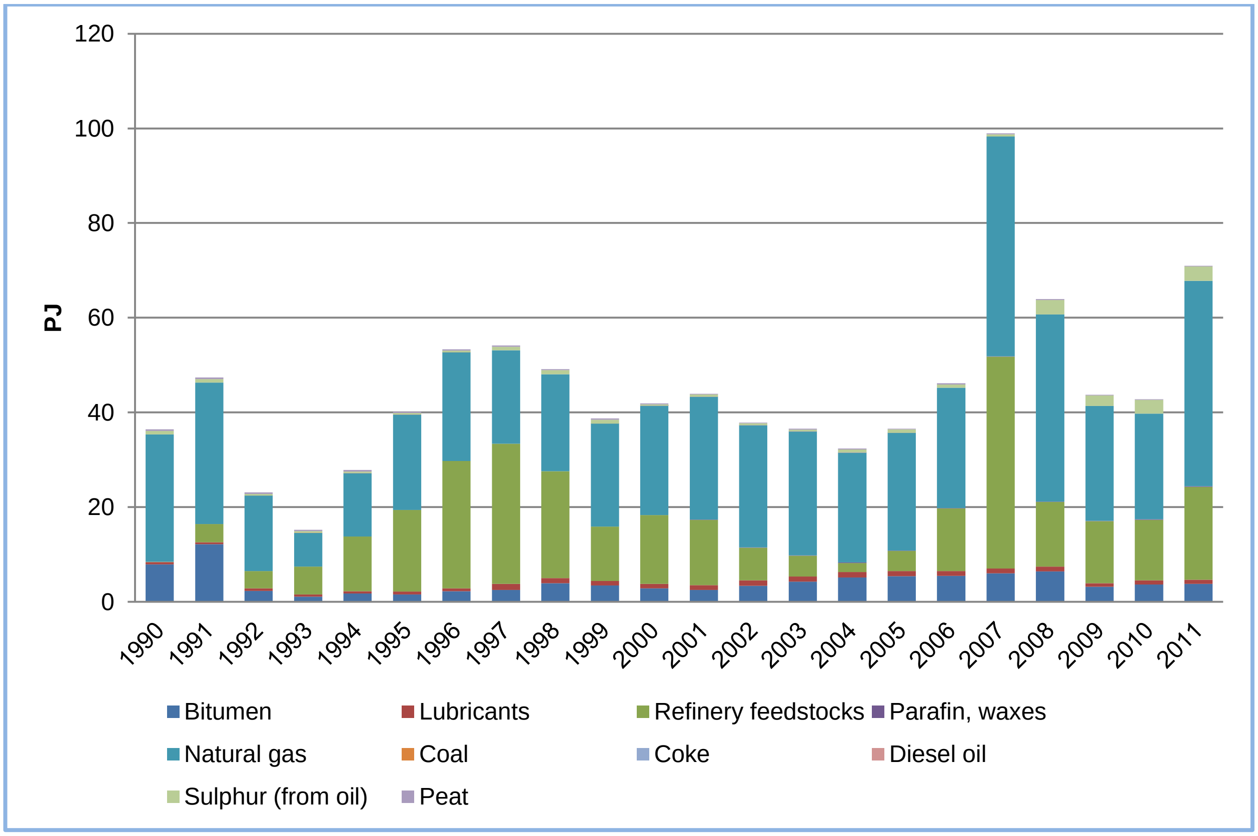


Figure 3-12. Feedstocks and non energy use of fuels in Lithuania

The amounts of non-emitted CO_2 were calculated in accordance with the methodology provided in 1996 IPCC Guidelines. The amounts of non-emitted CO_2 are reported in CRF 1.AD Feedstocks and non-energy use and linked to the CRF 1.AB Fuel Combustion - Reference Approach as carbon stored.

3.2.4 CO_2 capture from flue gases and subsequent CO_2 storage

CO_2 capture from flue gases and subsequent CO_2 storage is not occurring in Lithuania.

3.2.5 Country-specific issues

All country specific issues are explained in details under relevant chapters of source categories.
Table 3-9 provides information on the status of emission estimates of all subcategories of Category 1.A Fuel Combustion. Symbol "+" indicates that emissions from this subcategory have been estimated. "NO" indicates that the respective sector and fuel category is not relevant for Lithuanian energy balance.

Table 3-9. Overview on the status of emission estimation of Category 1.A Fuel Combustion (CRF 1.A)

IPCC Category	**CO_2**	**CH_4**	**N_2O**
1.A.1.a Public electricity and heat production			
1.A.1.a Liquid fuels	+	+	+
1.A.1.a Solid fuels	+	+	+
1.A.1.a Gaseous fuels	+	+	+
1.A.1.a Biomass	+	+	+

1.A.1.a Other fuels	NO	NO	NO
1.A.1.b Petroleum refining			
1.A.1.b Liquid fuels	+	+	+
1.A.1.b Solid fuels	NO	NO	NO
1.A.1.b Gaseous fuels	+	+	+
1.A.1.b Biomass	+	+	+
1.A.1.b Other fuels	NO	NO	NO
1.A.1.c Manufacture of solid fuels and other energy industries			
1.A.1.c Liquid fuels	+	+	+
1.A.1.c Solid fuels	+	+	+
1.A.1.c Gaseous fuels	+	+	+
1.A.1.c Biomass	+	+	+
1.A.1.c Other fuels	NO	NO	NO
1.A.2.a Iron and steel			
1.A.2.a Liquid fuels	NO	NO	NO
1.A.2.a Solid fuels	NO	NO	NO
1.A.2.a Gaseous fuels	NO	NO	NO
1.A.2.a Biomass	NO	NO	NO
1.A.2.a Other fuels	NO	NO	NO
1.A.2.b Non-ferrous metals			
1.A.2.b Liquid fuels	NO	NO	NO
1.A.2.b Solid fuels	+	+	+
1.A.2.b Gaseous fuels	+	+	+
1.A.2.b Biomass	NO	NO	NO
1.A.2.b Other fuels	NO	NO	NO
1.A.2.c Chemicals			
1.A.2.c Liquid fuels	+	+	+
1.A.2.c Solid fuels	+	+	+
1.A.2.c Gaseous fuels	+	+	+
1.A.2.c Biomass	+	+	+
1.A.2.c Other fuels	NO	NO	NO
1.A.2.d Pulp, Paper and Print			
1.A.2.d Liquid fuels	+	+	+
1.A.2.d Solid fuels	+	+	+
1.A.2.d Gaseous fuels	+	+	+
1.A.2.d Biomass	+	+	+
1.A.2.d Other fuels	NO	NO	NO
1.A.2.e Food processing, beverages and tobacco			
1.A.2.e Liquid fuels	+	+	+
1.A.2.e Solid fuels	+	+	+
1.A.2.e Gaseous fuels	+	+	+
1.A.2.e Biomass	+	+	+
1.A.2.e Other fuels	NO	NO	NO
1.A.2.f Other			

1.A.2.e Liquid fuels	+	+	+
1.A.2.e Solid fuels	+	+	+
1.A.2.e Gaseous fuels	+	+	+
1.A.2.e Biomass	+	+	+
1.A.2.e Other fuels	+	+	+
1.A.3.a Civil Aviation			
1.A.3.a Aviation Gasoline	+	+	+
1.A.3.a Jet Kerosene	+	+	+
1.A.3.b Road Transportation			
1.A.3.b Gasoline	+	+	+
1.A.3.b Diesel Oil	+	+	+
1.A.3.b LPG	+	+	+
1.A.3.b Natural Gas	+	+	+
1.A.3.b Biomass	+	+	+
1.A.3.b Other Fuels	NO	NO	NO
1.A.3.c Railways			
1.A.3.c Liquid Fuels	+	+	+
1.A.3.c Solid Fuels	NO	NO	NO
1.A.3.c Other Fuels	NO	NO	NO
1.A.3.d Navigation			
1.A.3.d Liquid Fuels	+	+	+
1.A.3.d Solid Fuels	NO	NO	NO
1.A.2.d Gaseous fuels	NO	NO	NO
1.A.3.d Other Fuels	NO	NO	NO
1.A.3.e Other			
1.A.3.d Liquid Fuels	+	+	+
1.A.3.d Solid Fuels	NO	NO	NO
1.A.2.d Gaseous fuels	NO	NO	NO
1.A.4.a Commercial/Institutional			
1.A.4.a Liquid fuels	+	+	+
1.A.4.a Solid fuels	+	+	+
1.A.4.a Gaseous fuels	+	+	+
1.A.4.a Biomass	+	+	+
1.A.4.a Other fuels	NO	NO	NO
1.A.4.b Residential			
1.A.4.b Liquid fuels	+	+	+
1.A.4.b Solid fuels	+	+	+
1.A.4.b Gaseous fuels	+	+	+
1.A.4.b Biomass	+	+	+
1.A.4.b Other fuels	NO	NO	NO
1.A.4.c Agriculture/Forestry/Fisheries			
1.A.4.c Liquid fuels	+	+	+
1.A.4.c Solid fuels	+	+	+
1.A.4.c Gaseous fuels	+	+	+

1.A.4.c Biomass	+	+	+
1.A.4.c Other fuels	NO	NO	NO
1.A.5 Other			
1.A.5 Liquid fuels	+	+	+
1.A.5 Solid fuels	NO	NO	NO
1.A.5 Gaseous fuels	NO	NO	NO
1.A.5 Biomass	NO	NO	NO
1.A.5 Other fuels	NO	NO	NO

3.2.6 Public Electricity and Heat Production (CRF 1.A.1.a)

3.2.6.1 Source category description

During last two decades Ignalina NPP was dominating in the internal electricity market - its share in the structure of electricity generation was fluctuating at around 80%. At the beginning of 2009 the total installed capacity of the Lithuanian power plants was 5029 MW, including Ignalina NPP with 1300 MW and Lithuanian TPP with 1800 MW of electrical capacity. After the decommissioning of Ignalina NPP (Unit 1 was closed in 2004 and Unit 2 in 2009) total available capacity of Lithuanian power plants was 3605 MW in 2010. Currently Lithuanian TPP is dominating in the structure of capacities. Almost 47% of the overall available electrical capacity is covered by this power plant. Characteristics of the Lithuanian power plants for 2011 are presented in Table 3-10.

Table 3-10. Characteristics of the Lithuanian power plants in 2011 (National Commission for Energy and Prices, 2012)

Power plant	Fuel	Available capacity, MW
Lithuanian TPP	Residual fuel oil, natural gas, orimulsion	1732
Vilnius CHP	Residual fuel oil, natural gas	330
Kaunas CHP	Residual fuel oil, natural gas	155
Petrasiunai CHP	Natural gas	5
Klaipeda CHP	Residual fuel oil, natural gas	9
ORLEN Lietuva CHP	Residual fuel oil	148
Panevezys CHP	Natural gas	33
Kaunas hydro PP	-	90
Kruonis hydro pumped storage PP	-	760

Small hydro PP	-	26
Wind PP	-	188
Biofuel PP	Biomass, biogas	49
Solar PP	-	0,4
Industrial PP	Residual fuel oil, natural gas, energy from chemical processes	162
Total	-	3687,4

Lithuania is a country, where living space heating season (when outside temperature is less than +10ºC) is on average 219 days per year (6-7 months). Lithuanian district heating systems are playing very important role in heat production sector. About 75% of residential buildings in Lithuania's towns are supplied with heat from district heating systems. In 2011 43% of heat supplied to district heating systems was produced at Combined Heat and Power plants(CHP) and 34% - at heat only boilers and 23% - at geothermal and other plants.

Natural gas is the main fuel used in the district heating sector. In 2011 natural gas covered about 73,1% of fuel consumption. Since 2000 the share of renewable energy increased significantly from 2% in 2000 to 22,4% in 2011 in Lithuanian district heating sector. Relevant share of residual fuel oil used for heat production in district heating systems was replaced by renewable energy sources (mainly by biomass).

Category 1.A.1.a Public Electricity and Heat Production covers emissions from fuel combustion in public power and heat plants.

3.2.6.2 Methodological issues

GHG emissions were calculated on the basis of the amount and type of fuel combusted and its carbon content. The following equation has been used:

$$Emission_{GHG,\,fuel} = Fuel\ consumption_{fuel} \cdot Emission\ factor_{GHG,\,fuel} \qquad (1)$$

where:

$Emission_{GHG,\,fuel}$ - emissions of GHG by type of fuel, kg GHG;

$Fuel\ consumption_{fuel}$ - amount of fuel combusted, TJ;

$Emission\ factor_{GHG,\,fuel}$ - emission factor of a given GHG by type of fuel, kg/TJ.

CO_2 emissions were calculated applying Tier 2 or Tier 3, CH_4 and N_2O were calculated applying Tier 1 or Tier 2 (as presented in Table 3-11).

Emission factors and methods

Emission factors and methods used in the calculations of emissions from Public Electricity and Heat Production (1.A.1.a) are presented in Table 3-11.

Table 3-11. Emission factors and methods for category Public Electricity and Heat Production (1.A.1.a)

Fuel	**CO_2**			**CH_4**			**N_2O**		
	CO_2, kg/GJ	**EF**	**Method**	**CH_4, kg/TJ**	**EF**	**Method**	**N_2O, kg/TJ**	**EF**	**Method**
Crude oil	77,74	CS	T2	3,0	D	T1	0,6	D	T1
Shale oil	77,40	CS	T2	3,0	D	T1	0,6	D	T1
Residual fuel oil	77,60	CS	T2	3,0	D	T1	0,6	D	T1
LPG	65,42	CS	T2	3,0	D	T1	0,6	D	T1
Not liquefied petroleum gas	56,18	CS	T2	3,0	D	T1	0,6	D	T1
Orimulsion	81,74	PS	T3	3,0	D	T1	0,6	D	T1
Gasoil	72,89	CS	T2	3,0	D	T1	0,6	D	T1
Diesel oil	72,89	CS	T2	3,0	D	T1	0,6	D	T1
Emulsified vacuum residue	79,41	PS	T3	3,0	D	T1	0,6	D	T1
Peat	104,34	CS	T2	1,0	CS	T2	1,5	CS	T2
Coking coal	94,90	CS	T2	1,0	D	T1	1,4	D	T1
Natural gas	55,23	CS	T2	1,0	D	T1	0,1	D	T1
Wood/ wood waste	109,90	CS	T2	30,0	D	T1	4,0	D	T1
Other solid biomass	109,90	CS	T2	30,0	D	T1	4,0	D	T1
Biogas	58,45	CS	T2	1,0	CS	T2	0,1	CS	T2

Abbreviations: CS - country specific emission factors were developed in August 2012 based on the results of the study "Determination of national GHG emission factors for energy sector" prepared by Lithuanian Energy Institute; PS - plant specific emission factors are based on EU ETS data; D - default emission factors (1996 IPCC); T1 - Tier 1; T2 - Tier 2; T3 - Tier 3.

In the 2012 submission, country specific CO_2 emission factors were applied based on the results of study "Determination of national GHG emission factors for energy sector", which was prepared by Lithuanian Energy Institute. Summary of this study is provided in the Annex IV. Plant specific CO_2 emission factor based on EU ETS data used for emulsified vacuum residue which is combusted at the ORLEN Lietuva CHP.

1996 IPCC default emission factors were used for CH_4 and N_2O emissions estimation, except biogas, peat and used tires (industrial waste). CH_4 and N_2O emission factors for biogas, peat and used tires were based on the results of study "Determination of national GHG emission factors for energy sector".

Activity data

In the Energy Sector all activity data for calculation of GHG emissions has been obtained from the Lithuanian Statistics database and yearly publications "Energy balance".

Fuel and energy balance has been compiled based on the data provided by legal entities (enterprises) consuming, producing or supplying fuel and energy. The data presented in the Energy balances shows domestic fuel and energy resources of the Republic of Lithuania, including their extraction, production, exports and imports, fuel consumption for generating electricity and heat, as well as final fuel and energy consumption by main economic activity and in households.

All heat generated in public power plants (CHP), public heat plants (heat only boilers), as well as energy (heat) from chemical processes, generated in chemical industry enterprises, is subsumed under the energy balance. Fuel is calculated in terms of tonnes of oil equivalent and terajoules using the net calorific value. The net calorific value (NCV) is the amount of heat which is actually available from the combustion process, i.e. excluding the latent heat of water formed during combustion.

Following the recommendation of expert review team (ERT) in 2010 in the individual review report, net calorific values (NCVs) used to convert fuel consumption in natural units into energy units are provided in the tables below.

Table 3-12. Specific net calorific values (Statistics Lithuania)

Type of fuel	Tonne	Tonne of oil equivalent (TOE)	TJ/tonne
Hard coal	1,0	0,600	0,02512
Coke	1,0	0,700	0,02930
Peat	1,0	0,280	0,01172
Peat briquettes	1,0	0,360	0,01500
Firewood (m^3)	1,0	0,196	0,00820
Biogas (1000 m^3)	1,0	0,480	0,02000
Natural gas (1000 m^3)	1,0	0,800	0,03349
Liquefied petroleum gases	1,0	1,109	0,04642
Motor gasoline	1,0	1,070	0,04479

Gasoline type jet fuel	1,0	1,070	0,04479
Kerosene type jet fuel	1,0	1,031	0,04316
Transport diesel	1,0	1,029	0,04307
Heating and other gasoil	1,0	1,029	0,04307
Fuel oil	1,0	0,957	0,04006
Crude oil	1,0	1,022	0,04278
Bioethanol	1,0	0,645	0,02700
Biodiesel (methyl ester)	1,0	0,884	0,03700

Table 3-13. Conversion factors (Statistics Lithuania)

Factor	TOE	GJ	Gcal	MWh
TOE	1,000	41,861	10,000	11,628
GJ	0,024	1,000	0,239	0,278
Gcal	0,100	4,186	1,000	1,163
MWh	0,086	3,600	0,860	1,000

Brief overview of the Lithuania's Energy balance is presented below:

- *Consumption in the energy sector* refers to the quantities consumed by the energy industry to support extraction (mining, oil and gas production) or plant operations of transformation activities, as well as for pumped water storage in hydropower stations. The quantities of fuels transformed into another form of energy are excluded. Energy enterprises are those which under the international methodology of energy are subsumed under the following kinds of activity according to the national version (EVRK Rev. 2) of the Statistical Classification of Economic Activities in the European Community (NACE Rev. 2):
  - Extraction of crude petroleum;
  - Extraction of peat;
  - Support activities for petroleum and natural gas mining;
  - Manufacture of refined petroleum products;
  - Electricity, gas, steam and air conditioning supply.
- *Non-energy use* covers energy resources used as raw materials, i.e. energy resources which are neither used as fuel nor converted into other kind of fuel.
- *Consumption in industry* refers to fuel quantities consumed by an industrial undertaking in support of its primary activities. Industrial enterprises are those which under the international methodology of energy are subsumed under the following kinds of activity according to EVRK Rev. 2 (excluding enterprises which are subsumed under the energy sector):
  - Mining and quarrying;
  - Manufacturing.
- *Consumption in the transport sector* includes fuel and energy consumed by all means of transport: railways, inland waterways (excluding fishing), air (international, domestic and military aviation), road (fuel used in road vehicles including fuel used by agricultural vehicles on highways), pipeline system and other transport, irrespective of the kind of enterprise industrial, construction, transport, agricultural, commercial or public) the transport facility belongs to. Moreover, fuel consumed by personal transport facilities is included. Fuel with which vehicles (cars, aircraft, ships, etc.) were fuelled abroad is not recorded.

- *Consumption in agriculture* encompasses fuel and energy consumption by enterprises whose economic activity is related to agriculture, hunting and forestry.
- *Consumption in fishing* encompasses fuels delivered to inland, coastal and deep-sea fishing vessels of all flags that are refuelled in the country (including international fishing) and fuel and energy used in the fishing industry.
- *Consumption in the service sector* encompasses fuel and energy consumed in other economic activities not mentioned above, i.e. for heating and lighting premises meant for trade, education, health, commercial services, administration, etc.
- *Consumption in households* encompasses fuel and energy sold to the population for heating, lighting, cooking. Fuel consumed for individual transport is subsumed under the item "Consumption in transport".
- *International marine bunkers* are defined as quantities of fuels delivered to ships of all flags that are engaged in international navigation. Consumption by ships engaged in fishing and domestic navigation vessels is excluded.

To improve transparency of the reporting in energy sector in the NIR the energy balance data for 1990, 1995 and 2000-2011 are provided in the Annex III. The entire time series (1990-2011) are publically available at the databases of the Statistics of Lithuania[2]. In the Annex III the energy balance data are provided in Terajoule (TJ).

Tendencies of fuel consumed and total GHG emissions in Public electricity and heat production is provided in Figure 3-13.

As it is seen from Figure 3-13, during the latter ten years the consumption of fuels in Public electricity and heat production was rather stable – about 67 PJ a year. However, in 2011 fuel consumption reduced by 18,9% in comparison to 2010. This is mainly due to reduction of natural gas consumption. Natural gas combustion volumes reduced by 17,5% in 2011.

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[2] http://www.stat.gov.lt/lt/

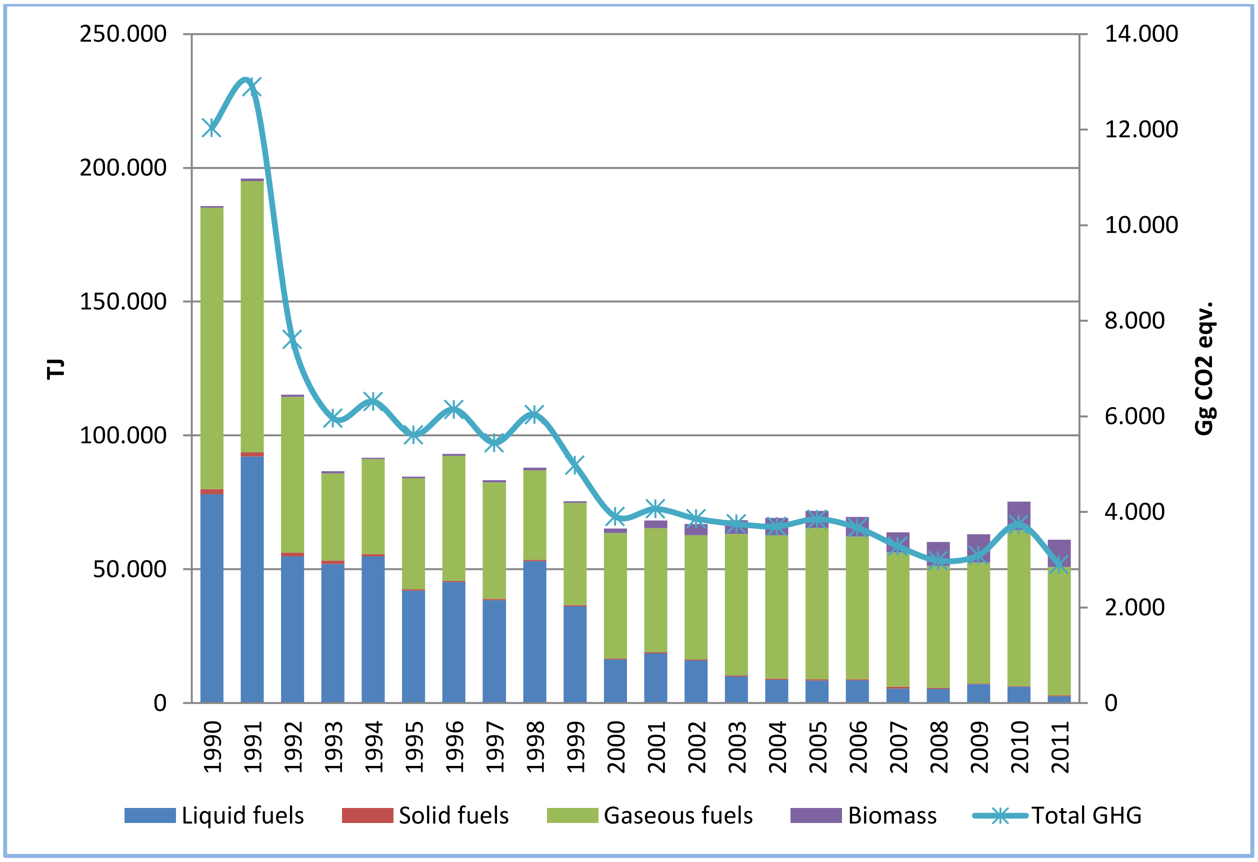

Figure 3-13. Tendencies of fuel consumed and GHG emissions in Public Electricity and Heat Production (1.A.1.a)

Natural gas dominates in the structure of total fuel combusted for Public Electricity and Heat Production. In 2011 natural gas accounted 78,6%. This is by 1,4 percentage points more than in 2010. The share and volume of liquid fuels (residual fuel oil, orimulsion, diesel oil) drastically reduced since 1990s and in 2011 accounted only 4,3% in structure of fuel combusted. Since 2000 wood/wood waste started to be widely used for Public Electricity and Heat Production. During a last decade the share of biomass increased from 2,5% (2000) till 16,7% (2011).

Total GHG emissions from Public Electricity and Heat Production reduced by 4 times since 1990.

3.2.6.3 Uncertainties and time-series consistency

Uncertainty in activity data in public electricity and heat production is ±2% taking into consideration recommendations provided by IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories 2000 and IPCC 2006 Guidelines for National GHG Inventories. Since data on biomass as fuel are not well developed as for fossil fuel, the uncertainty rage for biomass is ±50% as recommended by 2006 IPCC.

Uncertainties of CO_2 emission factors for liquid fuels (crude oil, shale oil, residual fuel oil, LPG, non liquefied petroleum gas, orimulsion, gasoil, diesel oil and emulsified vacuum residue) and gaseous fuels (natural gas) are ±2,5% in Public electricity and heat production. Uncertainties of CO_2 emission factors for solid fuels (peat and coking coal) are ±7%. Estimated uncertainties of CO_2

emission factors for biomass are ±50%. Uncertainties of all country specific CO_2 emission factors are derived in the study "Determination of national GHG emission factors for Lithuanian energy sector" (see Annex IV).

Uncertainties of CH_4 and N_2O emission factors for liquid, solid and gaseous fuels were assigned as very high about ±50%. Uncertainties of emission factors for biomass were assumed ±150%. Uncertainties were derived considering IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories 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 the time series. All emissions are estimated or reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.2.6.4 Source-specific QA/QC and verifications

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

The consumption of every type of fuel has been checked and compared with other available data sources. The time series for all data have been studied carefully in search for outliers.

The results are verified by calculating CO_2 emissions with the reference approach, and comparing results with the sectoral approach.

3.2.6.5 Source-specific recalculations

Following recalculations in this category has been done taking into account ERT recommendations:

- correction of activity data of liquid (residual fuel oil, LPG, orimulsion, gasoil, and diesel oil), solid (peat), and gaseous (natural gas) fuels consumption based on the newest information provided by Lithuanian Statistics in November 2012;
- removal of waste oil consumption and addition of emulsified vacuum residue consumption based on the newest information provided by Lithuanian Statistics in November 2012;
- correction of CO_2 emission factor for crude oil, shale oil, residual fuel oil, non liquefied petroleum gas, orimulsion, peat, coking coal, natural gas, wood/wood waste, other solid biomass and biogas based on the country specific values that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- correction of CH_4 emission factor for LPG, non liquefied petroleum gas based on default value provided in 1996 IPCC;
- correction of N_2O emission factor for LPG based on default value provided in 1996 IPCC;
- correction of NO_2 emission factor for peat based on the country specific value that is provided in the study "Determination of national GHG emission factors for Lithuanian energy sector".

Impact of these recalculations on GHG emissions from 1.A.1.a Public Electricity and Heat Production sector is presented in Table 3-14.

Table 3-14. Impact of recalculation on GHG emissions from 1.A.1a Public Electricity and Heat Production

Year	Submission 2012, Gg CO2 eq.	Submission 2013, Gg CO2 eq.	Absolute difference, Gg CO2 eq.	Relative difference, %
1990	12483,4	12039,2	-444,2	-3,6
1991	13389,3	12896,5	-492,8	-3,7
1992	7911,8	7612,2	-299,5	-3,8
1993	6211,3	5964,2	-247,1	-4,0
1994	6573,5	6309,9	-263,6	-4,0
1995	5847,3	5614,0	-233,3	-4,0
1996	6386,0	6145,6	-240,4	-3,8
1997	5661,8	5446,9	-214,9	-3,8
1998	6301,7	6033,8	-267,9	-4,3
1999	5199,1	4977,4	-221,8	-4,3
2000	4058,3	3903,6	-154,7	-3,8
2001	4212,7	4062,4	-150,3	-3,6
2002	3995,7	3859,4	-136,3	-3,4
2003	3877,1	3748,1	-129,1	-3,3
2004	3818,0	3697,7	-120,3	-3,2
2005	3968,3	3847,8	-120,5	-3,0
2006	3789,9	3667,8	-122,2	-3,2
2007	3351,1	3283,0	-68,1	-2,0
2008	3031,6	2982,2	-49,5	-1,6
2009	3195,1	3093,6	-101,5	-3,2
2010	3857,3	3737,8	-119,6	-3,1

3.2.6.6 Source-specific planned improvements

The following improvement are foreseen:

- further investigate the possibility of using data provided in the EU ETS, reported by the operators for the energy sector emission estimates.

3.2.7 Petroleum Refining (CRF 1.A.1.b)

3.2.7.1 Source category description

Refineries process crude oil into a variety of hydrocarbon products such as gasoline, kerosene and etc. UAB ORLEN Lietuva[3] is the only petroleum refining company operating in the Baltic States. Oil refinery processes approximately 10 million tons of crude oil a year. The company is the most important supplier of petrol and diesel fuel in Lithuania, Latvia and Estonia. Motor gasoline, jet kerosine, gas/diesel oil, residual fuel oil, LPG and non-liquefied petroleum gas used in Lithuania are

[3] http://www.orlenlietuva.lt

produced by the oil refinery UAB ORLEN Lietuva. Imports of the fuels specified above comprise only a minor fraction of the fuels used in Lithuania.

3.2.7.2 Methodological issues

CO_2 emissions were calculated applying Tier 2 or Tier 3, CH_4 and N_2O were calculated applying Tier 1 (as presented in Table 3-15) based on equation 1 (see chapter 3.2.6).

Emission factors and methods

Emission factors and methods used in the calculation of emissions from Petroleum Refinery (1.A.1.b) are presented in the Table 3-15.

Table 3-15. Emission factors and methods for category Petroleum Refinery (1.A.1.b)

Fuel	CO_2			CH_4			N_2O		
	CO_2, kg/GJ	EF	Method	CH_4, kg/TJ	EF	Method	N_2O, kg/TJ	EF	Method
Crude oil	77,74	CS	T2	3,0	D	T1	0,6	D	T1
Residual fuel oil	81,26	PS	T3	3,0	D	T1	0,6	D	T1
LPG	65,42	CS	T2	3,0	D	T1	0,6	D	T1
Petroleum coke	94,06	CS	T2	3,0	D	T1	0,6	D	T1
Diesel oil	72,89	CS	T2	3,0	D	T1	0,6	D	T1
Not liquefied petroleum gas	56,18	CS	T2	3,0	D	T1	0,6	D	T1
Natural gas	55,23	CS	T2	1,0	D	T1	0,1	D	T1
Wood / wood waste	109,9	CS	T2	30,0	D	T1	4,0	D	T1

Abbreviations: CS - country specific emission factors were developed in August 2012 based on the results of the study "Determination of national GHG emission factors for energy sector" prepared by Lithuanian Energy Institute; PS - plant specific emission factors are based on EU ETS data; D - default emission factors (1996 IPCC); T1 - Tier 1; T2 - Tier 2; T3 - Tier 3.

Activity data

For calculation of GHG emissions in category Petroleum Refinery (1.A.1.b) activity data had been obtained from the Lithuanian Statistics database (http://www.stat.gov.lt/lt/). Activity data is provided in the Annex III.

Tendencies of fuel consumed and total GHG emissions in Petroleum Refinery is presented in Figure 3-14.

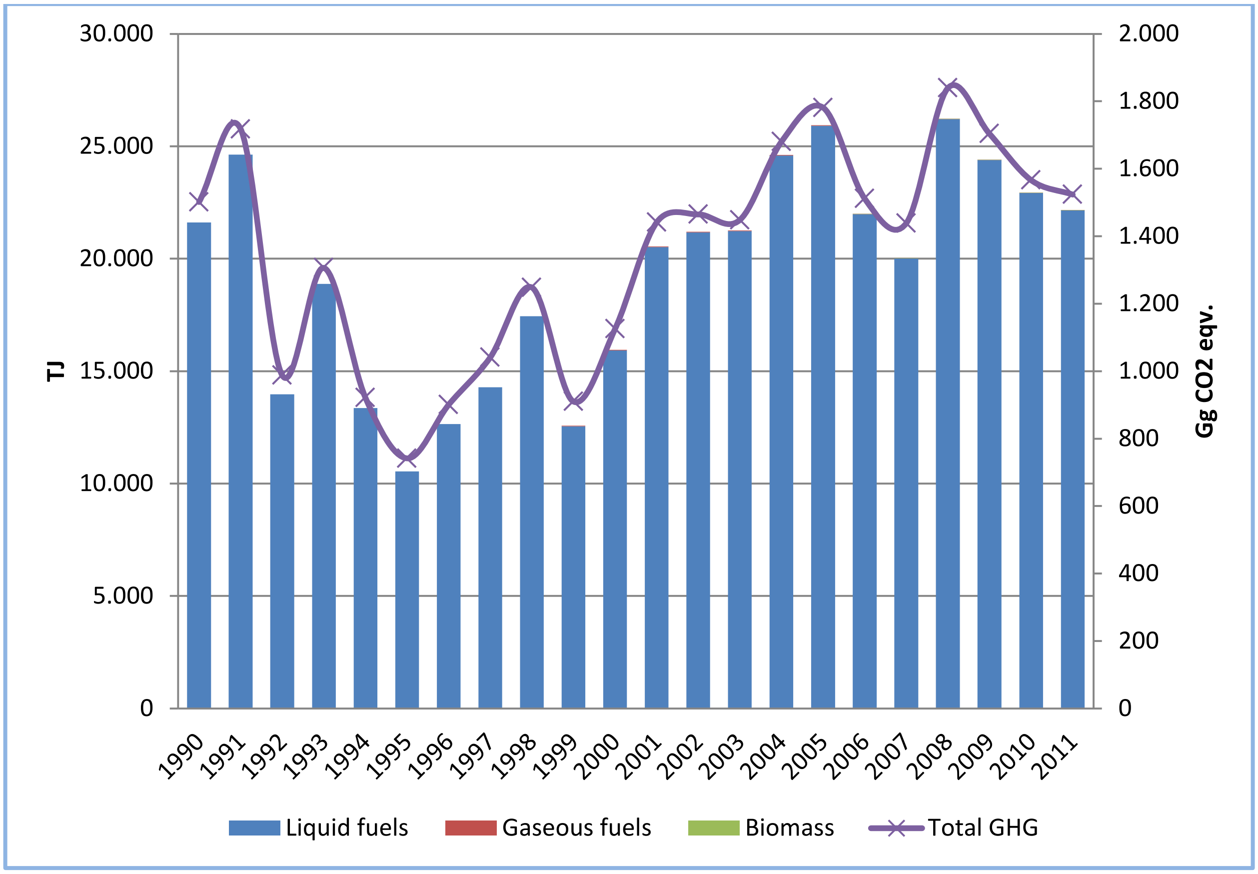

Figure 3-14. Tendencies of fuel consumed and total GHG emissions in Petroleum Rrefinery during 1990-2011

As it is seen from Figure 3-14, liquid fuels are mainly used in Lithuanian Petroleum Refinery industry. Liquid fuels accounted 99,9% of fuel structure in 2011. Historically, non liquefied petroleum gas made more than 50% of total fuel consumed in petroleum refinery, residual fuel oil – 27% and petroleum coke – 15%. With reference to data of 2011, there was consumed 22,2 PJ, from which non liquefied petroleum gas accounted 60%, residual fuel oil – 23%, petroleum coke – 18%.

Total GHG emissions from Petroleum Refinery in 2011 exceed 1990 level by 1,5%.

3.2.7.3 Uncertainties and time-series consistency

Uncertainty in activity data in Petroleum Refinery is ±2% taking into consideration recommendations provided by IPCC GPG 2000 and IPCC 2006 Guidelines for National GHG Inventories. Since data on biomass as fuel are not well developed as for fossil fuel, the uncertainty rage for biomass is ±50% as recommended by 2006 IPCC.

Uncertainties of CO_2 emission factors for liquid fuels (crude oil, residual fuel oil, LPG, non liquefied petroleum gas, diesel oil and petroleum coke) and gaseous fuels (natural gas) are ±2,5% in Petroleum refinery. Estimated uncertainties of CO_2 emission factors for biomass are ±50%.

Uncertainties of all country specific CO_2 emission factors are derived in the study "Determination of national GHG emission factors for Lithuanian energy sector" (see Annex IV).

Uncertainties of CH_4 and N_2O emission factors for liquid and gaseous fuels were assigned as very high about ±50%. Uncertainties of emission factors for biomass were assumed ±150%. Uncertainties were derived considering IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories 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. All emissions are estimated or reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.2.7.4 Source-specific QA/QC and verifications

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

The results are verified by calculating CO_2 emissions with the reference approach, and comparing results with the sectoral approach.

3.2.7.5 Source-specific recalculations

Following recalculations in this category has been done taking into account ERT recommendations:

- corrections of activity data of residual fuel oil, LPG, diesel oil and natural gas consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- addition of wood/wood waste consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- corrections of CO_2 emission factors for crude oil, residual fuel oil, petroleum coke, non liquefied petroleum gas, and natural gas based on the country specific values that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- corrections of CH_4 emission factors for LPG and non liquefied petroleum gas based on default value provided in 1996 IPCC;
- correction of N_2O emission factor for LPG based on default value provided in 1996 IPCC.

Impact of these recalculations on GHG emissions from 1.A.1.b Petroleum Refining are presented in Table 3-16.

Table 3-16. Impact of recalculation on GHG emissions from 1.A.1b Petroleum Refining

Year	Submission 2012, Gg CO2 eq.	Submission 2013, Gg CO2 eq.	Absolute difference, Gg CO2 eq.	Relative difference, %
1990	1500,1	1501,4	1,3	0,1
1991	1713,6	1717,8	4,2	0,2
1992	985,6	987,5	1,9	0,2
1993	1303,8	1306,2	2,4	0,2

1994	920,1	921,1	1,0	0,1
1995	744,0	741,5	-2,5	-0,3
1996	903,7	900,4	-3,3	-0,4
1997	1050,9	1040,8	-10,1	-1,0
1998	1258,8	1248,1	-10,7	-0,8
1999	916,9	911,5	-5,4	-0,6
2000	1133,8	1126,8	-7,0	-0,6
2001	1450,1	1442,7	-7,4	-0,5
2002	1469,6	1464,6	-5,0	-0,3
2003	1452,8	1448,3	-4,5	-0,3
2004	1686,8	1680,4	-6,5	-0,4
2005	1788,1	1781,3	-6,8	-0,4
2006	1517,4	1511,5	-5,9	-0,4
2007	1448,3	1438,6	-9,7	-0,7
2008	1849,2	1839,3	-9,8	-0,5
2009	1712,7	1703,6	-9,1	-0,5
2010	1574,1	1566,3	-7,8	-0,5

3.2.7.6 Source-specific planned improvements

Source-specific improvements are not planned.

3.2.8 Manufacture of Solid Fuels and other Energy Industries (CRF 1.A.1.c)

3.2.8.1 Source category description

Emissions in this sector arise from fuel combustion in Manufacturing of Solid Fuels and other Energy Industries.

3.2.8.2 Methodological issues

CO_2 emissions were calculated applying Tier 2, CH_4 and N_2O were calculated applying Tier 1 (as presented in Table 3-17) based on equation 1 (see chapter 3.2.6).

Emission factors and methods

Emission factors and methods used in the calculations of emissions from Manufacture of Solid Fuels and other Energy Industries (1.A.1.c) are presented in Table 3-17.

Table 3-17. Emission factors and methods for category Manufacture of Solid Fuels and other Energy Industries (1.A.1.c)

Fuel	CO_2			CH_4			N_2O		
	CO_2, kg/GJ	EF	Method	CH_4, kg/TJ	EF	Method	N_2O, kg/TJ	EF	Method
Motor gasoline	72,97	CS	T2	3,0	D	T1	0,6	D	T1

Gasoil	72,89	CS	T2	3,0	D	T1	0,6	D	T1
LPG	65,42	CS	T2	3,0	D	T1	0,6	D	T1
Diesel oil	72,89	CS	T2	3,0	D	T1	0,6	D	T1
Peat	104,34	CS	T2	1,0	CS	T2	1,5	CS	T2
Natural gas	55,23	CS	T2	1,0	D	T1	0,1	D	T1
Wood/wood waste	109,90	CS	T2	30,0	D	T1	4,0	D	T1

Abbreviations: CS - country specific emission factors were developed in August 2012 based on the results of the study "Determination of national GHG emission factors for energy sector" prepared by Lithuanian Energy Institute; D - default emission factors (1996 IPCC); T1 - Tier 1; T2 - Tier 2.

Activity data

For calculation of GHG emissions in category Manufacture of Solid Fuels and other Energy Industries (1.A.1.c) activity data had been obtained from the Lithuanian Statistics database (http://www.stat.gov.lt/lt/). Activity data are provided in the Annex III.

Tendencies of fuel consumption and total GHG emissions in Manufacture of Solid Fuels and other Energy Industries are presented in Figure 3-15.

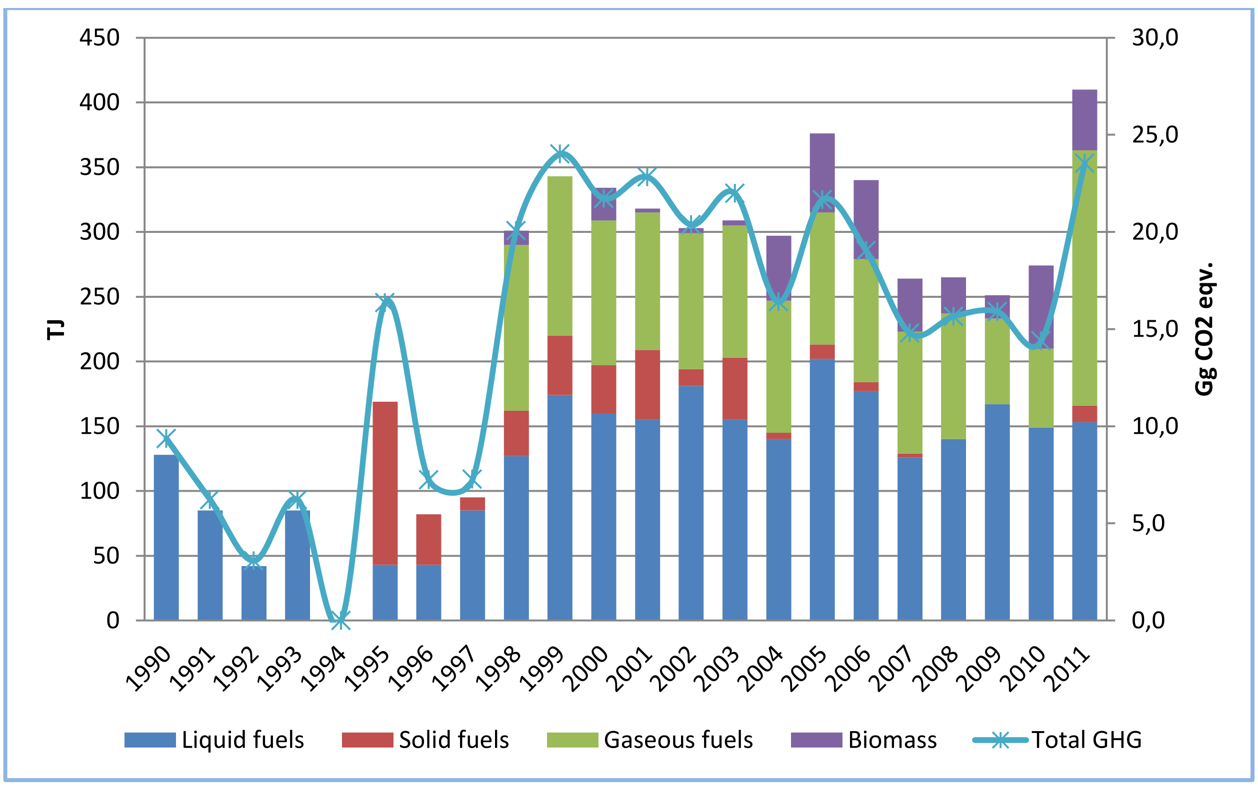

Figure 3-15. Tendencies of fuel consumption and total GHG emissions in Manufacture of Solid Fuels and other Energy Industries during 1990-2011

As it is seen from Figure 3-15, fuel consumption in Manufacture of Solid Fuels and other Energy Industries reduced during 2007-2010. Natural gas consumption increased by more than 3 times, therefore total fuel consumption in Manufacture of Solid Fuels and other Energy Industries increased by 49,6% till 410 TJ in 2011. With reference to data of 2011, natural gas accounted 48%, liquid fuels – 37,3%, biomass – 11, 5% and solid fuels 3,2% of structure.

In 2011, total GHG emissions from Manufacture of Solid Fuels and other Energy industries were about 2,5 times higher than in 1990.

3.2.8.3 Uncertainties and time-series consistency

Uncertainty in activity data in Manufacture of Solid Fuels and other Energy Industries is ±2% taking into consideration recommendations provided by IPCC GPG 2000 and IPCC 2006 Guidelines for National GHG Inventories. Since data on biomass as fuel are not well developed as for fossil fuel, the uncertainty rage for biomass is ±50% as recommended by 2006 IPCC.

Uncertainties of CO_2 emission factors for liquid fuels (motor gasoline, gasoil, LPG, diesel oil) and gaseous fuels (natural gas) are ±2,5% in Manufacture of solid fuels and other energy industries. Estimated uncertainties of CO_2 emission factors for biomass are ±50%. Uncertainties of all country specific CO_2 emission factors are derived in the study "Determination of national GHG emission factors for Lithuanian energy sector" (see Annex IV).

Uncertainties of CH_4 and N_2O emission factors for liquid and gaseous fuels were assigned as very high about ±50%. Uncertainties of emission factors for biomass were assumed ±150%. Uncertainties were derived considering IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories 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. All emissions are estimated or reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.2.8.4 Source-specific QA/QC and verifications

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

The results are verified by calculating CO_2 emissions with the reference approach, and comparing results with the sectoral approach.

3.2.8.5 Source-specific recalculations

Following recalculations in this category has been done:

- corrections of activity data of LPG, diesel oil, peat, natural gas, wood/wood waste based on the newest statistical information provided by Lithuanian Statistics in November 2012;

- addition gasoil consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- corrections of CO_2 emission factors for peat, natural gas and wood/wood waste based on the country specific values that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- correction of CH_4 emission factor for motor gasoline and LPG based on default value provided in 1996 IPCC;
- correction of N_2O emission factor for LPG based on default value provided in 1996 IPCC;
- correction of N_2O emission factor for peat based on the country specific value that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector".

Impact of these recalculations on GHG emissions from 1.A.1.c Manufacture of Solid Fuels and other Energy Industries is presented in Table 3-18.

Table 3-18. Impact of recalculation on GHG emissions from 1.A.1.c Manufacture of Solid Fuels and other Energy Industries

Year	Submission 2012, Gg CO2 eq.	Submission 2013, Gg CO2 eq.	Absolute difference, Gg CO2 eq.	Relative difference, %
1992	3,1	3,1	-0,1	-2,3
1993	6,2	6,2	0,0	0,0
1995	3,1	16,4	13,2	420,0
1996	3,1	7,2	4,1	130,0
1997	6,2	7,3	1,0	16,9
1998	16,6	20,1	3,5	20,8
1999	18,1	24,0	5,9	32,8
2000	19,1	21,7	2,6	13,9
2001	18,6	22,8	4,2	22,6
2002	19,2	20,4	1,2	6,2
2003	17,1	22,0	4,9	28,8
2004	16,1	16,4	0,4	2,2
2005	20,7	21,7	1,0	4,8
2006	18,5	19,0	0,6	3,1
2007	14,8	14,8	0,0	0,2
2008	15,8	15,7	-0,2	-1,0
2009	16,0	15,9	-0,1	-0,7

3.2.8.6 Source-specific planned improvements

Source-specific improvements are not planned.

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

3.3.1 Iron and Steel (CRF 1.A.2.a)

There is no Iron and Steel industries in Lithuania. All emissions are reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.3.2 Non-Ferrous Metals (CRF 1.A.2.b)

In this submission, GHG emissions from Non-Ferrous Metals industry is accounted for the first time as its activity started only since 2010. Non-ferrous metals industry accounts very small share in Lithuanian manufacturing industries. It contains the following activities: manufacturing of precious metals, production of aluminium, lead, zinc and tin, copper and other non-ferrous metal production, as well casting of light metals and other non-ferrous metal.

3.3.2.1 Methodological issues

CO_2 emissions were calculated applying Tier 2, CH_4 and N_2O were calculated applying Tier 1 (as presented in Table 3-19) based on equation 1 (see chapter 3.2.6).

Emission factors and methods

Emission factors and methods used in the calculation of emissions from Non-Ferrous Metals industries (1.A.2.b) are presented in table 3-19.

Table 3-19. Emission factors and methods for category Non-Ferrous Metals industries (1.A.2.b)

Fuel	CO_2			CH_4			N_2O		
	CO_2, kg/GJ	EF	Method	CH_4, kg/TJ	EF	Method	N_2O, kg/TJ	EF	Method
Coke	109,11	CS	T2	10,0	D	T1	1,4	D	T1
Peat	104,34	CS	T2	2,0	CS	T2	1,5	CS	T2
Natural gas	55,23	CS	T2	5,0	D	T1	0,1	D	T1

Abbreviations: CS - country specific emission factors were developed in August 2012 based on the results of the study "Determination of national GHG emission factors for energy sector" prepared by Lithuanian Energy Institute; D - default emission factors (1996 IPCC); T1 - Tier 1; T2 - Tier 2.

Activity data

For calculation of GHG emissions in category Non-Ferrous Metals industries (1.A.2.b) activity data had been obtained from the Lithuanian Statistics. The Lithuanian Statistics provided data on energy consumption in manufacturing industries and construction according to the type of economic activity based on special request on November 2012. In the delivered data Lithuanian Statistics provided information about energy consumption in Non-Ferrous Metals industries. Activity data are provided below in the Table 3-20.

Table 3-20. Energy consumption by fuel type in Non-Ferrous Metals industries, TJ

Year	Coke	Peat	Natural gas	Total
2010	28	0	0	**28**
2011	0	3	48	**51**

3.3.2.2 Uncertainties and time-series consistency

Uncertainty of activity data in Chemical industries is ±2% taking into consideration recommendations provided by IPCC GPG 2000 and IPCC 2006 Guidelines for National GHG Inventories.

Uncertainties of CO_2 emission factors for solid fuels (peat and coke) and gaseous fuels (natural gas) are ±7%. Uncertainties of country specific CO_2 emission factors are derived in the study "Determination of national GHG emission factors for Lithuanian energy sector" (see Annex IV).

Uncertainties of CH_4 and N_2O emission factors for solid and gaseous fuels were assigned as very high about ±50%. Uncertainties were derived considering IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories 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. All emissions are estimated or reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.3.2.3 Source-specific QA/QC and verifications

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

The results are verified by calculating CO_2 emissions with the reference approach, and comparing results with the sectoral approach.

3.3.2.4 Source-specific recalculations

No recalculations have been done for the sector. In this submission, GHG emissions from Non-Ferrous Metals industry is accounted for the first time.

3.3.2.5 Source-specific planned improvements

Source-specific improvements are not planned.

3.3.3 Chemicals (CRF 1.A.2.c)

3.3.3.1 Source category description

The chemical industry is the second largest manufacturing industry in Lithuania. It produces a number of different products such as chemicals, plastics, solvents, petrochemical products, cosmetics etc. During the latter decade it has been noticed an intensive development of this industry. According to the data of 2011, chemical industry has created 8,4% of the total value added created in a manufacturing industry. The historical data has disclosed that since 1995 value added created in chemical industry has had a tendency to grow by 8,3% a year. During the latter economic crisis, when the price of fertilizer has been decreasing and natural gas price has been increasing, the value added of the industry has decreased by 10,3% in 2008 (compared to value in 2007) and exceeded by 2,8% pre-crisis (2007) level in 2011. It is worth noting that labour productivity and new technology implementation in Lithuanian chemical industry is rather above the country's average (Kaunas Technology University, 2009).

3.3.3.2 Methodological issues

CO_2 emissions were calculated applying Tier 2, CH_4 and N_2O were calculated applying Tier 1 or Tier 2 (as presented in Table 3-21) based on equation 1 (see chapter 3.2.6).

Emission factors and methods

Emission factors and methods used in the calculation of emissions from Chemical industries (1.A.2.c) are presented in table 3-21.

Table 3-21. Emission factors and methods for category Chemical industries (1.A.2.c)

Fuel	CO_2			CH_4			N_2O		
	CO_2, kg/GJ	EF	Method	CH_4, kg/TJ	EF	Method	N_2O, kg/TJ	EF	Method
Residual fuel oil	77,60	CS	T2	2,0	D	T1	0,6	D	T1
LPG	65,42	CS	T2	2,0	D	T1	0,6	D	T1
Gasoil	72,89	CS	T2	2,0	D	T1	0,6	D	T1
Coking coal	94,90	CS	T2	10,0	D	T1	1,4	D	T1
Natural gas	55,23	CS	T2	5,0	D	T1	0,1	D	T1
Wood/ wood waste	109,9	CS	T2	30,0	D	T1	4,0	D	T1
Biogas	58,45	CS	T2	1,0	CS	T2	0,1	CS	T2

Abbreviations: CS - country specific emission factors were developed in August 2012 based on the results of the study "Determination of national GHG emission factors for energy sector" prepared by Lithuanian Energy Institute; D - default emission factors (1996 IPCC); T1 - Tier 1; T2 - Tier 2.

Activity data

For calculation of GHG emissions in category Chemical industries (1.A.2.c) activity data had been obtained from the Lithuanian Statistics. The Lithuanian Statistics provided data on energy consumption in manufacturing industries and construction according to the type of economic activity based on special request. Activity data are provided below in the Table 3-22.

Table 3-22. Energy consumption by fuel type in Chemicals industries, TJ

Year	RFO	LPG	Gasoil	Coking coal	Natural gas	Wood/ wood waste	Biogas	Total
1990	883	0	0	0	6001	0	0	**6884**
1995	281	0	0	0	1563	0	0	**1844**
2000	20	0	0	0	191	3	0	**214**
2001	72	0	0	3	191	2	0	**268**
2002	67	1	0	1	251	1	0	**321**
2003	17	4	0	2	352	1	0	**376**
2004	4	0	5	0	1852	3	0	**1864**
2005	0	7	0	0	2019	0	0	**2026**
2006	23	8	0	0	3419	2	0	**3452**
2007	0	21	0	0	2399	0	0	**2420**
2008	0	22	0	0	2438	1	0	**2461**
2009	0	16	0	0	3470	2	0	**3488**
2010	47	17	0	0	3284	0	94	**3442**
2011	0	4	0	0	2756	0	31	**2791**

Tendencies of fuel consumption and total GHG emissions in Chemical industries are presented in Figure 3-16.

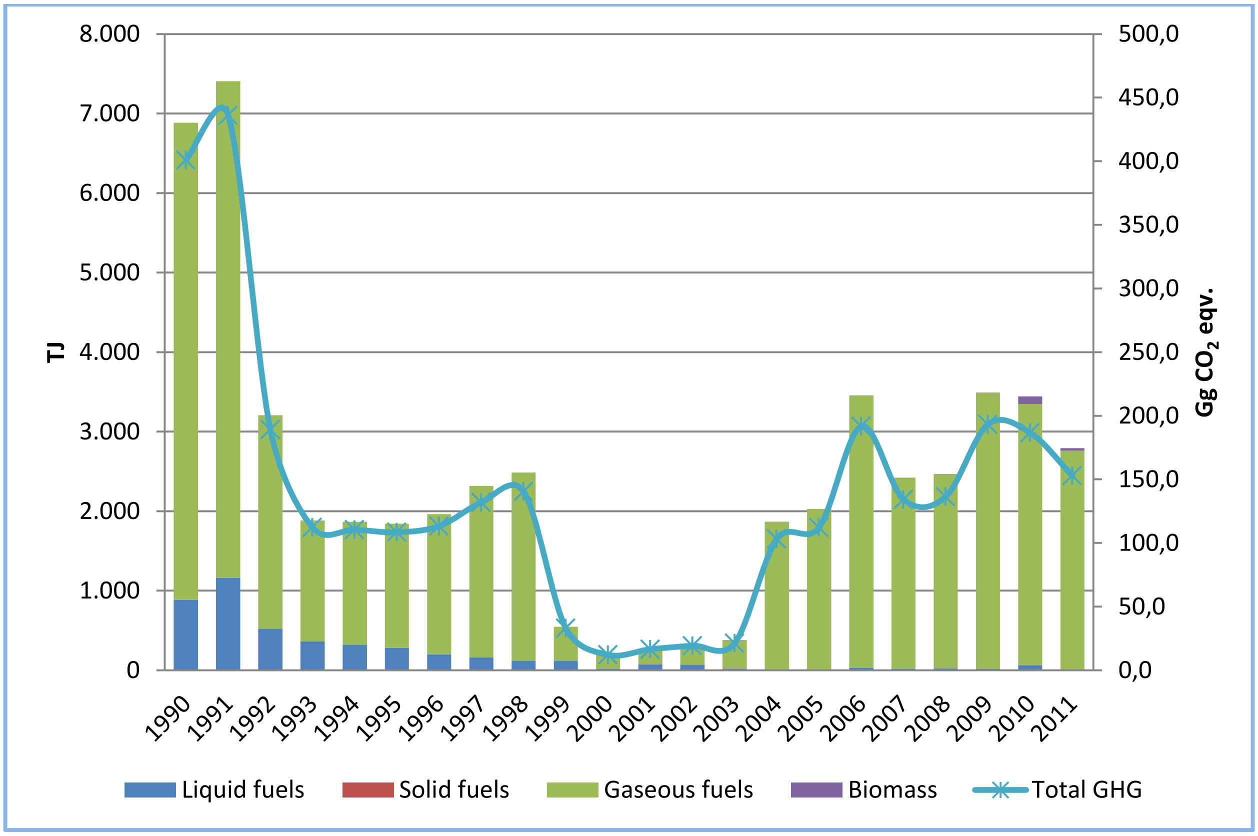

Figure 3-16. Tendencies of fuel consumption and total GHG emissions in Chemical industries during 1990-2011

Natural gas is the main fuel used in chemical industry in Lithuania. During 1990-2011 period it has contained 85-99% of total fuel used in industry. During economic recession and "recovery" period (1990-2002) fuel consumption in Lithuania's chemical industry has had a tendency to decrease by 22,5% a year with a large decrease of natural gas consumption (Figure 3-16). Since 2002, when economy has started to grow at very fast rates, energy consumption in Chemical industries began to increase by 49,8% per year. During 2008-2009, the growth rates of fuel consumption in Chemical industries went slow and 1,3% fuel consumption decrease has been noticed in 2010. In 2011 energy consumption in Chemical industries further reduced. The reduction rate was 18,9%.

In 2011, total GHG emissions from Chemical industries were about 2,6 times lower than in 1990 and amounted 152,9 Gg CO_2 eqv.

3.3.3.3 Uncertainties and time-series consistency

Uncertainty of activity data in Chemical industries is ±2% taking into consideration recommendations provided by IPCC GPG 2000 and IPCC 2006 Guidelines for National GHG Inventories. Since data on biomass as fuel are not well developed as for fossil fuel, the uncertainty rage for biomass is ±50% as recommended by 2006 IPCC.

Uncertainties of CO_2 emission factors for liquid fuels (residual fuel oil, LPG, and gasoil) and gaseous fuels (natural gas) are ±2,5% in Chemical industries. Uncertainties of CO_2 emission factors for solid fuels (coking coal) are ±7%. Estimated uncertainties of CO_2 emission factors for biomass are ±50%.

Uncertainties of all country specific CO_2 emission factors are derived in the study "Determination of national GHG emission factors for Lithuanian energy sector" (see Annex IV).

Uncertainties of CH_4 and N_2O emission factors for liquid, solid and gaseous fuels were assigned as very high about ±50%. Uncertainties were derived considering IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories 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. All emissions are estimated or reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.3.3.4 Source-specific QA/QC and verifications

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

The results are verified by calculating CO_2 emissions with the reference approach, and comparing results with the sectoral approach.

3.3.3.5 Source-specific recalculations

Following recalculations in this category has been done:

- correction of activity data of residual fuel oil, LPG, gasoil, coking coal, natural gas and wood/wood waste consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- addition of biogas consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- correction of CO_2 emission factor for residual fuel oil, coking coal, natural gas and wood/wood waste based on the country specific values that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector:;
- correction of N_2O emission factor for LPG based on default value provided in 1996 IPCC;
- corrections of CH_4 emission factors for residual fuel oil, LPG and gasoil based on default value provided in 1996 IPCC.

Impact of these recalculations on GHG emissions from 1.A.2.c Chemical industries is presented in Table 3-23.

Table 3-23. Impact of recalculation on GHG emissions from 1.A.2.c Chemical industries

Year	Submission 2012, Gg CO2 eq.	Submission 2013, Gg CO2 eq.	Absolute difference, Gg CO2 eq.	Relative difference, %
1990	414,3	401,0	-13,3	-3,2
1991	450,9	436,2	-14,7	-3,3
1992	195,7	189,3	-6,4	-3,3
1993	116,1	112,2	-3,9	-3,3
1994	114,2	110,5	-3,8	-3,3
1995	112,1	108,4	-3,7	-3,3

1996	130,1	113,2	-16,9	-13,0
1997	140,4	131,8	-8,6	-6,1
1998	144,8	140,3	-4,5	-3,1
1999	109,2	33,0	-76,2	-69,8
2000	88,0	12,1	-75,8	-86,2
2001	67,1	16,5	-50,6	-75,4
2002	16,9	19,3	2,3	13,7
2003	22,0	21,3	-0,7	-3,3
2004	107,5	103,2	-4,3	-4,0
2005	115,7	112,2	-3,4	-3,0
2006	197,4	191,6	-5,8	-2,9
2007	138,1	134,2	-3,9	-2,9
2008	140,5	136,4	-4,1	-2,9
2009	199,0	193,2	-5,8	-2,9
2010	192,3	186,6	-5,7	-2,9

3.3.3.6 Source-specific planned improvements

Source-specific improvements are not planned.

3.3.4 Pulp, Paper and Print (CRF 1.A.2.d)

3.3.4.1 Source category description

The Pulp, Paper and Print industries is an important branch of manufacturing industry in Lithuania. With reference to data of 2011, value added created by Pulp, Paper and Print industries made 11,7% in the structure of manufacturing industry. The Pulp, Paper and Print industries has been growing by 12,3% in 1995-2007, and the growth rates have been by 3,8 percentage points higher than the average growth rate of manufacturing industry in Lithuania. However, in 2009 when economic crisis pick up the steam and the average value added created in Lithuanian manufacturing industry went down by 16,0%, the Pulp, Paper and Print industries has remained the third sector (after food processing, beverage and tobacco, as well chemical and furniture production) with the lowest decline rates. The decline rate of value added in this industry has been 18,0% in 2009. Value added of Pulp, Paper and Print industries exceeded the pre-crisis level by 7,7% in 2011.

3.3.4.2 Methodological issues

CO_2 emissions were calculated applying Tier 2, CH_4 and N_2O were calculated applying Tier 1 or Tier 2 (as presented in Table 3-24) based on equation 1 (see chapter 3.2.6).

Emission factors and methods

Emission factors and methods used in the calculation of emissions from Pulp, Paper and Print industries (1.A.2.c) is presented in Table 3-24.

Table 3-24. Emission factors and methods for category Pulp, Paper and Print industries (1.A.2.d)

Fuel	CO_2			CH_4			N_2O		
	CO_2, kg/GJ	EF	Method	CH_4, kg/TJ	EF	Method	N_2O, kg/TJ	EF	Method
Gasoil	72,89	CS	T2	2,0	D	T1	0,6	D	T1
Residual fuel oil	77,60	CS	T2	2,0	D	T1	0,6	D	T1
LPG	65,42	CS	T2	2,0	D	T1	0,6	D	T1
Coke	109,11	CS	T2	10,0	D	T1	1,4	D	T1
Coking coal	94,90	CS	T2	10,0	D	T1	1,4	D	T1
Peat	104,34	CS	T2	2,0	CS	T2	1,5	CS	T2
Natural gas	55,23	CS	T2	5,0	D	T1	0,1	D	T1
Wood/ wood waste	109,90	CS	T2	30,0	D	T1	4,0	D	T1
Other solid biomass	109,90	CS	T2	30,0	D	T1	4,0	D	T1

Abbreviations: CS - country specific emission factors were developed in August 2012 based on the results of the study "Determination of national GHG emission factors for energy sector" prepared by Lithuanian Energy Institute; D - default emission factors (1996 IPCC); T1 - Tier 1; T2 - Tier 2.

Activity data

For calculation of GHG emissions in category Pulp, paper and print industries (1.A.2.d) activity data had been obtained from the Lithuanian Statistics. The Lithuanian Statistics provided data on energy consumption in manufacturing industries and construction according to the type of economic activity based on special request. Activity data are provided in the Table 3-25.

Table 3-25. Energy consumption by fuel type in Pulp, paper and print industries, TJ

	Gasoil	RFO	LPG	Coke	Coking coal	Peat	Natu-ral gas	Other solid bio-mass	Wood/ wood waste	Total
1990	0	2087	0	0	0	0	4555	0	243	**6885**
1995	0	721	0	0	75	0	1200	0	289	**2285**
2000	4	212	47	0	18	0	1450	0	467	**2198**
2001	6	128	9	0	12	0	1594	0	995	**2744**
2002	1	141	13	0	0	0	1873	0	1914	**3942**
2003	0	120	10	0	0	0	1507	0	2265	**3902**
2004	0	140	14	0	0	0	1290	0	2251	**3695**

2005	3	146	7	0	13	1	1495	0	2081	**3746**
2006	1	116	10	0	10	4	1282	0	1990	**3413**
2007	1	69	19	0	3	11	1598	0	2205	**3906**
2008	0	18	17	0	2	12	2207	0	2103	**4359**
2009	1	22	11	0	2	6	1650	4	1701	**3397**
2010	0	31	22	0	0	1	2116	0	2033	**4203**
2011	20	0	10	0	0	0	1570	1	1944	**3545**

Tendencies of fuel consumption and total GHG emissions in Pulp, Paper and Print industries are presented in Figure 3-17.

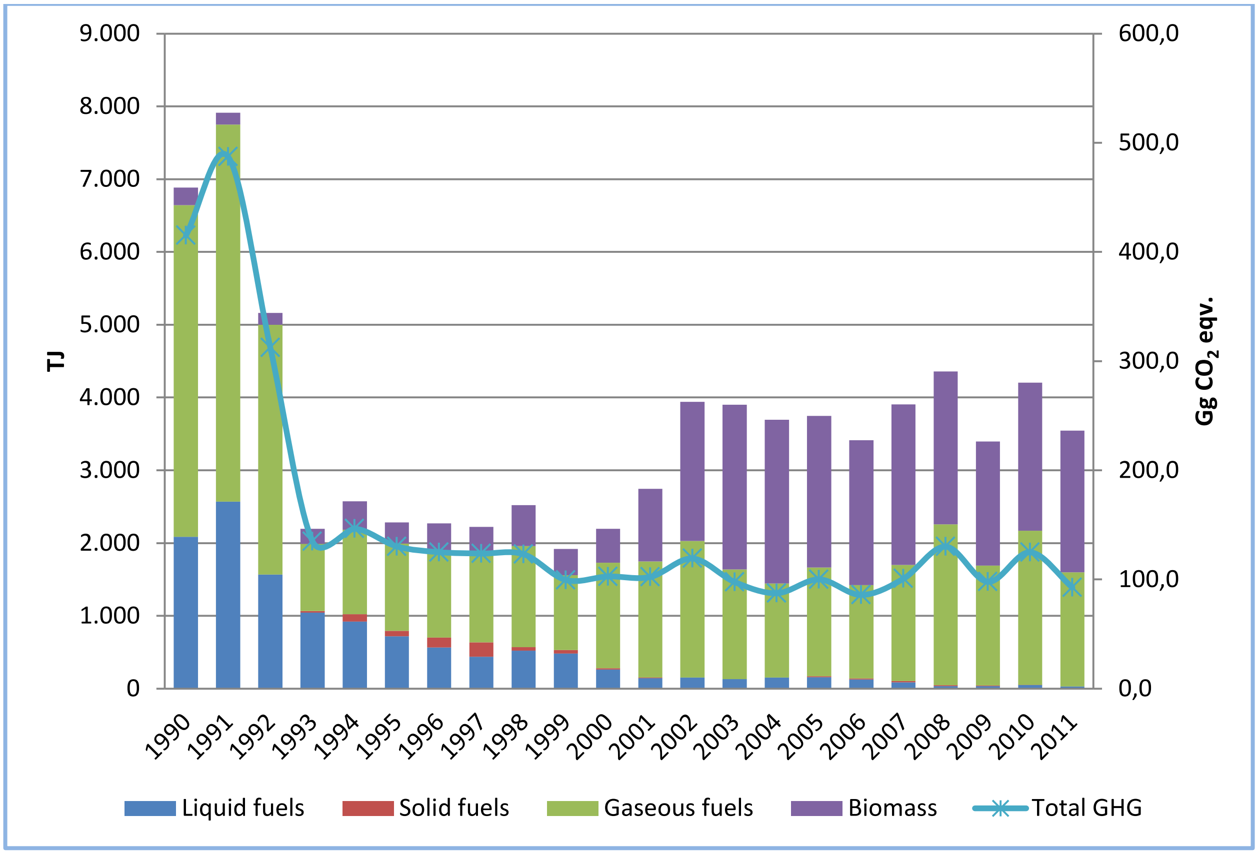

Figure 3-17. Tendencies of fuel consumption and total GHG emissions in Pulp, Paper and Print industries during 1990-2011

Historically natural gas was the main fuel used in Pulp, Paper and Print industries. Since 2000 biomass consumption started to increase almost 12,6% per annum (Figure 3-17). In 2011, share of biomass accounted 54,9%, natural gas - 44,3% in the structure of fuel used in Pulp, Paper and Print industries.

In 2011, total GHG emissions from Pulp, Paper and Print industries were even 4,5 times lower than in 1990 and amounted 92,7 Gg CO_2 eqv.

3.3.4.3 Uncertainties and time-series consistency

Uncertainty in activity data in Pulp, Paper and Print industries is ±2% taking into consideration recommendations provided by IPCC GPG 2000 and IPCC 2006 Guidelines for National GHG Inventories. Since data on biomass as fuel are not well developed as for fossil fuel, the uncertainty rage for biomass is ±50% as recommended by 2006 IPCC.

Uncertainties of CO_2 emission factors for liquid fuels (residual fuel oil, LPG, and gasoil) and gaseous fuels (natural gas) are ±2,5% in Pulp, Paper and Print industries. Uncertainties of CO_2 emission factors for solid fuels (coke, coking coal) are ±7%. Estimated uncertainties of CO_2 emission factors for biomass are ±50%. Uncertainties of all country specific CO_2 emission factors are derived in the study "Determination of national GHG emission factors for Lithuanian energy sector".

Uncertainties of CH_4 and N_2O emission factors for liquid, solid and gaseous fuels were assigned as very high about ±50%. Uncertainties were derived considering IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories 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. All emissions are estimated or reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.3.4.4 Source-specific QA/QC and verifications

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

The results are verified by calculating CO_2 emissions with the reference approach, and comparing results with the sectoral approach.

3.3.4.5 Source-specific recalculations

Following recalculations in this category has been done:

- corrections of activity data of residual fuel oil, LPG, coking coal, natural gas and wood/wood waste consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- addition gasoil, coke, peat and other solid biomass consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- correction of CO_2 emission factor for residual fuel oil, coking coal, natural gas and wood/wood waste based on the country specific values that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector;
- correction of N_2O emission factor for LPG based on default value provided in 1996 IPCC;
- corrections of CH_4 emission factors for residual fuel oil and LPG based on default value provided in 1996 IPCC.

Impact of these recalculations on GHG emissions from 1.A.2.d Pulp, paper and print industries is presented in Table 3-26.

Table 3-26. Impact of recalculation on GHG emissions from 1.A.2.d Pulp, Paper and Print industries

Year	Submission 2012, Gg CO2 eq.	Submission 2013, Gg CO2 eq.	Absolute difference, Gg CO2 eq.	Relative difference, %
1990	265,2	415,1	149,8	56,5
1991	293,7	487,1	193,4	65,8
1992	185,0	312,3	127,3	68,8
1993	73,5	134,9	61,4	83,4
1994	89,8	146,4	56,7	63,1
1995	82,6	130,3	47,7	57,7
1996	93,2	125,0	31,8	34,1
1997	90,6	123,8	33,2	36,6
1998	79,7	123,2	43,5	54,6
1999	58,5	99,5	41,0	70,0
2000	52,9	102,8	49,9	94,3
2001	57,8	102,3	44,5	77,0
2002	54,8	119,2	64,3	117,3
2003	23,0	97,7	74,6	323,7
2004	1,5	87,4	86,0	5755,6
2005	3,9	100,1	96,1	2457,4
2006	2,8	85,8	83,0	2916,6
2007	3,0	100,7	97,7	3258,1
2008	34,0	130,1	96,1	282,4
2009	50,7	97,9	47,2	93,0
2010	67,3	124,9	57,6	85,5

3.3.4.6 Source-specific planned improvements

Source-specific improvements are not planned.

3.3.5 Food Processing, Beverages and Tobacco (CRF 1.A.2.e)

3.3.5.1 Source category description

Food Processing, Beverages and Tobacco industries has old traditions in Lithuania. Currently this branch of the manufacturing industry consists of the following important structural parts – production of meet and its products, preparation and processing of fish and its products, preparation, processing and preservation of fruits, berries and vegetables, production of dairy products, production of grains, production of strong and soft drinks as well tobacco. Till the beginning of last economic crisis Food Processing, Beverages and Tobacco industries meet a slow decrease in the structure of value added created, i.e. from 32,1% (1995) till 19,3% (2008), but remained the largest manufacturing industry in Lithuania. During economic crisis the decline rates have been one of the lowest (7,5% a year). During the last decade food processing industry has passed a rapid restructuring process, when number of active economic entities in the main branches of food industry (except in fruit and berries industry) has noticeably decreased. However, the share of large companies has increased. Food processing industry has kept a stable share in terms of value added in the structure of national economy and rapid growth rates in the export structure (Kaunas Technology University, 2009). Currently, the share of value added in Food Processing, Beverages and Tobacco industry accounts 18,4% of total value added in manufacturing industry.

3.3.5.2 Methodological issues

CO_2 emissions were calculated applying Tier 2, CH_4 and N_2O were calculated applying Tier 1 or Tier 2 (as presented in Table 3-27) based on equation 1 (see chapter 3.2.6).

Emission factors and methods

Emission factors and methods used in the calculation of emissions from Food Processing, Beverages and Tobacco industries (1.A.2.e) are presented in Table 3-27.

Table 3-27. Emission factors and methods for category Food Processing, Beverages and Tobacco industries (1.A.2.e)

Fuel	CO_2			CH_4			N_2O		
	CO_2, kg/GJ	EF	Method	CH_4, kg/TJ	EF	Method	N_2O, kg/TJ	EF	Method
Shale oil	77,40	CS	T2	2,0	D	T1	0,6	D	T1
Residual fuel oil	77,60	CS	T2	2,0	D	T1	0,6	D	T1
LPG	65,42	CS	T2	2,0	D	T1	0,6	D	T1
Gasoil	72,89	CS	T2	2,0	D	T1	0,6	D	T1
Peat	104,34	CS	T2	2,0	CS	T2	1,5	CS	T2
Coking coal	94,90	CS	T2	10,0	D	T1	1,4	D	T1
Coke	109,11	CS	T2	10,0	D	T1	1,4	D	T1
Natural gas	55,23	CS	T2	5,0	D	T1	0,1	D	T1
Wood/ wood waste	109,90	CS	T2	30,0	D	T1	4,0	D	T1
Biogas	58,45	CS	T2	1,0	CS	T2	0,1	CS	T2

Abbreviations: CS - country specific emission factors were developed in August 2012 based on the results of the study "Determination of national GHG emission factors for energy sector" prepared by Lithuanian Energy Institute; D - default emission factors (1996 IPCC); T1 - Tier 1; T2 - Tier 2.

Activity data

For calculation of GHG emissions in category Food Processing, Beverages and Tobacco industries (1.A.2.e) activity data had been obtained from the Lithuanian Statistics. The Lithuanian Statistics provided data on energy consumption in manufacturing industries and construction according to the type of economic activity based on special request. Activity data are provided in the Table 3-28.

Table 3-28. Energy consumption by fuel type in Food Processing, Beverages and Tobacco industries, TJ

Year	Shale oil	RFO	LPG	Gasoil	Peat	Co-king coal	Coke	Natu-ral gas	Wood / wood waste	Biogas	Total
1990	0	2248	0	0	0	352	0	8498	36	0	**11134**
1995	0	1606	0	0	0	151	0	2077	57	0	**3891**
2000	0	1566	121	3	0	68	106	2890	77	0	**4831**
2001	0	1120	60	0	0	38	99	2987	43	0	**4347**
2002	0	876	64	4	1	67	98	3792	49	0	**4951**
2003	0	677	74	30	2	45	105	4025	72	0	**5030**
2004	5	588	102	47	2	38	76	3711	112	0	**4681**
2005	13	351	158	148	5	56	63	3694	298	0	**4786**
2006	40	291	210	90	2	45	62	3865	140	5	**4750**
2007	22	379	237	52	2	40	60	4214	82	13	**5101**
2008	27	301	205	93	2	36	29	3932	102	10	**4737**
2009	0	234	186	74	1	43	45	3644	78	18	**4323**
2010	0	212	194	93	15	45	54	4005	92	10	**4720**
2011	0	268	193	86	9	55	49	4297	88	10	**5055**

Tendencies of fuel consumption and total GHG emissions in Food processing, beverages and tobacco industries are presented in Figure 3-18.

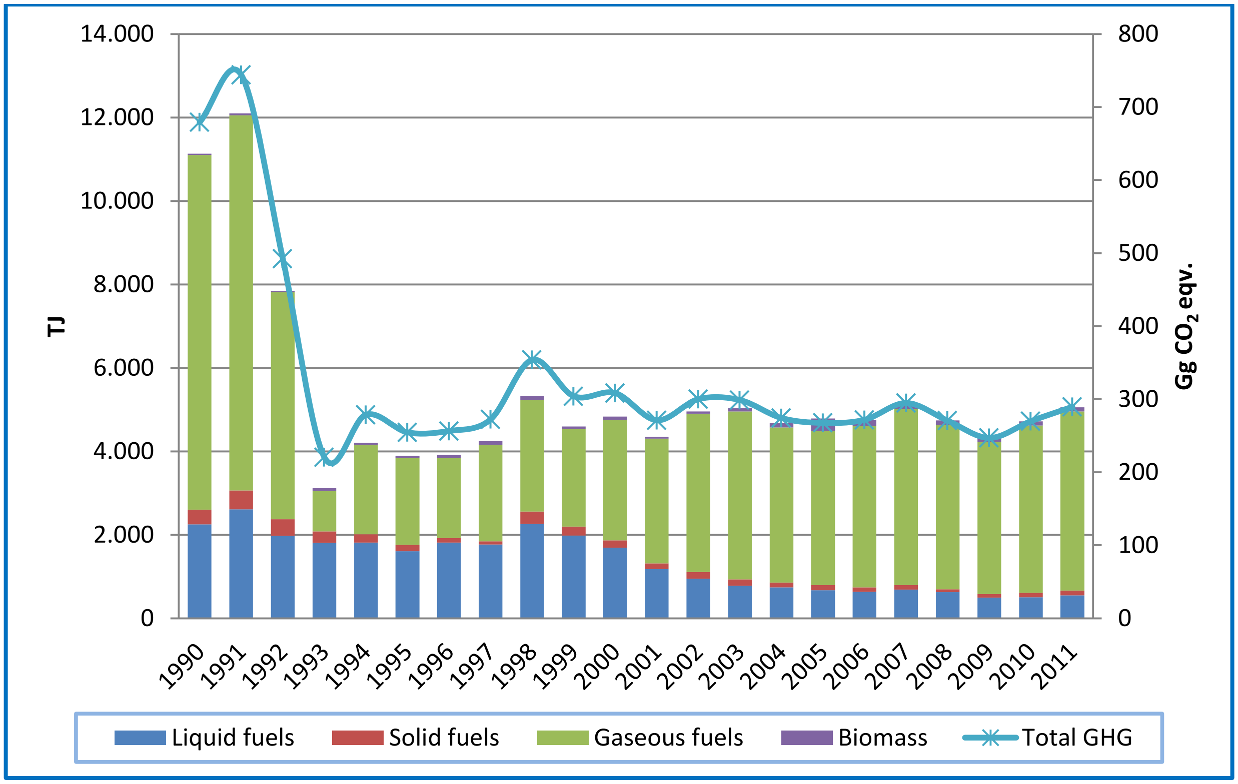

Figure 3-18. Tendencies of fuel consumption and total GHG emissions in Food Processing, Beverages and Tobacco industries during 1990-2011

Fuel consumed in Food Processing, Beverages and Tobacco industries has become more diversified in 2011 compared to the structure that have existed in 1990. Instead of three fuels (residual fuel oil, coking coal and natural gas) that have been widely used in industry in early 1990s, currently LPG, gasoil, wood/wood waste and biogas penetrate the market (Figure 3-18). The share of residual fuel oil in the structure of energy consumed in industry has reduced from 41,3% (1995) till 5,3% (2011). The share of natural gas has a tendency to increase, i.e. it has increased by 25,2 percentage points during 1995-2011.

In 2011, total GHG emissions from Food Processing, Beverages and Tobacco industries were 2,3 times lower than in 1990 and amounted 289,5 Gg CO_2 eqv.

3.3.5.3 Uncertainties and time-series consistency

Uncertainty in activity data in Food Processing, Beverages and Tobacco industries is ±2% taking into consideration recommendations provided by IPCC GPG 2000 and IPCC 2006 Guidelines for National GHG Inventories. Since data on biomass as fuel are not well developed as for fossil fuel, the uncertainty rage for biomass is ±50% as recommended by 2006 IPCC.

Uncertainties of CO_2 emission factors for liquid fuels (shale oil, residual fuel oil, LPG, and gasoil) and gaseous fuels (natural gas) are ±2,5% in Food Processing, Beverages and Tobacco industries. Uncertainties of CO_2 emission factors for solid fuels (peat, coking coal and coke) are ±7%. Estimated uncertainties of CO_2 emission factors for biomass are ±50%. Uncertainties of all country specific CO_2 emission factors are derived in the study "Determination of national GHG emission factors for Lithuanian energy sector".

Uncertainties of CH_4 and N_2O emission factors for liquid, solid and gaseous fuels were assigned as very high about ±50%. Uncertainties were derived considering IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories 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. All emissions are estimated or reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.3.5.4 Source-specific QA/QC and verifications

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

The results are verified by calculating CO_2 emissions with the reference approach, and comparing results with the sectoral approach.

3.3.5.5 Source-specific recalculations

Following recalculations in this category has been done taking into account ERT recommendations:

- corrections of activity data of shale oil, residual fuel oil, LPG, gasoil, peat, coking coal, natural gas, wood/wood waste and biogas consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- addition of coke consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- correction of CO_2 emission factor for shale oil, residual fuel oil, peat, coking coal, natural gas, wood/wood waste and biogas based on the country specific values that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- correction of N_2O emission factor for LPG based on default value provided in 1996 IPCC;
- correction of N_2O emission factor for peat based on the country specific value that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- corrections of CH_4 emission factors for shale oil, residual fuel oil, LPG and gasoil based on default value provided in 1996 IPCC.

Impact of these recalculations on GHG emissions from 1.A.2.e Food Processing, Beverages and Tobacco industries is presented in Table 3-29.

Table 3-29. Impact of recalculation on GHG emissions from 1.A.2.e Food Processing, Beverages and Tobacco industries

Year	Submission 2012, Gg CO2 eq.	Submission 2013, Gg CO2 eq.	Absolute difference, Gg CO2 eq.	Relative difference, %
1990	701,7	679,2	-22,6	-3,2
1991	768,7	744,0	-24,7	-3,2

1992	508,6	492,3	-16,3	-3,2
1993	228,8	220,4	-8,3	-3,6
1994	288,8	278,6	-10,2	-3,5
1995	264,0	254,5	-9,4	-3,6
1996	374,7	256,4	-118,3	-31,6
1997	349,7	272,3	-77,5	-22,2
1998	363,4	353,7	-9,6	-2,6
1999	242,0	304,0	62,0	25,6
2000	249,5	308,3	58,8	23,6
2001	276,8	271,1	-5,8	-2,1
2002	283,8	300,0	16,2	5,7
2003	304,7	298,8	-6,0	-2,0
2004	283,7	274,1	-9,5	-3,4
2005	272,8	267,4	-5,4	-2,0
2006	278,2	271,7	-6,5	-2,3
2007	303,2	294,6	-8,6	-2,8
2008	277,7	270,5	-7,2	-2,6
2009	253,2	246,9	-6,3	-2,5
2010	275,0	269,7	-5,2	-1,9

3.3.5.6 Source-specific planned improvements

Source-specific improvements are not planned.

3.3.6 Other Industries (CRF 1.A.2.f)

3.3.6.1 Source category description

Other non-specified industries in Lithuania include the following activities:

- manufacturing of textile goods;
- sewing of goods;
- production of leather and its products;
- manufacturing of wood and its products, excluding production of furniture;
- production of medicine industry goods and pharmaceutical preparations;
- manufacturing of rubber and plastic goods;
- manufacturing of other non-metalic mineral products;
- manufacturing of basic metals;
- manufacturing of metal goods, excluding machines and equipments;
- manufacturing of computers, electronic and optical goods;
- manufacturing of electrical goods;
- manufacturing of other machines and equipment;
- manufacturing of motor vehicle and trailers;
- manufacturing of other vehicles and equipment;
- manufacturing of furniture;
- manufacturing of other goods;
- construction.

Other non-specified industries in Lithuania have accounted 41,4% of value added in 2011. Textile goods industry is the largest industry prescribed to other non-specified industries and the third largest (after food processing, beverages and tobacco and pulp, paper and print) manufacturing industry in Lithuania. Since 1999 its structural share has been reducing from 19,6% (1999) till 8,3% (2009) and with a 1,7 percentage points increase in 2011. Rubber and plastic goods industry has been an advanced branch of manufacturing industry in Lithuania during 1995-2008 in terms of growth rates of value added created and trade (Kaunas Technology University). During 1995-2006 added value created increased by 18,8% a year. During the following three years, a deceleration of activities was fixed in the industry (value added was decreasing by 15,6% a year). Since 2010 volume of value added is increasing by 16,6% a year.

3.3.6.2 Methodological issues

CO_2 emissions were calculated applying Tier 2, CH_4 and N_2O were calculated applying Tier 1 or Tier 2 (as presented in Table 3-30) based on equation 1 (see chapter 3.2.6).

Emission factors and methods

Emission factors and methods used in the calculation of emissions from Other industries (1.A.2.f) are presented in the Table 3-30.

Table 3-30. Emission factors and methods for category Other industries (1.A.2.f)

Fuel	CO_2			CH_4			N_2O		
	CO_2, kg/GJ	EF	Method	CH_4, kg/TJ	EF	Method	N_2O, kg/TJ	EF	Method
Residual fuel oil	77,60	CS	T2	2,0	D	T1	0,6	D	T1
LPG	65,42	CS	T2	2,0	D	T1	0,6	D	T1
Gasoil	72,89	CS	T2	2,0	D	T1	0,6	D	T1
Jet kerosene	72,24	CS	T2	2,0	D	T1	0,6	D	T1
Petroleum coke	94,06	CS	T2	2,0	D	T1	0,6	D	T1
Peat	104,34	CS	T2	2,0	CS	T2	1,5	CS	T2
Coking coal	94,90	CS	T2	10,0	D	T1	1,4	D	T1
Coke	109,11	CS	T2	10,0	D	T1	1,4	D	T1
Natural gas	55,23	CS	T2	5,0	D	T1	0,1	D	T1

Wood/ wood waste	109,90	CS	T2	30,0	D	T1	4,0	D	T1
Other solid biomass	109,90	CS	T2	30,0	D	T1	4,0	D	T1
Biogas	58,45	CS	T2	1,0	CS	T2	0,1	CS	T2
Used tires (industrial waste)	85,03	PS	T3	30	CS	T2	4,0	CS	T2

Abbreviations: CS - country specific emission factors were developed in August 2012 based on the results of the study "Determination of national GHG emission factors for energy sector" prepared by Lithuanian Energy Institute; PS - plant specific emission factors are based on EU ETS data; D - default emission factors (1996 IPCC); T1 - Tier 1; T2 - Tier 2; T3 - Tier 3.

Activity data

For calculation of GHG emissions in category Other industries (1.A.2.e) activity data had been obtained from the Lithuanian Statistics. The Lithuanian Statistics provided data on energy consumption in manufacturing industries and construction according to the type of economic activity based on special request. Activity data are provided in the Table 3-31.

Table 3-31. Energy consumption by fuel type in Other industries, TJ

Year	Residual fuel oil	LPG	Gasoil	Jet kerosene	Petroleum coke	Peat	Coking coal	Coke	Natural gas	Wood/ wood waste	Other solid biomass	Biogas	Total
1990	39819	92	0	0	0	170	1457	0	18041	225	0	0	**59804**
1995	9113	46	0	0	0	233	502	0	4295	515	0	0	**14704**
2000	3825	107	7	10	0	43	70	240	4020	771	0	0	**9093**
2001	3761	174	0	5	0	35	70	205	4318	891	0	0	**9459**
2002	2083	170	13	5	0	12	1916	204	4244	1372	47	0	**10066**
2003	711	152	83	5	0	15	3185	255	4509	1744	84	0	**10743**
2004	1155	155	105	0	17	13	3216	283	4514	1858	91	0	**11407**
2005	1319	134	279	0	46	10	3336	471	4925	1813	41	0	**12374**
2006	900	157	171	0	325	9	4871	655	4500	1686	10	1	**13285**
2007	130	141	176	0	793	14	5076	650	4263	1410	76	0	**12729**
2008	197	181	173	0	218	10	4485	458	3426	1244	19	0	**10411**
2009	91	135	139	0	685	6	2333	276	2200	975	4	0	**6844**
2010	80	162	174	0	111	23	3055	391	2596	938	11	0	**7541**
2011	93	100	157	0	0	56	3814	473	2843	1140	6	0	**8682**

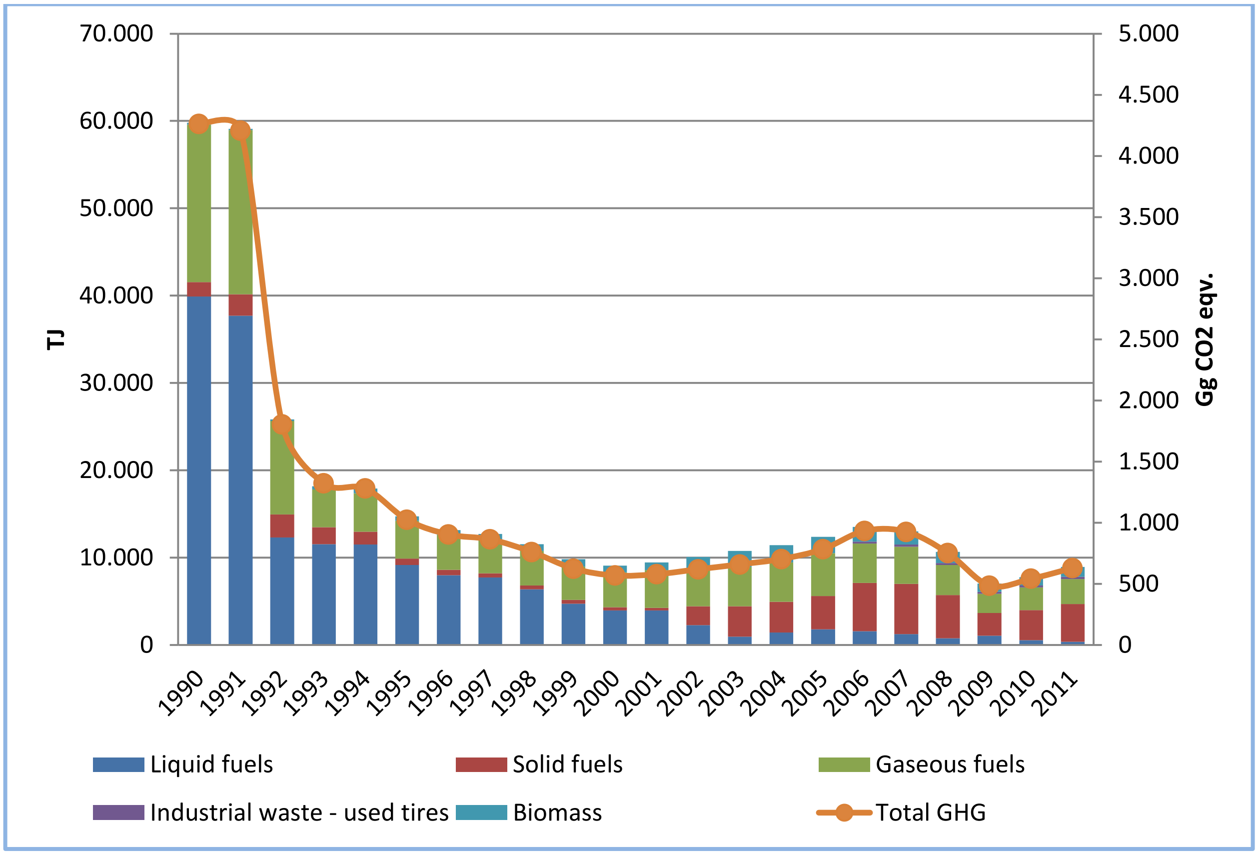

Figure 3-19. Tendencies of fuel consumption and total GHG emissions in Other industries during 1990-2011

In Other Industries sector the largest reductions have been noticed in residual fuel oil consumption during the period 1990-2011 (Table 3-31). The share of residual fuel oil has decreased from 67% (1990) till 1% (2011). Although, volume of natural gas has been reducing, however its share has remained rather stable during 1990-2011 (Figure 3-19). It has accounted about 30-40% in the structure. During the period of rapid economic development coking coal has rapidly penetrated the market, i.e. the share has increased from 19% (2002) till 40% (2007). During 2008-2011 consumption of coking coal has been reducing, however the share has remained stable – 35-40%. The share of wood/wood waste fluctuates around 15% in the structure of fuel consumption during 2002-2011.

In 2011, total GHG emissions from Other industries were even 6,8 times lower than in 1990 and amounted 628,6 Gg CO_2 eqv.

3.3.6.3 Uncertainties and time-series consistency

Uncertainty in activity data in Other industries is ±2% taking into consideration recommendations provided by IPCC GPG 2000 and IPCC 2006 Guidelines for National GHG Inventories. Since data on biomass as fuel are not well developed as for fossil fuel, the uncertainty rage for biomass is ±50% as recommended by 2006 IPCC.

Uncertainties of CO_2 emission factors for liquid fuels (residual fuel oil, LPG, and gasoil) and gaseous fuels (natural gas) are ±2,5% in Other industries. Uncertainties of CO_2 emission factors for solid fuels (peat, coking coal and coke) are ±7%. Estimated uncertainties of CO_2 emission factors for biomass are ±50%. Uncertainties of all country specific CO_2 emission factors are derived in the study "Determination of national GHG emission factors for Lithuanian energy sector".

Uncertainties of CH_4 and N_2O emission factors for liquid, solid and gaseous fuels were assigned as very high about ±50%. Uncertainties were derived considering IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories 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. All emissions are estimated or reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.3.6.4 Source-specific QA/QC and verifications

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

The results are verified by calculating CO_2 emissions with the reference approach, and comparing results with the sectoral approach.

3.3.6.5 Source-specific recalculations

Following recalculations in this category has been done taking into account ERT recommendations:

- corrections of activity data of residual fuel oil, gasoil, LPG, peat, coking coal, coke, natural gas, wood/wood waste, other solid biomass and biogas consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- removal of shale oil consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- addition of used tires consumption based on EU ETS data;
- correction of CO_2 emission factor for residual fuel oil, petroleum coke, peat, coking coal, natural gas, wood/wood waste, other solid biomass and biogas based on the country specific values that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- correction of N_2O emission factor for LPG, jet kerosene based on default value provided in 1996 IPCC;
- correction of N_2O emission factor for peat based on the country specific value that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- corrections of CH_4 emission factors for residual fuel oil, gasoil, petroleum coke and LPG based on default value provided in 1996 IPCC.

Impact of these recalculations on GHG emissions from 1.A.2.f Other industries is presented in Table 3-32.

Table 3-32. Impact of recalculation on GHG emissions from 1.A.1.f Other industries

Year	Submission 2012, Gg CO2 eq.	Submission 2013, Gg CO2 eq.	Absolute difference, Gg CO2 eq.	Relative difference, %
1990	4604,4	4261,4	-343,0	-7,4
1991	4587,9	4206,6	-381,3	-8,3
1992	2005,0	1803,1	-201,9	-10,1
1993	1438,9	1322,5	-116,4	-8,1
1994	1391,9	1280,0	-111,8	-8,0
1995	1117,1	1023,4	-93,6	-8,4
1996	851,2	903,1	51,9	6,1
1997	863,3	863,5	0,2	0,0
1998	840,5	760,7	-79,7	-9,5
1999	686,3	624,4	-61,8	-9,0
2000	635,2	567,5	-67,7	-10,7
2001	600,0	578,1	-21,9	-3,6
2002	729,7	618,9	-110,7	-15,2
2003	748,3	658,7	-89,7	-12,0
2004	799,5	702,6	-96,9	-12,1
2005	896,9	783,8	-113,1	-12,6
2006	1011,5	933,0	-78,5	-7,8
2007	1015,2	925,7	-89,5	-8,8
2008	838,7	752,0	-86,7	-10,3
2009	526,6	485,3	-41,3	-7,8
2010	590,6	541,0	-49,6	-8,4

3.3.6.6 Source-specific planned improvements

Source-specific improvements are not planned.

3.4 Transport (1.A.3)

The source category 1.A.3 comprises the sources presented on Table 3-33. The source category Civil Aviation only includes emissions from domestic civil aviation, i.e., civil aviation with departure and arrival in the Lithuania. In the same manner, the source category Water-borne Navigation only includes emissions from domestic inland navigation.

Table 3-33. Description of categories in the 1.A.3 Transport sector

CRF source category	Description	Remarks
	CRF 1.A.3	
1.A.3.a *Civil Aviation*	Jet and turboprop powered aircraft (turbine engine fleet) and piston engine aircraft	Combustion of jet fuel (jet kerosene and jet gasoline). Emissions from helicopters are not calculated separately. Emissions caused by fuel consumption by military aviation are included in 1.A.5.b – Other (military mobile combustion).
1.A.3.b *Road Transportation*	Transportation on roads by vehicles with combustion engines: Passenger Cars, Light Duty Vehicles, Heavy Duty Vehicles and Buses, Mopeds and Motorcycles.	Farm and forest tractors are included in CRF 1.A.4.c Agriculture/Forestry/Fishery. Fuel consumption and emissions from off-road vehicles and pipelines are included in category 1.A.3e Other transportation.
1.A.3.c *Railways*	Railway transport operated by diesel locomotives	
1.A.3.d *Water-borne Navigation*	Merchant ships, passenger ships, container ships, cargo ships, technical ships, tourism ships and other inland vessels.	Fishing emissions are included in the CRF 1.A(a).4.c
1.A.5.b; 1.A.3.e *Other*	Transport of gases via pipelines, military activity and off-road transport.	

Emissions from motorized mobile road traffic in Lithuania includes traffic on public roads within country, except for agricultural and forestry transports. The source category *Civil Aviation* only includes emissions from national aviation. The source category *Water-borne Navigation* includes emissions only from inland navigation. The source categories *Road transportation* and *Railways* include all emissions from fuel sold to road transport and railways in the Lithuania. CO_2 emissions from 1.A.3.b *Road transportation* are dominant in this source category (Table 3-34).

Table 3-34. GHG emissions (Gg) by subcategories from 1.A.3 Transport sector in 1990 – 2011

Year	1.A.3.A *Civil Aviation*			1.A.3.B *Road Transportation*			1.A.3.C *Railways*			1.A.3.D *Water-borne navigation*			1.AA.3.E *Transprt via pipelines*			1.AA.3.E *Off-road*		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
1990	9,02380	0,00006	0,00025	5247,15	1,69	0,13	349,972	0,024	0,003	15,4855	0,0011	0,0001	88,08120	0,00774	0,00015	1765,349	0,121	0,015
1991	8,66260	0,00006	0,00024	5818,71	2,01	0,18	371,652	0,025	0,003	9,2913	0,0006	0,0001	84,78100	0,00745	0,00015	1338,071	0,092	0,011
1992	8,22978	0,00006	0,00023	3713,65	1,28	0,11	359,275	0,025	0,003	3,0614	0,0002	0,0000	48,64950	0,00428	0,00009	1002,676	0,069	0,008
1993	7,93958	0,00006	0,00022	2763,11	0,97	0,08	353,069	0,024	0,003	3,0614	0,0002	0,0000	27,25510	0,00240	0,00005	865,917	0,059	0,007
1994	7,43514	0,00005	0,00021	2071,29	0,79	0,06	374,800	0,026	0,003	3,0614	0,0002	0,0000	29,75870	0,00262	0,00005	819,413	0,056	0,007
1995	7,07394	0,00005	0,00020	2769,67	0,97	0,08	241,573	0,017	0,002	3,0614	0,0002	0,0000	34,76590	0,00306	0,00006	772,683	0,053	0,006
1996	6,71212	0,00005	0,00019	3050,41	0,99	0,08	251,471	0,017	0,002	15,5256	0,0011	0,0001	38,97650	0,00343	0,00007	506,493	0,035	0,004
1997	6,49416	0,00005	0,00018	3444,72	1,10	0,10	240,974	0,017	0,002	15,5985	0,0011	0,0001	36,58670	0,00322	0,00006	459,836	0,032	0,004
1998	6,20458	0,00004	0,00017	3645,30	1,06	0,10	233,175	0,016	0,002	10,8606	0,0007	0,0001	28,33620	0,00249	0,00005	407,286	0,028	0,003
1999	5,84276	0,00004	0,00016	3243,84	0,95	0,10	206,570	0,014	0,002	9,2570	0,0006	0,0001	32,20540	0,00283	0,00006	298,749	0,02	0,002
2000	5,48156	0,00004	0,00015	2860,00	0,73	0,09	217,941	0,015	0,002	8,9907	0,0006	0,0001	39,48860	0,00347	0,00007	229,342	0,016	0,002
2001	5,98228	0,00004	0,00017	3137,58	0,75	0,10	191,482	0,013	0,002	10,4485	0,0007	0,0001	19,23220	0,00169	0,00003	192,226	0,013	0,002
2002	8,07724	0,00006	0,00022	3238,40	0,74	0,10	206,716	0,014	0,002	11,8811	0,0008	0,0001	21,33750	0,00188	0,00004	191,714	0,013	0,002
2003	2,65924	0,00002	0,00007	3282,37	0,76	0,10	226,688	0,016	0,002	13,0809	0,0009	0,0001	18,32180	0,00161	0,00003	181,727	0,012	0,001
2004	4,03180	0,00003	0,00011	3610,30	0,78	0,11	225,740	0,015	0,002	17,0086	0,0012	0,0001	18,37870	0,00162	0,00003	184,57	0,013	0,002
2005	1,79794	0,00001	0,00005	3832,12	0,81	0,12	228,437	0,016	0,002	16,7983	0,0012	0,0001	36,81430	0,00324	0,00006	204,689	0,014	0,002
2006	2,08690	0,00005	0,00006	4093,12	0,78	0,14	217,650	0,015	0,002	19,1419	0,0013	0,0002	62,13480	0,00546	0,00011	193,098	0,013	0,002
2007	3,89104	0,00011	0,00012	4839,15	0,70	0,17	226,032	0,016	0,002	17,8608	0,0012	0,0001	65,15050	0,00573	0,00011	192,149	0,013	0,002
2008	4,39238	0,00011	0,00013	4816,61	0,70	0,18	228,437	0,016	0,002	18,9457	0,0013	0,0002	57,12760	0,00502	0,00010	197,034	0,014	0,002
2009	2,58948	0,00006	0,00008	3965,41	0,62	0,12	175,009	0,012	0,001	16,4927	0,0011	0,0001	57,75350	0,00508	0,00010	151,182	0,01	0,001
2010	1,65036	0,00002	0,00005	4088,43	0,59	0,13	185,141	0,013	0,002	19,7532	0,0014	0,0002	58,49320	0,00514	0,00010	156,648	0,011	0,001
2011	1,86708	0,00003	0,00005	4005,19	0,52	0,13	193,013	0,013	0,002	16,3274	0,0011	0,0001	49,04780	0,00431	0,00009	164,812	0,011	0,001

Fuel combustion emissions in 1.A.3 *Transport* sector accounted for 102940 and 63580 TJ in 1990 and 2011, respectively. The sectors emissions decreased from 7560 in 1990 to 4482 Gg CO_2 equivalent in 2011. In 2011 the most important source of transportation GHGs was transport, with a share of 91% (Figure 3-20). Lithuania's railway system is mainly driven by diesel oil (4%). Fuels used by ships on inland waterways have a share of 0.4% in transport fuel consumption. About 0.04% of transportation fuel consumption arises from civil aviation sector in 2011. However, emissions from international transport at inland waterways are excluded from the national total and reported as marine bunkers.

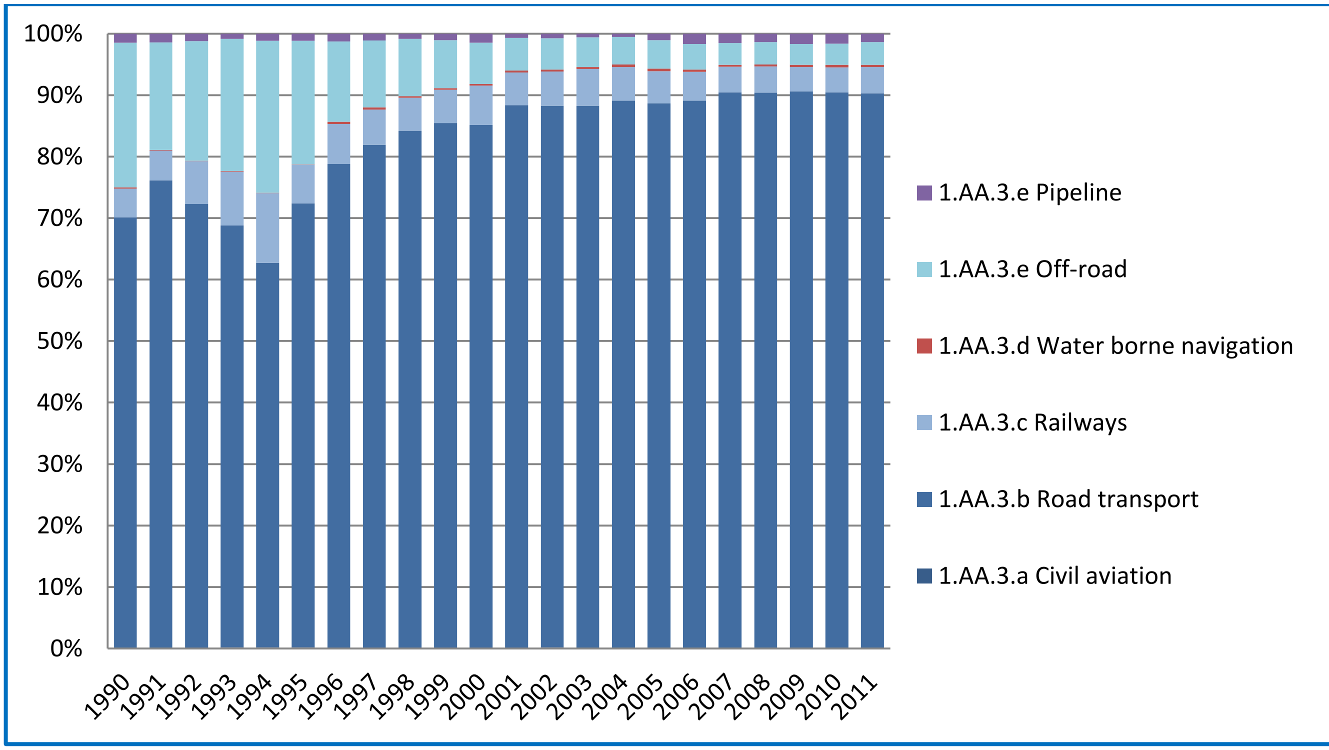

Figure 3-20. Fuel consumption distribution in Transport sector

Activity Data

Calculations demand speed mode of vehicles and fuel consumption are supplied by The Lithuanian Road Administration under the Ministry of Transport and Communications of the Republic of Lithuania, and the Lithuanian Statistics yearly publications "Energy balance" (Statistics Lithuania, 2012). Meteorological data is obtained from Lithuanian Hydrometeorological Service under the Ministry of Environment of the Republic of Lithuania (LHMS). For Lithuania from 2004 through 2011 registered car was obtained on the basis of the officially published ownership provided by State Enterprises Regitra and before 2003 Ministry of Interior data.

According to the information provided by Lithuanian Statistics, fuel use in road transport data collection methodology is part of the annual energy and fuel statistics survey. Functional enterprises are surveyed irrespective to their kind and ownership form. Statistical survey covers enterprises producing, supplying and consuming fuel and (or) energy.

Statistical information about oil products (motor gasoline, diesel, liquefied petroleum gas (LPG)) consumption in road transport is reported by the following enterprises:

- Enterprises producing oil products;

- Enterprises importing and exporting oil products;
- Oil products wholesale trade enterprises;
- Enterprises, which according to Law on State's oil and oil products reserve are obliged to store and manage State's oil and oil products reserve;
- Enterprises consuming fuel and energy belonging to the following economical activities: agricultural (with 10 and more employees), forestry and fishing, mining and quarrying, manufacturing industry, construction, transport and storage (except for road transportation) (with 20 and more employees).

Energy balance statistical report EN-01 and Oil/ Oil products balance statistical report EN-06 are the sources for statistical data.

In the statistical reports respondents are providing statistical data about each fuel and energy type: changes in stocks at the beginning and end of the year, production, inter-product transfer processes, import and export, purchase and sale in the internal market, consumption allocated by consumption purposes.

Statistical indicator "Consumption in road transport" is based on the territorial principle, not on the resident, i.e. the fuel sold (purchased) in Lithuania's territory is accounted, regardless of the country the vehicle originates.

In the balance row "Consumption in road transport" is included fuel used by all commercial and passenger vehicle's engines, i.e. consumed in industry, construction, transportation, service and other sectors. Fuel used by agricultural vehicles used on highways is accounted as well.

For fuels in common circulation, the carbon content of the fuel and net calorific values were obtain from fuel suppliers in accordance with the *IPCC GPG* 2000.

3.4.1 Civil aviation (1.A.3.a)

3.4.1.1 Source category description

Civil International airports in Lithuania (Vilnius, Kaunas and Palanga) are operated by State owned assets of the enterprises under the supervision of the Ministry of Transport and Communications. The Resolution No 1355 dated 28 October 2004 of the Government of the Republic of Lithuania approved the Šiauliai Airport as military, granting the right to use it for international civil air transport. Vilnius International Airport is the main airport in Lithuania handling around 1,37 million passengers every year; more than 70 % of passenger and aircraft movements in Lithuania are operated through Vilnius International Airport (Fig. 3-21).

Domestic civil aviation is essentially narrow (0,01 %) in Lithuania. Aviation gasoline (avgas) is used for piston-type powered aircraft engines, while the jet fuel used in turbine engines for aircraft and diesel engines. The corresponding figure was 9,1 Gg (CO_2 equivalent) in 1990 (Fig. 3-22 and Table 3-34).

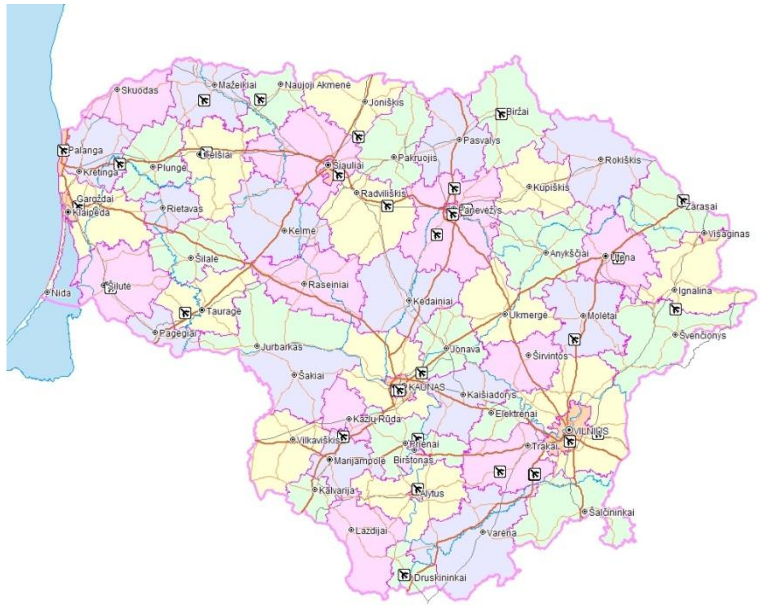

Figure 3-21. Map of aerodromes in Lithuania

Aviation gasoline is more common as fuel for private aircraft, while the jet fuel used in aircraft, airlines, military aircraft and other large aircraft. Following the recommendation of ERT in 2010 in the individual review report, net calorific values (NCVs) used to convert fuel consumption in natural units into energy units are provided in the Table 3-35[4].

Table 3-35. Specific net calorific values (conversion factors)

Type of fuel	Tonne	Tonne of oil equivalent (TOE)	TJ/tonne
Gasoline type jet fuel	1,0	1,070	0,04479
Kerosene type jet fuel	1,0	1,031	0,04316

[4] IPCC 2006 Guidelines. Energy. Mobile Combustion. P. 3.16

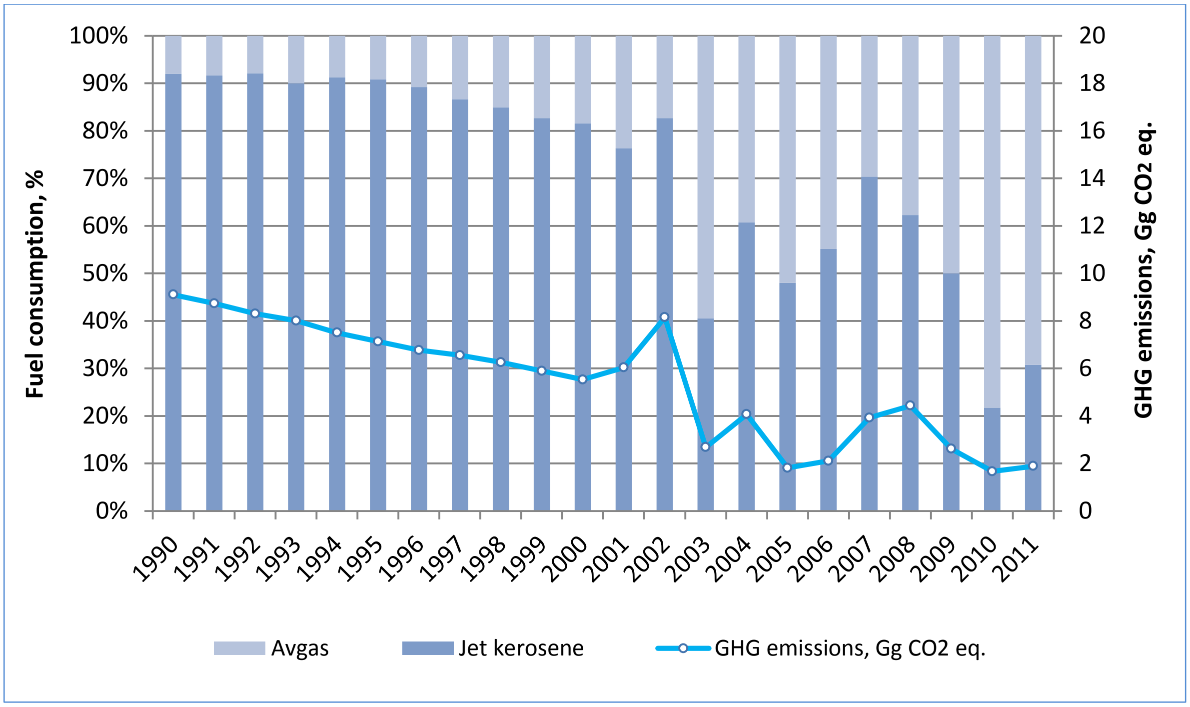

Figure 3-22. Trend of GHG emissions in Civil Aviation sector

3.4.1.2 Methodological issues

The aviation gasoline consumption and GHG emissions were based on Tier 1 approach as this method should be used to estimate emissions from aircraft that use aviation gasoline which is only used in small aircraft and generally represents less than 1 % of fuel consumption from aviation. The jet kerosene fuel consumption and emissions within Lithuania associated with sub-category 1.A.3(a) Civil Aviation was estimated using a Tier 2 approach (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual (Vol. 3) p. 1.95) based on aircraft type and LTO data for domestic and international air travel, the fuel consumption rates given by the EMEP/EEA emission inventory guidebook (2009) appropriate to the type of aircraft. This approach was used for all years from 2005 to 2011 where data is available.

For the purpose of these guidelines, operations of aircraft were divided into *Landing/Take-Off (LTO) cycle* and *Cruise*. Generally, about 10 percent of aircraft emissions of all types (except hydrocarbons and CO) are produced during airport ground level operations and during the LTO cycle[5]. The bulk of aircraft emissions (90 percent) occur at higher altitudes.

In Tier 2 the emissions for the LTO and cruise phases are estimated separately (Fig. 3-23), in order to harmonise with methods that were developed for air pollution programmes that cover only emissions below 914 meters (3000 feet). Emissions depend on the number and type of aircraft operations, the types and efficiency of the aircraft engines, the length of flight, the power setting, and the time spent at each stage of flight.

[5] LTO cycle is defined in ICAO, 1993. If countries have more specific data on times in mode these can be used to refine computations in higher tier methods.

The level of detail necessary for this methodology is the aircraft types used for both domestic and international aviation, together with the number of LTOs carried out by the various aircraft types. Apart from this level of further detail according to aircraft type, the algorithms are the same as for the Tier 1 approach:

$$E_{pollutant} = \sum AR_{fuel\ consumption,\ aircraft\ type} \times EF_{pollutant,\ aircraft\ type}, \quad (1)$$

where:

$E_{pollutant}$ – annual emission of pollutant for each of the LTO and cruise phases of domestic and international flights;

$AR_{fuel\ consumption,\ aircraft\ type}$ – activity rate by fuel consumption for each of the flight phases and trip types, fore ach aircraft type;

$EF_{pollution,\ aircraft\ type}$ – emission factor of pollutant for the respective flight phase and trip type, for each aircraft type.

Activity data

Following advice from experts[6] it was decided to distinguish GHG emissions from aviation bunkers in such a way that all aviation gasoline is used for domestic purposes and thus all the rest (gasoline type jet fuel and kerosene type jet fuel) is used for international flights – the latter could therefore be considered as aviation bunkers. Data on jet fuel (kerosene and aviation gasoline) split between domestic and international aviation is available only from 2001. Following the recommendation of ERT in 2011 the estimates of aviation gasoline consumption were linearly interpolated for the period 1996-1999 since effect of annual fluctuations was considered negligible. Emissions were estimated by assuming a constant annual rate of growth in fuel consumption from 1995 to 2000 (*IPCC 2006, Vol. 1. General Guidance and Reporting*). Trend extrapolation of GHG from jet kerosene for 1990-2000 was evaluated in combination with surrogate data. To improve the accuracy of estimates changes in total jet kerosene consumption during 1990-2010 were used underlying activity for simulation of trend in GHG emissions (*IPCC 2006, Vol. 1. General Guidance and Reporting*).

[6] ICR Lithuania 17-21 May, 2004, Branca Americano (Brazil); consultant Domas Balandis (Lithuania).

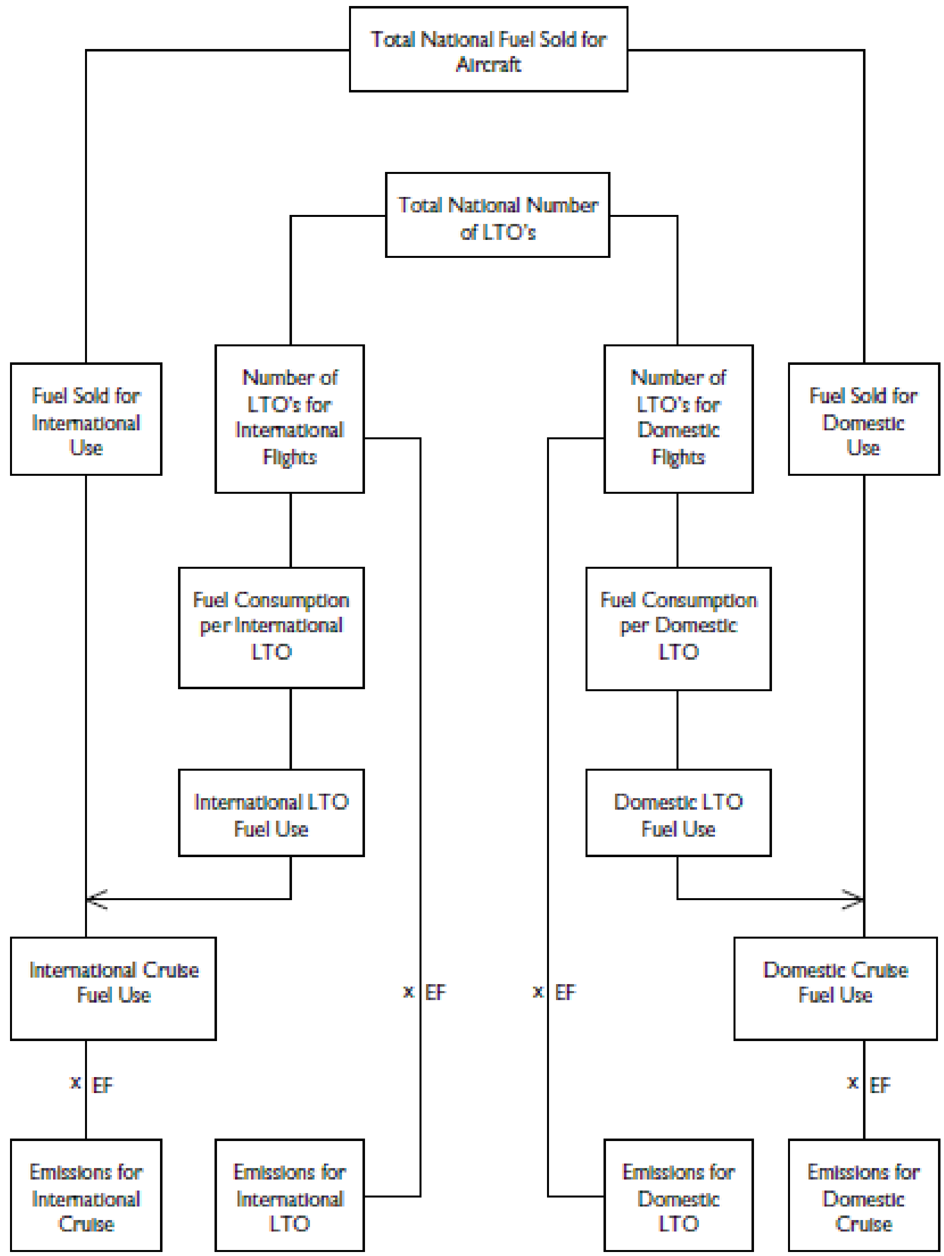

Figure 3-23. Estimation of Aircraft Emissions with the Tier 2 Method

Following the recommendation of ERT in 2012[7] the extrapolation procedure was explained. In a case when we have very sharp annual fluctuations in time-series the partial correlation can be done. Bearing in mind that the relationship between emissions and surrogate can be developed on the basis of data for a single year, the use of multiple years might provide a better estimate. Two underlying activities for surrogate data were used: average length of carriage per tonne, km and international fuel consumed, TJ. The extrapolation was made using it's own extrapolation alghoritm and surrogate data was used as parameters for comparison (for example Average length of carriage per tonne, km) (Fig. 3-24).

[7] ICR Lithuania 1-6 October, 2012, Tomas Gustafsson (Sweden)

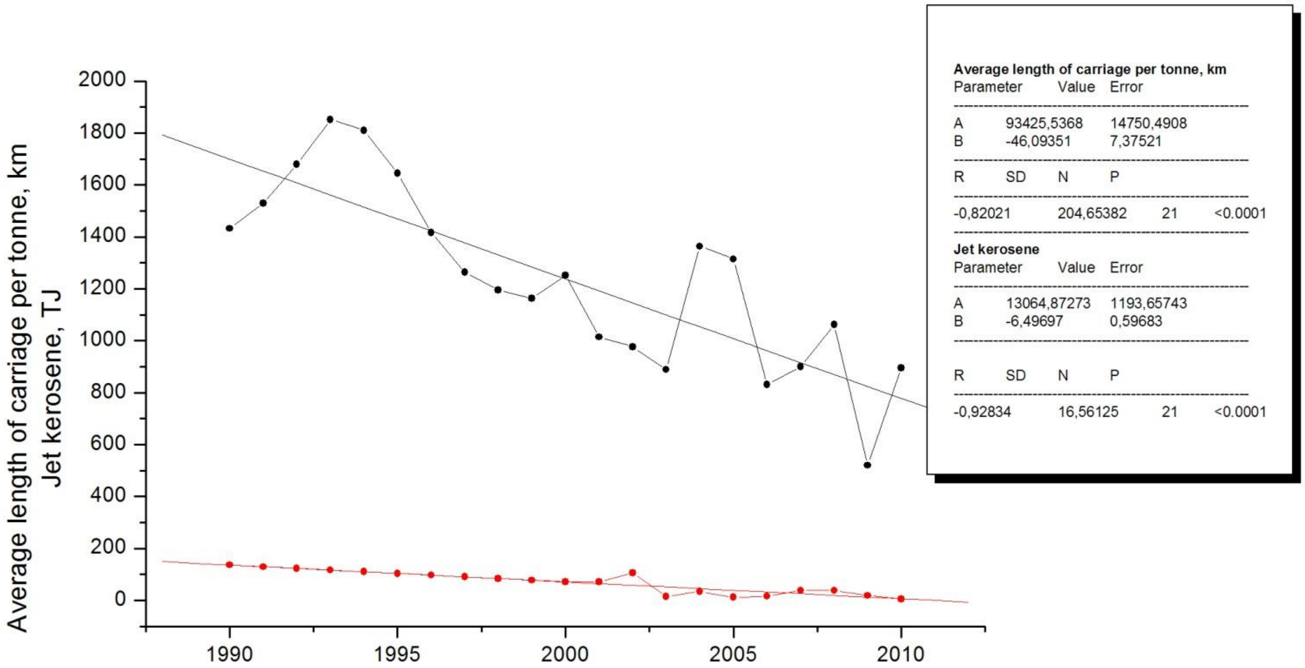

Figure 3-24. The intercomparison between surrogate data and trend of civil aviation emissions

The underlying algorithm used in the SLOPE functions is different than the underlying algorithm used in the EXTRAPOLATION function. The difference between these algorithms can lead to different results when data is undetermined and collinear. In this reason the tendency of surrogate data was compared to tendency of time-series after extrapolation was applied.

Data on jet kerosene used for military in Lithuania is available starting from 2001, therefore GHG emissions are reported for 2001-2011.

Additionally expert asks the data by special inquiry data on consumption of aviation fuels for international bunkering and inland consumption every year because this data is not published in the National Energy Balances and Annual Yearbooks, i.e. data of aviation fuels is given in total and is not splitted into national and international use. For 2006-2011 the air flight statistics is provided by the statistical data from Vilnius International Airport and SE "Oro navigacija".

Emission factors

Emission factors for *Civil aviation* sources used in the Lithuanian national GHG inventory are provided in Table 3-36 – 3-38. Country specific CO_2 EF was developed based on research data from the Lithuanian oil refinery (research protocols of UAB ORLEN Lietuva Quality Research Center) in 2010. Jet kerosene used in the country is produced by oil refinery UAB ORLEN Lietuva.

Table 3-36. CO_2 emission factors for Civil aviation sector used in the Lithuanian GHG inventory

Fuel	Emission factor [kg/GJ]	Source / Comments
Aviation gasoline	71,62	Country specific EF based on "Greenhouse gas emissions characteristics of national energy sector" study, 2012
Jet kerosene	72,24	Country specific EF based on producer data (research protocols of UAB ORLEN Lietuva Quality Research Center)

Table 3-37. CH_4 emission factors for Civil aviation sector used in the Lithuanian GHG inventory

Fuel	Emission factor [kg/TJ]	Source / Comments
Aviation gasoline	0,5	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual. Table 1-7. p. 1.35
Jet kerosene	0,5	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual. Table 1-7. p. 1.35

Table 3-38. N_2O emission factors for Civil aviation sector used in the Lithuanian GHG inventory

Fuel	Emission factor [kg/TJ]	Source / Comments
Aviation gasoline	2	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual. Table 1-8. p. 1.36
Jet kerosene	2	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual. Table 1-8. p. 1.36

It should be noted that the reporting of emissions from military aircraft is under CRF code 1.A.5, not 1.A.3.a. Military activity is defined in this report as those activities using fuel purchased by or supplied to the military authorities of the country.

3.4.1.3 Uncertainties and time-series consistency

Uncertainty in activity data of aviation fuel consumption in civil aviation is ±10 % influenced mainly by domestic and international fuel split and extrapolation procedure. In fuel combustion activity, the CO_2 emission factor mainly depends on the carbon content of the fuel instead of on combustion technology. CO_2 emission factor (uncertainty 2%) was estimated according physical characterization of used fuels in country based on average NCV and emission factors of jet kerosene reported by ORLEN Lietuva. Uncertainty in activity data of fuel consumption for 1990-2000 in civil aviation is influenced by data based on extrapolation (jet kerosene).

The current limited knowledge of CH_4 and N_2O emission factors, more detailed methods not significantly reduce uncertainties for CH_4 and N_2O emissions, so uncertainty was assigned about 57%/+100% and -70%/+150% for N_2O. The time series for all data have been studied carefully in search for outliers.

3.4.1.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

3.4.1.5 Source-specific recalculations

Emissions from *Civil Aviation* have been recalculated for the entire time-series for this year submission. The default emission factor for aviation gasoline CO_2 and CH_4 was applied. Changes with respect to the 2012 report year include recalculation of CH_4 and N_2O at new Tier 2 method 2006-2011 (Table 3-39).

Table 3-39. Recalculated GHG emissions from Civil Aviation

Year	Submission 2012, [Gg CO_2 eq.]	Submission 2013, [Gg CO_2 eq.]	Absolute difference	Relative difference, %
1990	9,10	9,10	0,00	0,00
1991	8,74	8,74	0,00	0,00
1992	8,30	8,30	0,00	0,00
1993	8,00	8,01	0,01	0,12
1994	7,50	7,50	0,00	0,00
1995	7,13	7,14	0,01	0,14
1996	6,77	6,77	0,00	0,00
1997	6,54	6,55	0,01	0,15
1998	6,25	6,26	0,01	0,16
1999	5,88	5,89	0,01	0,17
2000	5,52	5,53	0,01	0,18
2001	6,74	6,03	-0,71	-11,77
2002	9,22	8,15	-1,07	-13,13
2003	2,66	2,68	0,02	0,75
2004	4,04	4,07	0,03	0,74
2005	1,80	1,81	0,01	0,55
2006	2,09	2,11	0,02	0,95
2007	3,91	3,93	0,02	0,51
2008	4,41	4,44	0,03	0,68
2009	2,59	2,61	0,02	0,77
2010	1,64	1,67	0,03	1,80

Emissions of GHG CO_2 Gg eq. decreased due to split of fuel consumption between military and civil aviation sectors in 2001-2002.

3.4.1.6 Source-specific planned improvements

No improvements are planned.

3.4.2 Road transportation (1.A.3.b)

3.4.2.1 Source category description

Lithuania has a fairly well-developed road network provided with a dense road (1,270 km/km²) network (2011). There are 5.8 km of roads per 1,000 of population in Lithuania and 331 km of state roads per 1,000 km^2 of its territory. At the end of 2011, the length of roads amounted to 82.9 thous. km and, compared to 2010, increased by 0,9 %; the length of E-roads amounted to 1642 km, that of motorways – 309 km (Statistics Lithuania, 2012).

Road transportation is the most important emission source in the Transport sector. This sector includes all types of vehicles on roads (passenger cars, light duty vehicles, heavy duty trucks, buses, motorcycles, mopeds) (Table 3-40). The source category does not cover farm and forest tractors driving occasionally on the roads because they are included in other sectors as off-roads.

26.2 % of motorcycles, 14.3 % of passenger cars, 19.1 % of buses, 45.4 % of lorries and 66.8 5 of road tractors were produced up to 10 years ago.

Table 3-40. Number of vehicles in road transport sector by UNECE classification (thousands) (Passenger Cars-M1, Light Duty Vehicles-N1, Heavy Duty Vehicles-N2, N3, Urban Buses & Coaches-M2, M3, Two Wheelers-L1, L2, L3, L4, L5)

Year	L1, L2, L3, L4, L5	M1	N1, N2, N3, M2, M3	Total
1990	192,1	493,0	105,9	791,0
1991	181,2	530,8	114,0	826,0
1992	177,5	565,3	129,5	872,3
1993	180,5	609,1	106,4	896,0
1994	162,8	652,8	111,2	926,8
1995	19,2*	718,5	125,9	863,6
1996	19,4	785,1	104,8	909,3
1997	19,1	882,1	108,6	1009,8
1998	19,3	980,9	114,6	1114,8
1999	19,5	1089,3	112,2	1221,0
2000	19,8	1172,4	113,7	1305,9
2001	20,2	1133,5	115,6	1269,3
2002	21,0	1180,9	120,9	1322,8
2003	21,9	1256,9	126,1	1404,9
2004	22,9	1315,9	130,1	1468,9
2005	24,0	1455,3	137,3	1616,6
2006	25,5	1592,2	150,7	1768,4
2007	35,3	1587,9	161,6	1784,8
2008	45,6	1671,1	163,9	1880,6
2009	51,4	1695,3	159,7	1906,4
2010	56,3	1691,9	147,2	1895,4
2011	63,8	1747,6	193,6	2005,0

*Number of re-registered motorcycles

Greenhouse gas emissions from road transport decreased by 22,5% to 4.1 Tg CO_2 eq. during 1990 – 2010, that was 93,5% and 95,2% of the sector's emissions, respectively. GHG emissions from road transport comparing with 2010 decreased by 2% in 2011. This increase is primarily caused by a 15% decrease (1601 TJ) in gasoline fuel and liquefied petroleum gases – 4% (290 TJ) consumption by road transportation, while consumption of diesel oil increased by 721 TJ. The lowest emission level in the road transportation was achieved in 1994 because of the economic depression in Lithuania. Greenhouse gas emissions from transport sector amounted to 5,3 Tg CO_2 equivalent in 1990. The greenhouse gas emissions from the transport sector are summarised in Figure 3-25.

Table 3-41. Fuel consumption, [TJ]

Year	Motor gasoline	Transport diesel	LPG	Bioethanol*	Biodiesel*
1990	41840	29276	920	-	-
1991	47290	31868	690	-	-
1992	28568	22308	46	-	-
1993	22722	14872	322	-	-
1994	18547	9560	322	-	-
1995	25887	11133	1058	-	-
1996	28347	12398	1196	-	-
1997	28347	17725	1288	-	-
1998	27117	21254	1794	-	-
1999	21140	20450	3220	-	-
2000	16337	18366	5032	-	-
2001	16169	22127	5272	-	-
2002	15710	22977	6378	-	-
2003	15662	22772	7332	-	-
2004	14970	26595	8857	3	29
2005	14686	29262	9593	35	119
2006	15580	31753	9810	219	589
2007	18858	38798	9708	482	1762
2008	18631	39697	8615	656	1916
2009	15364	32128	7681	590	1581
2010	12405	36892	7554	436	1454
2011	10804	37613	7264	397	1481

Following the recommendation of ERT in 2010 of the individual review report, net calorific values (NCVs) used to convert fuel consumption in natural units into energy units are provided in the Table 3-42[8].

Table 3-42. Specific net calorific values for Road transportation (conversion factors)

Type of fuel	Tonne	Tonne of oil equivalent (TOE)	TJ/tonne
Liquefied petroleum gases	1,0	1,109	0,04642

*Carbon from biofuel is reported as a memo item but not included in national CO2 totals, as required by the IPCC Gudelines.

[8] IPCC 2006 Guidelines. Energy. Mobile Combustion. P. 3.16.

Motor gasoline	1,0	1,070	0,04479
Transport diesel	1,0	1,029	0,04307
Bioethanol	1,0	0,645	0,02700
Biodiesel (methyl ester)	1,0	0,884	0,03700

CO_2 emissions depend directly on fuel consumption[9]. From 2000-2007, these emissions increased, since growth in mileage travelled outweighed improvements in vehicle fuel consumption (Figure 3-13). Road traffic is an important source of N_2O from fuel combustion and from 1994-2007 emissions has increased in line with the increasing share of catalyst-controlled vehicles in the national fleet (exception 2000 when the consumption of motor gasoline was noticeably decreased). The use of liquefied petroleum gas is strongly influenced by the fluctuation of fuel prices.

Since 1990 the density of transport routes as well as the number of road vehicles has increased rapidly. Since 1995, the number of personal cars more than doubled (Table 3-40). 90% of the fuel in transportation sector is consumed by road transport.

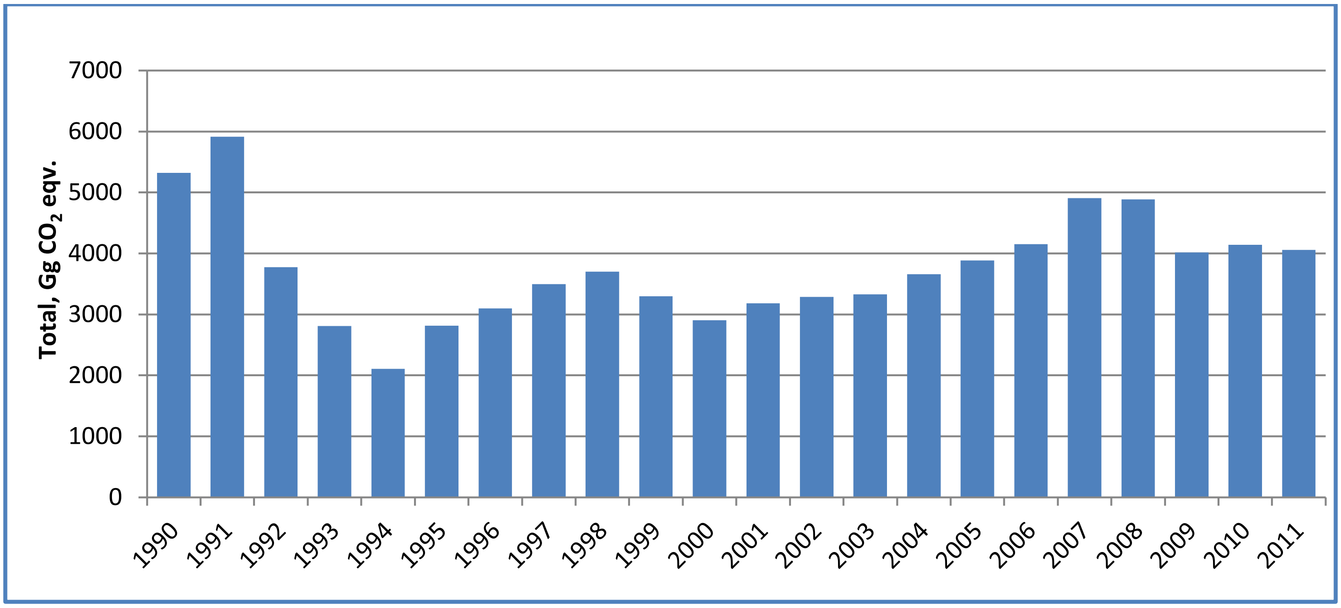

Figure 3-25. Development of greenhouse-gas emissions from road transport, Gg CO_2 eq. in 1990-2011

Bigger amount of passenger cars with petrol engines have catalysers installed. N_2O emissions result primarily from incomplete reduction of NO to N_2 in 3-way catalytic converters. N_2O emissions are dependent on driving cycle variables, catalyst composition, catalyst age, catalyst exposure to variable levels of sulfur compounds. They are not limited by law. Initially, growth in numbers of cars with catalytic converters caused increases in N_2O emissions in comparison to the 1990 level. Newer catalytic converters are optimized to produce only small amounts of N_2O. For this reason, the increasing trend in N_2O emissions that have been observed since 2000. The last two years, 2008 and 2009, emissions of N_2O have decreased. The effect of fuel sulfur is another important factor that can

[9] CO_2 emissions can be estimated from the mileage, however, it is usually best to estimate the total emissions from the fuel consumption (as this is the more reliable data) and then allocate this emission to the vehicle types by vehicle mileage data and relative fuel effiencies.

influence the formation of N_2O over the catalyst (Baronick *et al*., 2000). This is primarily due to a decrease in consumption of motor gasoline, but also because emission factors for petrol-driven vehicles have decreased substantially, reflecting the improved control of N_2O emissions (TNO, 2002; Riemersma et al., 2003) in more modern vehicles.

There is a marked switch from petrol engines to diesel. The number of petrol engines (all vehicles) has dropped between 1990 and 2011 (-54%), while the number of diesel engines has more than doubled from ~116 to 664 thousands for the same period.

3.4.2.2 Methodological issues

Emission estimations from road transportation are made using the *IPCC Guidance* 2006 Tier 2 method (for CO_2 emissions) and for CH_4 and N_2O emissions based on the COPERT IV (v9.0) model (best practice) which corresponds to the *IPCC Guidance* Tier 3 method. The country-specific and default emission factors of LPG were used for emission evaluation.

In order to apply the CORINAIR methodology the vehicle categories were broken down into so-called *vehicle layers* with the same emissions technology behavior, by type of fuel used, vehicle size (heavy duty trucks and buses by weight class, passenger cars and motorcycles by engine displacement) and pollution control equipment used, as defined by EU directives for emissions control ("EURO norms"), and by regional traffic distribution (urban, rural and highways). The classification of vehicles was done according to the UN-ECE. The main vehicle categories were allocated to the UNECE classification as follows:

Passenger Cars	M1
Light Duty Vehicles	N1
Heavy Duty Vehicles	N2, N3
Urban Buses & Coaches	M2, M3
Two Wheelers	L1, L2, L3, L4, L5

In the Tier 3 method, emissions are calculated using a combination of firm technical data and activity data. The activity data of road transport was split and filled in for a range of parameters including:
- Fuel consumed, quality of each fuel type;
- Emission controls fitted to vehicle in the fleet;
- Operating characteristics (e.g. average speed per vehicle type and per road)
- Types of roads;
- Maintenance;
- Fleet age distribution;
- Distance driven (mean trip distance), and
- Climate

The program calculates vehicle mileages, fuel consumption, exhaust gas emissions, evaporative emissions of the road traffic. The balances use the vehicle stock and functions of the km driven per vehicle and year to assess the total traffic volume of each vehicle category. The production year of vehicles in this category has been taken into account by introducing different classes, which either reflects legislative steps ('ECE', 'Euro') applicable to vehicles registered in each Member State. The technology mix in each particular year depends on the vehicle category and the activity dataset considered.

For the period between 1990 and 2006, it was necessary to estimate the figures with the aid of numerous assumptions. The total emissions were calculated by summing emissions from different sources, namely the thermally stabilized engine operation (hot) and the warming-up phase (cold start) (EEA 2000; MEET, 1999). For Tier 3 approaches cold start emissions were estimated:

$$E_{COLD;i,j} = \beta_{i,k} \times N_k \times M_k \times E_{HOT;i,k} \times (e_{COLD} / e_{HOT} \big|_{i,k} - 1) \,. \quad (1)$$

Where:

$E_{COLD;i,k}$ - cold start emissions of pollutant *i*(for the reference year), produced by vehicle technology *k*,

$\beta_{i,k}$ - fraction of mileage driven with a cold engine or the catalyst operated below the light-off temperature for pollutant *i* and vehicle [veh] technology *k*,

N_k - number of vehicle of technology *k* in circulation,

M_k - total mileage per vehicle [km veh^{-1}] in vehicle technology *k*,

e_{COLD}/e_{HOT} - cold/hot emission quotient for pollutant *i* and vehicle of *k* technology.

$$E_{TOTAL} = E_{HOT} + E_{COLD.} \quad (2)$$

where,

E_{TOTAL} - total emissions (g) of compound for the spatial and temporal resolution of the application,

E_{HOT} - emissions (g) during stabilized (hot) engine operation,

E_{COLD} - emissions (g) during transient thermal engine operation (cold start).

The *β*-parameter depends upon ambient temperature *ta* (for practical reasons the average monthly temperature was used).Since information on average trip length is not available for all vehicle classes, simplifications have been introduced for some vehicle categories. According to the available statistical data (André *et al*., 1998), a European value of 12,4 km has been established for the l_{trip} value and used in estimations in Lithuania.

Due to the fact that concentrations of some pollutants during the warming-up period are many times higher than during hot operation. In this respect, a distinction is made between urban, rural and highway driving modes. Cold-start emissions are attributed mainly to urban driving (and secondarily to rural driving), as it is expected that a limited number of trips start at highway conditions. Therefore, as far as driving conditions are concerned, total emissions were calculated by means of the equation:

$$E_{TOTAL} = E_{URBAN} + E_{RURAL} + E_{HIGHWAY\,.} \quad (3)$$

where:

E_{URBAN}, E_{RURAL} and $E_{HIGHWAY}$ - the total emissions (g) of any pollutant for the respective driving situations.

Fuel was distributed to transport categories, types, ecology standards and driving modes according to data taken from State Enterprise Transport and Road Research Institute under the Ministry of Transport and Communications of the Republic of Lithuania.

Emissions was estimated from the fuel consumed (represented by fuel sold) and the distance travelled by the vehicles. The first approach (fuel sold) was applied for CO_2 and the second (distance travelled by vehicle type and road type) for CH_4 and N_2O.

Emissions of CO_2 was calculated on the basis of the amount and type of fuel combusted (equal to the fuel sold) and its carbon content (*IPCC Guidance* 2006. Energy. Mobile Combustion. P. 3-10):

$$Emission = \sum [Fuel_a \cdot EF_a] \tag{4}$$

where:

Emission - emissions of CO_2, kg;
$Fuel_a$ -fuel sold, TJ;
EF_a - emission factor, kg/TJ. This is equal to the carbon content of the fuel multiplied by44/12;
a -type of fuel (petrol, diesel, natural gas).

Emission factor assumes full oxidation of the fuel.

Emission equation for CH_4 and N_2O for Tier 3 is:

$$Emission = \sum_{a,b,c,d} \left[Distance_{a,b,c,d} \cdot EF_{a,b,c,d}\right] + \sum_{a,b,c,d} C_{a,b,c,d} \ . \tag{5}$$

where:

Emission - emission of CH_4 or N_2O;
$EF_{a,b,c,d}$ - emission factor, kg/km;
$Distance_{a,b,c,d}$ - distance travelled during termally stabilized engine operation phase, km;
$C_{a,b,c,d}$ - emission during (g) during transient thermal engine operation (cold start), kg;
b – vehicle type;
c – emission control technology;
d – driving situation (urban, rural, highway).

Mileage data

The annual mileage driven by the stock of vehicle per year is an important parameter in emission calculation as it affects both the total emissions calculated but also the relative contributions of the vehicle types considered. Calculations demand annual mileage per vehicle technology and the number of vehicles was supplied by the Lithuanuan Road Administration and study funded by the European Commission – DG Environment and executed in collaboration with, KTI, Renault, E3M-Lab/NTUA, Oekopol, and EnviCon. The source for these data is various European measurement programmes. Fuel consumption was calculated on the basis of appropriate assumptions for annual mileage of the different vehicle categories can be balanced with available fuel statistics (Ntziachristos et al., 2008). In general the COPERT data are transformed into trip-speed dependent fuel consumption and emission factors for all vehicle categories and layers. The calculated fuel consumption in COPERT IV must equal the statistical fuel sale totals according to the UNFCCC and UNECE emissions reporting format. The statistical fuel sales for road transport are derived from the Statistics Lithuania.

For example, if a country has bulk fuel sold but does not have fuel use by vehicle type, they may allocate total fuel consumption across vehicle types based on the consumption patterns of their fleet (TRB's National Cooperative Highway Research Program (NCHRP) project report, Greenhouse Gas

Emission Inventory Methodologies for State Transportation Departments). By applying a trial-and-error approach, it was possible to reach acceptable estimates of mileage. For each group, the emissions was estimated by combining vehicle type and annual mileage with hot emission factors, cold/hot ratios and evaporation factors.

Emission factors

Country specific CO_2 EF was developed in 2010 based on research data from the Lithuanian oil refinery (research protocols of UAB ORLEN Lietuva Quality Research Center). Motor gasolines, diesel oil, LPG used in the country are produced by the oil refinery UAB ORLEN Lietuva. Imports of the fuels listed above comprise only a minor fraction of the fuels used in Lithuania.

All mileage depend emission factors for diesel and motor gasoline are listed in the EMEP/EEA Guidebook, 2009. Correction factors were applied to the baseline emission factors for gasoline cars and light-duty vehicles to account for different vehicle age (COPERT IV v9.0). It is assumed that emissions do not further degrade above 120 000 km for Euro 1 and Euro 2 vehicles, and above 160 000 km for Euro 3 and Euro 4 vehicles.

Following the remarks of the ERT, a review of emission factors for mobile sources was undertaken in 2010 (discussion and comparison with EF provided in the literature was presented in National Greenhouse Gas Emission Inventory Report 2010, covering the period 1990-2008). Emission factors for Road transportation used in the Lithuanian national GHG inventory are provided in Tables 3-43 – 3-45.

Table 3-43. CO_2 emission factors for Road transportation sector used in the Lithuanian GHG inventory

Fuel	**Emission factor [kg/GJ]**	**Source / Comments**
Motor gasoline	72,97	Country specific EF based on producer data (research protocols of UAB ORLEN Lietuva Quality Research Center)
Gas/Diesel oil	72,89	Country specific EF based on producer data (research protocols of UAB ORLEN Lietuva Quality Research Center)
LPG	65,42	Country specific EF based on producer data (research protocols of UAB ORLEN Lietuva Quality Research Center)
Biodiesel	70,8	2006 *IPCC Guidelines*
Bioethanol	70,8	2006 *IPCC Guidelines*

Table 3-44. CH_4 emission factors for Road transportation sector used in the Lithuanian GHG inventory

Fuel	**Emission factor [kg/TJ]**	**Source / Comments**
Biodiesel	10,0	2006 *IPCC Guidelines*
Bioethanol	10,0	2006 *IPCC Guidelines*

Table 3-45. N_2O emission factors for Road transportation sector used in the Lithuanian GHG inventory

Fuel	Emission factor, [kg/TJ]	Source / Comments
Biodiesel	0,6	2006 *IPCC Guidelines*
Bioethanol	0,6	2006 *IPCC Guidelines*

Because fuel prices in Lithuania are higher – significantly, in some cases – than in almost all of neighbours, for some time the fuels used in Lithuania have included fuels purchased in other countries and brought into the country as "grey" imports. At present, no precise data are available on this phenomenon, which is significant for truck and automobile traffic in country border regions and which is referred to as "refuelling tourism".

3.4.2.3 Uncertainties and time-series consistency

The activity data for fuels used in road transportation are very accurate due to accurate total fuel sales statistics. Uncertainty in the activity data is 2%. The uncertainty on activity data for CO_2 emissions from road transport is given in *IPCC GPG* 2000[10], where mentions that this is the main source of uncertainty for CO_2. The uncertainty in road transport CO_2 emission factor is estimated to be ±2%. The uncertainty in annual N_2O emissions from road transport is estimated to be ±50%. The estimated uncertainty of the CH_4 emissions from road transport is estimated to be ± 40%. The time series for all data have been studied carefully in search for outliers.

Emissions of N_2O are a function of many complex aspects of combustion and mileage dynamics as well as the type of emission control systems used. During the last decades the stock of Lithuanian diesel passenger cars and heavy-duty vehicles has intensively grown. In the period from 1990 to 2000 the number of diesel-powered vehicles was increased by about 13% per year. As was expected, the linear regression analysis did not provide statistically significant linear relationship between total diesel fuel consumption and N_2O IEF values for the reason that the variation from year to year between sub-sectors and technology differ due to changes in abatement technologies and mileage. For the period between 1990 and 2000, it was necessary to estimate the figures with the aid of numerous scientific assumptions regarding mileage distribution between subsectors. In conjunction with decreasing fuel consumption 1990-1994 the number of diesel powered vehicles was increased (for example, in 1992 the fuel consumption was sharply decreased by 26% while the number of diesel powered vehicles was increased by 13%). We had to make fuel correction by reduce/increase mileage from our initial calculations to match the statistical fuel consumption. The correction for fuel consumption within ± one standard deviation of the official value is very critical as it reduces the uncertainty of the calculation N_2O, conversely good knowledge of the statistical fuel consumption and comparison with the calculated fuel consumption was necessary to improve the quality of the inventory. The uncertainty in annual N_2O emissions from road transport is estimated to be ±50%.

Following in-country review ERT 2012 recommended providing justification of gasoline N_2O IEF fluctuation 2006-2008. Over 1990-2011 period the number of passenger cars (dominant gasoline consumers) increased despite the fact of economic crisis. Therefore, decreasing fuel consumption was balanced by mileage, although N_2O emission exceptionally differ according to the fuel sulphur level

[10]IPCC GPG 2000. Energy. P. 2-49.

(Fig. 3-26) since a regression line of nitrous oxide emission factors against mileage for passenger vehicles yielded a slight not significant slope (Barton and Simpson, 1994):

$$EF_{N2O} = (a\times Mj,k + b) \times EF_{BASE}, \quad (2)$$

where,

a, b, EF_{BASE} depend on technology level for gasoline PCs & LCVs
a, b depend on fuel sulfur content

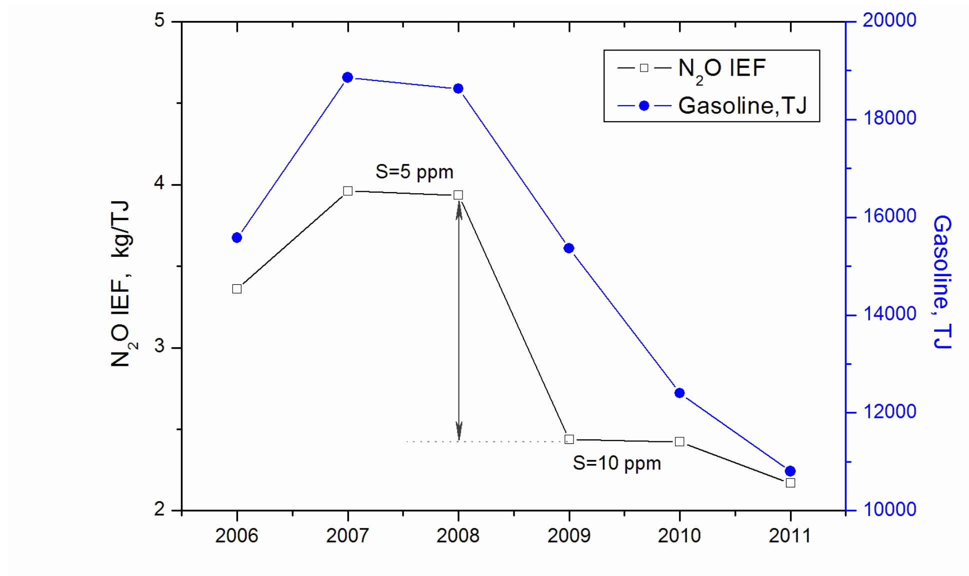

Figure 3-26. Dynamic of Implied Emission Factors of N_2O for gasoline

The fuel consumption slightly decreased in 2007-2011, however the amount of vehicles remain increasing. Lithuanian car fleet consists mainly of 16-20 year old cars (31,3 %) and younger than 10 years – 23,1 %. This means that one of the determining factors is the large proportion of petrol cars fitted with a three-way catalyst. The effect of fuel sulfur is another significant factor that influences the formation of N_2O over the catalyst (Baronick et al., 2000). Since January 2008, Lietuva group's company ORLEN started producing and supplying gasoline which already meets the EU requirements to be effective on January 1st, 2009 with sulfur content less than 10 ppm. The implementation of regulations reducing fuel sulfur levels across the EU in 2008 also reduced N_2O emissions for vehicles of all technology categories[11] .

3.4.2.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

[11] TNO, 2002; Riemersma et al., 2003

3.4.2.5 Source-specific recalculations

Emissions from *Road Transportation* have been recalculated for the entire time-series for this year submission, using the software COPERT IV version 10.0 (November, 2012). Changes with respect to the 2012 report year include recalculation of LPG CH_4 and N_2O at new Tier 3 method (Table3-46 – 3-48).

Table 3-46. Revised gasoline activity data for Road transport

Gasoline, TJ	Year	Submission 2012	Submission 2013
	2006	15433	15580
	2007	18587	18858
	2008	18251	18631
	2009	15293	15364
	2010	12396	12405

Table 3-47. Revised diesel oil activity data for Road transport

Diesel oil, TJ	Year	Submission 2012	Submission 2013
	1990	29276	29275,61
	1991	31530	31867,5
	1992	23187	22308
	1993	16794	14872
	1994	12532	9560
	1995	12316	11133
	1997	17731	17725
	1998	21158	21254
	1999	20448	20450
	2000	18365	18366
	2003	22769	22772
	2006	31787	31753
	2007	38872	38798
	2008	39547	39697
	2009	32199	32128
	2010	36746	36892

Table 3-48. Recalculated GHG emissions from Road Transportation

Year	Submission 2012 [Gg CO_2 eq.]	Submission 2013 [Gg CO_2 eq.]	Absolute difference	Relative difference [%]
1990	5322,73	5323,09	0,36	0,01
1991	5887,48	5916,02	28,55	0,48
1992	3840,42	3775,59	-64,82	-1,72
1993	2947,39	2807,50	-139,89	-4,98
1994	2322,94	2105,90	-217,04	-10,31
1995	2888,63	2815,31	-73,33	-2,60

1996	3096,34	3097,10	0,75	0,02
1997	3496,87	3497,66	0,79	0,02
1998	3690,16	3698,82	8,66	0,23
1999	3289,48	3294,76	5,28	0,16
2000	2900,37	2903,07	2,69	0,09
2001	3179,37	3183,63	4,26	0,13
2002	3279,97	3284,96	4,99	0,15
2003	3324,64	3330,41	5,77	0,17
2004	3654,57	3661,47	6,91	0,19
2005	3878,84	3886,46	7,62	0,20
2006	4135,87	4152,50	16,63	0,40
2007	4924,63	4907,98	-16,65	-0,34
2008	4841,74	4886,69	44,96	0,92
2009	4011,14	4016,87	5,73	0,14
2010	4123,73	4140,61	16,88	0,41

3.4.2.6 Source-specific planned improvements

Fuel consumption factors for road transport vehicles will be updated by the time when new data becomes available from COPERT model updates. Implementation of COPERT 4 10.0 version with a new subsector for very small (<0.8 l) gasoline and (<1.4 l) diesel passenger cars of Euro 4-6 technologies.

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

3.4.3.1 Source category description

Emissions of railway transportation comprise railway transport operated by diesel locomotives. In 2011 electric locomotives run only 0.7 % of railway transportation in Lithuania. Emissions from producing electricity used in electric trains are not included this category, but in category 1.A 1.

Lithuanian Railways (*Lithuanian*: "Lietuvos Geležinkeliai") is the national, state-owned railway company of Lithuania. Lithuanian's trains operate frequent services across the whole of Lithuania (Fig. 3-27).

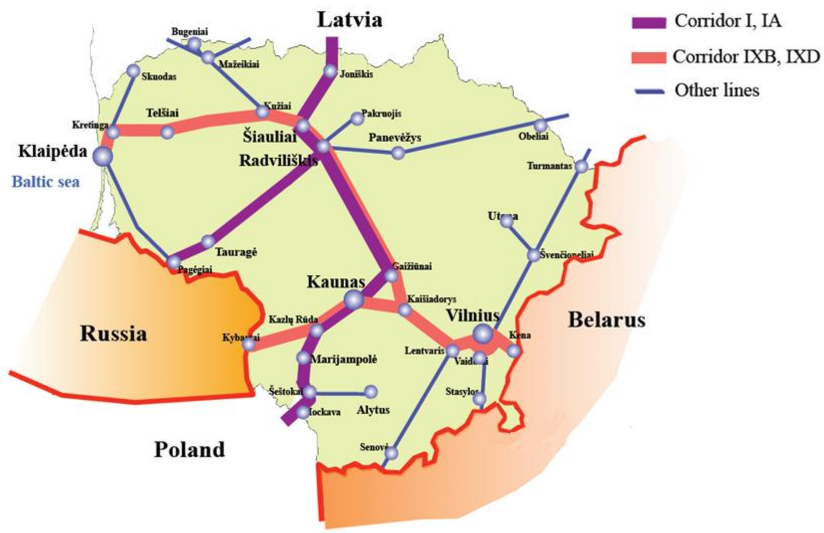

Figure 3-27. Lithuanian railways network

This sector concerns the movement of goods or people mostly by diesel locomotives. Most locomotives (79,7 %), 88,4 % of coaches (including diesel and electric railcars) and 91,3% of wagons were produced 15 years ago or even earlier.

In 2011, goods transport by rail amounted to 52.3 million tonnes, which is by 8.9 % more than in 2010. National goods transport by rail amounted to 15 million tonnes, which is by 6.6 % more than in 2010; international goods transport by rail amounted to 37.3 million tonnes, which is by 9.8 % than in 2010. In 2011, 32.5 % of all goods carried (17 million tonnes) were coke and refined petroleum products. Chemicals, chemical products and man-made fibres, rubber and plastic products, nuclear fuel carried amounted to 14 million tonnes, or 26.7 %, metal ores and other mining and quarrying products, peat, uranium and thorium – 5.3 million tonnes, or 10.2 %.

The major share of goods was carried from Belarus (64.4 %) and Russia (26.9 %). Most goods from Lithuania were carried to Latvia (21.4 %), Belarus (17.8 %), and Ukraine (16.2 %). Fuel consumption 1990-2011 for railways, based on energy statistics from Statistics Lithuania is shown in Figure 3-28.

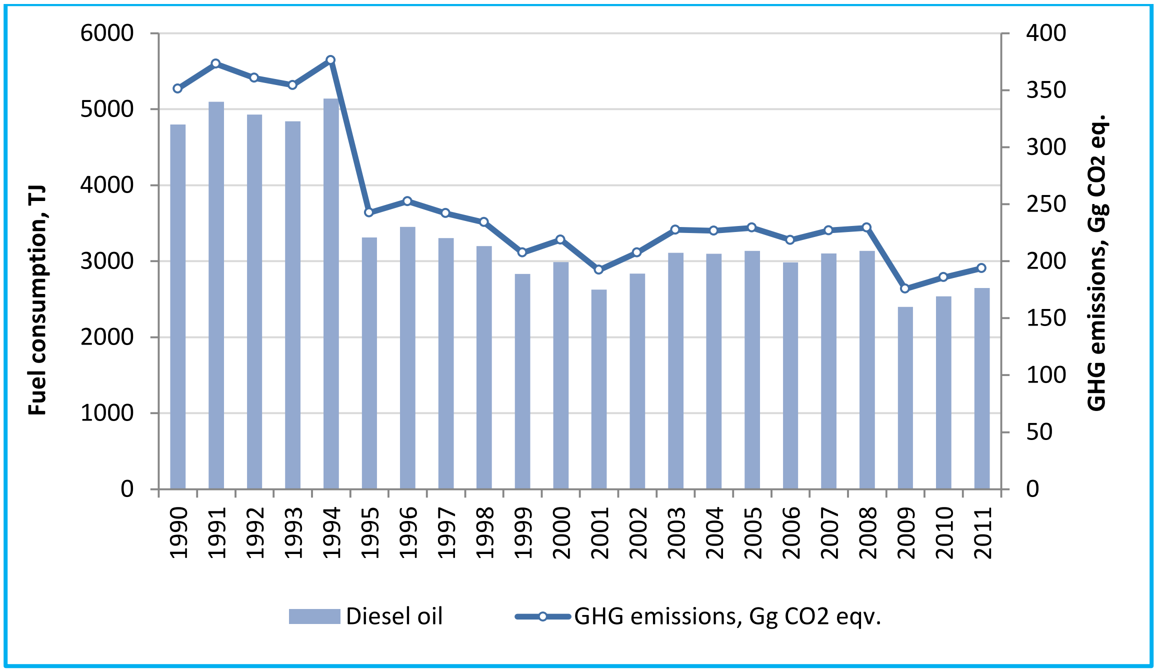

Figure 3-28. Trend of GHG emissions in *Railways* sector

The trend of Gg CO2 eq. emissions follows in general the fuel consumption trend in the railway transportation sector. The Lithuanian railway transport has suffered two obvious downturns within the last two decades, the first relating to Lithuania's separation from the Soviet Union and the second one – to the global financial and economic crisis.

3.4.3.2 Methodological issues

CO_2 emission calculations are based on the Tier 2 methodology with country specific emission factors and CH_4 and N_2O on default Tier 1 methodology (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual). Currently, the Tier 2 methodology for CH4 and N2O emissions will not be used throughout the lack of activity data. Emissions of railway transport sector are calculated by multiplying the statistical fuel consumption by respective emission factors assuming that for each fuel type the total fuel is consumed by a single locomotive type. Tier 2 uses equation (5) with country-specific data on the carbon content of the fuel (*IPCC Guidance* 2006. Energy. Mobile Combustion. P. 3.41):

$$Emission = \sum_j (Fuel_j \cdot EF_j)\,. \tag{6}$$

where:

Emission - emissions, kg;
Fuel$_j$ - fuel type *j* consumed (as represent by fuel sold), TJ;
EF$_j$ - emission factor for fuel type *j*, kg TJ^{-1};
j - fuel type.

Activity data

The data about fuel consumption of diesel are obtained from official statistics (Statistics Lithuania).

Emission factor

The emission factors used in the calculation of emissions from Railway transportation are presented in Table 3-49 – 3-51.

Table 3-49. CO_2 emission factors for Railways sector used in the Lithuanian GHG inventory

Fuel	Emission factor [kg/GJ]	Source / Comments
Diesel oil	72,89	Country specific EF based on producer data (research protocols of UAB ORLEN Lietuva Quality Research Center)

Table 3-50. CH_4 emission factors for Railways sector used in the Lithuanian GHG inventory

Fuel	Emission factor, [kg/TJ]	Source / Comments
Diesel oil	5,0	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual. 1.35. TABLE 1-7.

Table 3-51. N_2O emission factors for Railways sector used in the Lithuanian GHG inventory

Fuel	Emission factor, [kg/TJ]	Source / Comments
Diesel oil	0,6	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual. 1.36. TABLE 1-8.

Emissions from electricity used in electric trains are not included in this category, but in category 1.A 1. Emissions of railway transportation were 0,19 Tg (CO_2 eq.) in 2011, it was only 4,3% of the *Transport* sector emissions. The emissions were 0,35 Tg (CO_2 eq.) in 1990. Substantial decrease from the year 2008 is caused by the ongoing economic depression.

3.4.3.3 Uncertainties and time-series consistency

The uncertainty in activity data (fuel use) is 5%. Uncertainties in CH_4 and N_2O emission factors are larger than those in CO_2 (±5%). *IPCC Guidance* 2006 refers that the uncertainty range for the default factors for Tier 1 method is estimated to be +50%/-100%. The time series for all data have been studied carefully in search for outliers.

3.4.3.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

3.4.3.5 Source-specific recalculations

N_2O emissions were recalculated according to default emission factor by Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and new activity data from Statistics Lithuania (Table 3-52 – 3-53).

Table 3-52. Revised activity data for Railways

Diesel oil, TJ	Year	Submission 2012	Submission 2013
	1991	5193	5099
	1992	3819	4929
	1993	2766	4844
	1994	2064	5142
	1995	2028	3314
	1997	3300	3306
	1998	3198	3199
	1999	2836	2834
	2000	2992	2990
	2003	3111	3110

Table 3-53. Recalculated GHG emissions from Railways

Year	Submission 2012 [Gg CO_2 eq.]	Submission 2013 [Gg CO_2 eq.]	Absolute difference	Relative difference [%]
1990	354,91	351,37	-3,54	-1,00
1991	383,89	373,14	-10,75	-2,80
1992	282,32	360,71	78,39	27,77
1993	204,48	354,48	150,00	73,36
1994	152,58	376,30	223,72	146,62
1995	149,92	242,54	92,62	61,78
1996	255,04	252,47	-2,57	-1,01
1997	243,95	241,94	-2,01	-0,82
1998	236,41	234,11	-2,30	-0,97
1999	209,65	207,39	-2,26	-1,08
2000	221,18	218,81	-2,37	-1,07
2001	194,20	192,25	-1,95	-1,00
2002	209,65	207,54	-2,11	-1,01
2003	229,98	227,59	-2,39	-1,04
2004	228,95	226,64	-2,31	-1,01
2005	231,68	229,35	-2,33	-1,01
2006	220,74	218,52	-2,22	-1,01
2007	229,24	226,93	-2,31	-1,01
2008	231,68	229,35	-2,33	-1,01
2009	177,49	175,71	-1,78	-1,00
2010	187,77	185,88	-1,89	-1,01

3.4.3.6 Source-specific planned improvements

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

3.4.4 Water borne navigation (CRF 1.A.3.d)

Lithuania has ~900 km of inland waterways, of which ~477 km cargo and passengers. Inland waterways are navigable rivers, canals, lakes, man-made water bodies, and part of the Curonian Lagoon belonging to the Republic of Lithuania. Lenght of inland waterways regularly used for transport in Lithuania equalled 452 km in 2011. Transport of goods by inland waterways amounted to 1037,7 thous. tonnes in 2011. In 2011, compared to 2010, passenger transport by inland waterways decreased by 8.3 %.

As seen in Figure 3-29 fuel consumption increased by 5,4 % between 1990 and 2011. This increase is obviously due to the impact of the increased lenght of inland waterways and transport of goods (Statistics Lithuania, 2011; Eurostat).

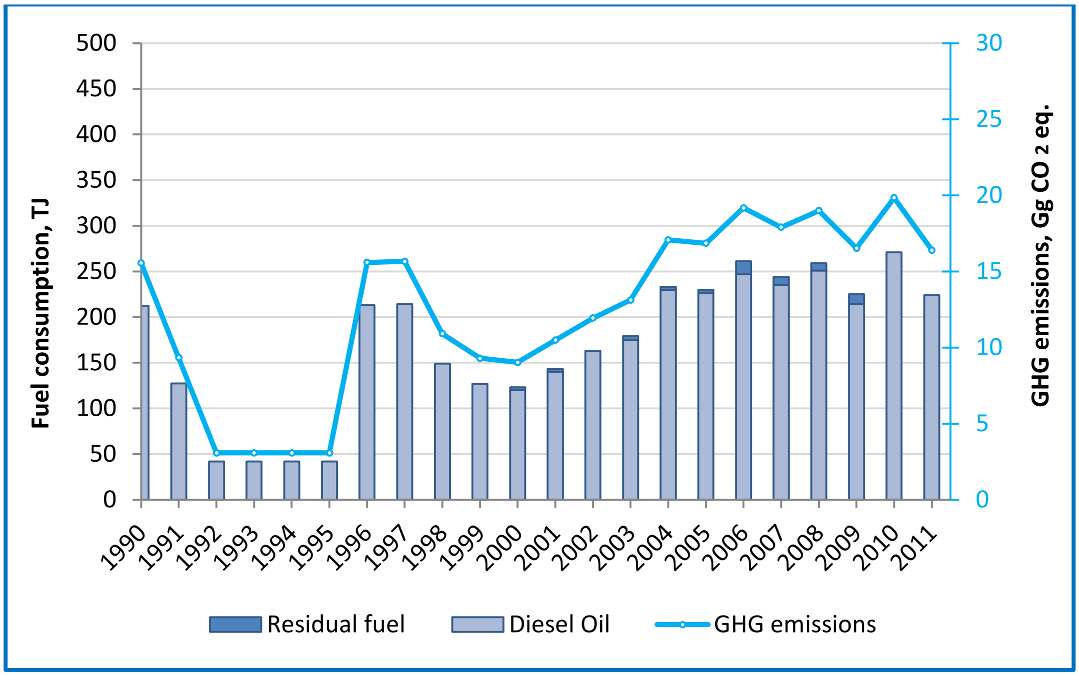

Figure 3-29. Trend of GHG emissions in *Water navigation* sector

3.4.4.1 Source category description

Inland waterways are navigable rivers, canals, lakes, man-made water bodies, and part of the Curonian Lagoon belonging to the Republic of Lithuania. Emissions of domestic navigation were 0,020 Tg (CO_2 eq.) in 2010, it was ~0.4% of the sector's emissions. Emissions were 0,016 Tg (CO_2 eq.) in 1990.

3.4.4.2 Methodological issues

Tier 1 method was applied with default and country specific (for CO_2 and CH_4) values (Tables 3-23-24). The existing default Tier 2 approach provided in the *IPCC Guidelines* provides only limited benefits over the Tier 1 approach:

$$Emission = \sum (FuelConsumed_{ab} \cdot EF_{ab}) . \quad (7)$$

where:

Emission - emissions, kg;

EF_j - emission factor for fuel type, kg TJ^{-1};

a - fuel type;

b - water-borne navigation type. At Tier 1 fuel used differentiation by type of vessel can be ignored) (*IPCC Guidelines* 2006. Energy. Mobile Combustion. P. 3.47).

Activity data

Data of fuel consumption are obtained from official statistics (Statistics Lithuania) excluding fishing vessels.

Emission factors

Emission factors used in the calculation of emissions from *Water-borne navigation* are presented in Tables 3-54 – 3-56.

Table 3-54. CO_2 emission factors for Water-borne navigation sector used in the Lithuanian GHG inventory

Fuel	Emission factor [kg/GJ]	Source / Comments
Residual Fuel Oil	77,60	Country specific EF based on "Greenhouse gas emissions characteristics of national energy sector" study, 2012
Gasoil and Diesel oil	72,89	Country specific EF based on producer data (research protocols of UAB ORLEN Lietuva Quality Research Center)

Table 3-55. CH_4 emission factors for Water-borne navigation sector used in the Lithuanian GHG inventory

Fuel	Emission factor, [kg/TJ]	Source / Comments
Residual Fuel Oil	5,0	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual. 1.35. TABLE 1-7.
Gasoil and Diesel oil	5,0	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual. 1.35. TABLE 1-7.

Table 3-56. N_2O emission factors for Water-borne navigation sector used in the Lithuanian GHG inventory

Fuel	Emission factor, [kg/TJ]	Source / Comments
Residual Fuel Oil	0,6	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual. 1.36. TABLE 1-8.
Gasoil and Diesel oil	0,6	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual. 1.36. TABLE 1-8.

3.4.4.3 Uncertainties and time-series consistency

The uncertainty in activity data (fuel use) is 5%. The uncertainty value of CO_2 is ± 3%. The uncertainty of the N_2O emission factor ± 140% and CH_4± 50% (2006 *IPCC Guidelines*).

3.4.4.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

3.4.4.5 Source-specific recalculations

Following in-country review ERT 2012 recommendations EF for CH_4 by Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories was applied. The data for the years 1990-2011 have been revised. These AD have been corrected in national energy balance by Statistics Lithuania (Table 3-57 – 3-58):

Table 3-57. Revised activity data for Water-borne navigation

	Year	Submission 2012	Submission 2013
Gasoil and Diesel oil, TJ	1990	212	212,45
	1991	371	127,47
	1992	273	42
	1993	198	42
	1994	148	42
	1995	145	42
	1998	246	149
	2000	119	120
	2003	177	175
	2010	235	271

Table 3-58. Recalculated GHG emissions from Water borne navigation

Year	Submission 2012 [Gg CO_2 eq.]	Submission 2013 [Gg CO_2 eq.]	Absolute difference	Relative difference [%]
1990	15,51	15,55	0,04	0,27
1991	27,13	9,33	-17,80	-190,78
1992	19,97	3,07	-16,90	-550,49
1993	14,48	3,07	-11,41	-371,66
1994	10,82	3,07	-7,75	-252,44
1995	10,61	3,07	-7,54	-245,60
1996	15,58	15,59	0,01	0,06
1997	15,65	15,66	0,01	0,06
1998	17,99	10,90	-7,09	-65,05
1999	9,29	9,29	0,00	0,00
2000	8,95	9,03	0,08	0,89
2001	10,48	10,49	0,01	0,10
2002	11,92	11,93	0,01	0,08
2003	13,27	13,13	-0,14	-1,07

2004	17,07	17,08	0,01	0,06
2005	16,86	16,87	0,01	0,06
2006	19,21	19,22	0,01	0,05
2007	17,92	17,93	0,01	0,06
2008	19,01	19,02	0,01	0,05
2009	16,55	16,56	0,01	0,06
2010	17,19	19,83	2,64	13,31

3.4.4.6 Source-specific planned improvements

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

3.4.5 Other (CRF 1.A.3.e; 1.A.5.b)

3.4.5.1 Natural gas transportation in pipelines (1.A.3.e)

In Lithuania, natural gas is transported via gas transmission and distribution systems (Fig. 3-29) Statistics Lithuania started collecting data on consummption of natural gas used for gas transportation in pipeline compressor staitions from 2001.

AB "Lietuvos Dujos" is the operator of Lithuania's natural gas transmission system in charge of the safe operation, maintenance and development of the system. The transmission system is comprised of gas transmission pipelines, gas compressor stations, gas metering and distribution stations (Table 3-59).

Table 3-59. Lithuanian natural gas transmission system

Gas transmission pipelines	**Gas distribution stations**	**Gas metering stations**	**Gas compressor stations**
1.9 thous. km	65 stations	3 stations	2 stations

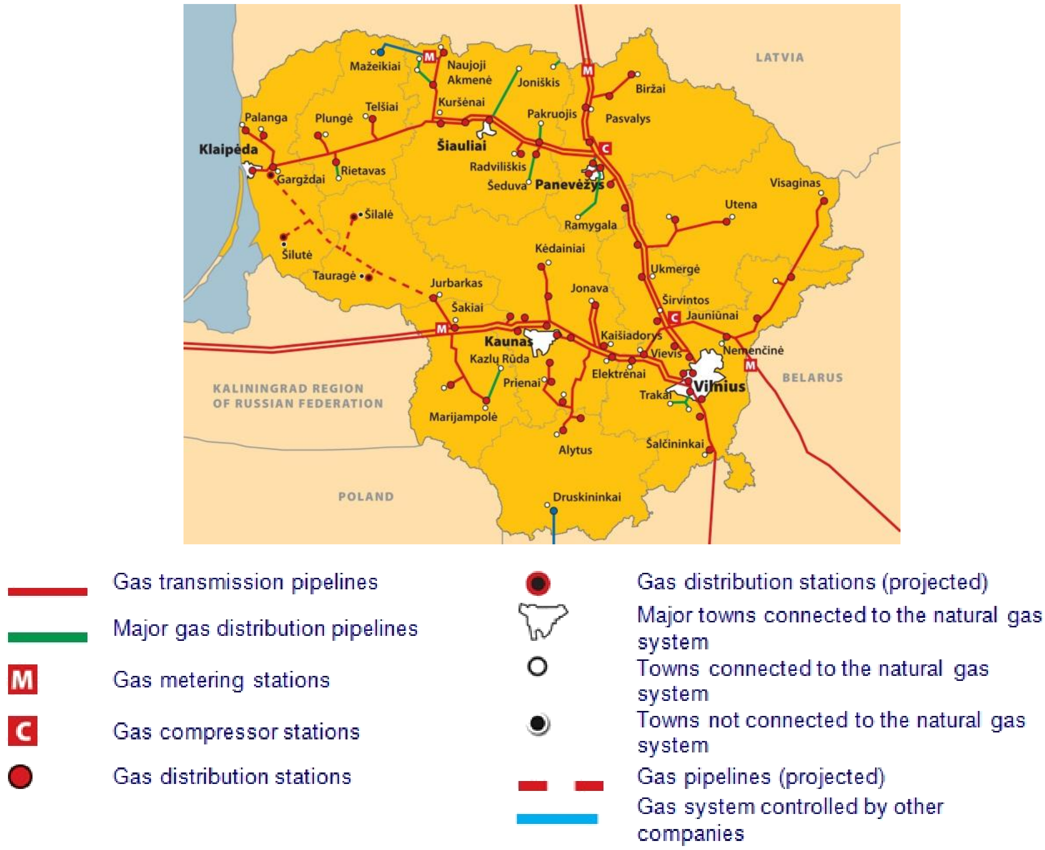

Figure 3-29. Gas distribution network in Lithuania

3.4.5.1.1 Source category description (1.A.3.e)

Transport via pipelines includes transport of gases via pipelines.

3.4.5.1.2 Methodological issues (1.A.3.e)

Activity Data

Statistics Lithuania has started collecting data on consumption of natural gas used for gas transportation in pipeline compressor stations from 2001. For the period prior to 2001 data on use of natural gas for transmission are not available.

The surrogate method to estimate unavailable data during 1990-2000 was used since the extrapolation approaches should not be done to long periods and inconsistent trend. To evaluate more accurate relationships the regression analysis was developed by relating emissions to more than one statistical parameter. The relationship between gas pipeline emissions and surrogate data was developed on the basis of underlying activity data during multiple years.

Emission factors

Emission factors used in the calculation of emissions from *Natural gas transportation in pipelines* are presented in Table 3-60 - 3-62.

Table 3-60. CO_2 emission factor for Natural gas transportation in pipelines sector used in the Lithuanian national GHG inventory

Fuel	Emission factor, [kg/TJ]	Source / Comments
Natural gas	0,06	Country specific emission factor have been developed on the basis of international experience, to which local circumstances have been applied, by scientist prof. B. Jaskelevicius and consultant P. Liuga who based themselves on emission factors developed by Danish, German and Slovak experts[12]2006 *IPCC Guidelines*

Table 3-61. CH_4 emission factor for Natural gas transportation in pipelines sector used in the Lithuanian GHG inventory

Fuel	Emission factor, [kg/TJ]	Source / Comments
Natural gas	5,0	*Revised 1996 IPCC Guidelines*

Table 3-62. N_2Oemission factor for Natural gas transportation in pipelines sector used in the Lithuanian national GHG inventory

Fuel	Emission factor, [kg/TJ]	Source / Comments
Natural gas	0,1	*Revised 1996 IPCC Guidelines* and *2006 IPCC Guidelines*

3.4.5.1.3 Uncertainties and time-series consistency

The uncertainty in activity data (fuel use) is 5%. CO_2 emission factor uncertainty is ±7% based on *IPCC 1996* Guidelines. The uncertainty of the N_2O and CH_4 emission factor is± 50% (2006 *IPCC Guidelines*).

3.4.5.1.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

3.4.5.1.5 Source-specific recalculations

Emissions for the 1990-2000 period using surrogate method were estimated for the first time in submission 2012.

3.4.5.1.6 Source-specific planned improvements

No improvements are planned.

[12] Jes Fenger, Jorgen Fenhann, Niels Kilde. Danish Budget for Greenhouse Gases Nord, 1990, Umweltpolitic. Klimaschutz in Deutschland. Zweiter Bericht der Regierung der Bundesrepublik Deutschland nach dem Rahmenũbereinkommen der Vereinten Nationen ũber Klimaänderungen. Bundesumweltminiisterium. Bundesumweltministerium fũr Umwelt, Naturschutz und Reaktorsicherheit. 1997; (2) Jiri Balajka. Estimating CO2 Emissions from Energy in Slovakia using the IPCC Reference Method. JDOJARAS, Vol. 99, No. 3-4, July-December, 1995).

3.4.5.2 Off-road vehicles and other machinery (1.A.3.E)

3.4.5.2.1 Source category description (1.A.3.e)

The off-road category includes vehicles and mobile machinery used within the agriculture, forestry, industry (including construction and maintenance), residential, and sectors, such as agricultural tractors, chain saws, forklifts, snowmobiles (2006 *IPCC Guidelines*).

3.4.5.2.2 Methodological issues

Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories Tier1 Sectoral approach was used to calculate GHG emissions from the 1.A.3.e sector.

Activity Data

Data on fuel consumption by off-road vehicles and machinery in industry, construction, agriculture, fishery and forestry are not collected separately and provided in statistical reports but included in overall fuel consumption by separate sectors (industry, construction, agriculture). Consumption of motor gasoline and diesel oil in these sectors as shown in energy balances provided by the Statistics Lithuania actually should be assigned to consumption by off-road machinery. Therefore consumption of motor gasoline and diesel oil can be separated from other fuels and emissions caused by off-road vehicles can be calculated from these data.

Emission factors

Emission factors for off-road vehicles and machinery sector used in the Lithuanian GHG inventory are provided in tables 3-63 – 3-65.

Table 3-63. CO_2emission factors for Off-road vehicles and other machinery sector used in the Lithuanian national GHG inventory

Fuel	Emission factor, [kg/TJ]	Source / Comments
Motor gasoline	72,97	Country specific EF based on producer data (research protocols of UAB ORLEN Lietuva Quality Research Center)
Diesel oil	72,89	Country specific EF based on producer data (research protocols of UAB ORLEN Lietuva Quality Research Center)

Table 3-64. CH_4emission factors for Off-road vehicles and other machinery sector used in the Lithuanian national GHG inventory

Fuel	Emission factor, [kg/TJ]	Source / Comments
Motor gasoline	5	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual. Table 1-7. p. 1.35
Diesel oil	5	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual. Table 1-7. p. 1.35

Table 3-65. N_2Oemission factors for Off-road vehicles and other machinery sector used in the Lithuanian national GHG inventory

Fuel	Emission factor, [kg/TJ]	Source / Comments
Motor gasoline	0,6	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual. 1.36. TABLE 1-8.
Diesel oil	0,6	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual. 1.36. TABLE 1-8.

3.4.5.2.3 Uncertainties and time-series consistency

GHG emissions from off-road sources are typically much smaller than those from road transportation, but activities in this category are diverse and are thus typically associated with higher uncertainties because of the additional uncertainty in activity data. Uncertainty in activity data is determined by the accuracy of the surveys 10%. The uncertainty estimate is likely to be dominated by the activity data. The uncertainty on CO_2 emission factor from off-road transport is given in *IPCC GPG* 2000 ±5%). The uncertainty in N_2O emission factor from off-road transport is estimated to be ±50% and CH_4 is estimated to be ±40%. The time series for all data have been studied carefully in search for outliers.

3.4.5.2.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

3.4.5.2.5 Source-specific recalculation

Following ERT 2012 recommendations IPCC 1996 EF for CH_4 and N_2O was applied (Table 3-66).

Table 3-66. Recalculated GHG emissions from Off-road transportation

Year	Submission 2012 [Gg CO_2 eq.]	Submission 2013 [Gg CO_2 eq.]	Absolute difference	Relative difference [%]
1990	1971,549	1772,396	-199,153	-11,236
1991	1491,597	1343,412	-148,185	-11,030
1992	1118,045	1006,678	-111,366	-11,063
1993	966,207	869,373	-96,834	-11,138
1994	914,106	822,684	-91,422	-11,113
1995	862,352	775,768	-86,584	-11,161
1996	563,232	508,514	-54,718	-10,760
1997	511,559	461,672	-49,888	-10,806
1998	452,251	408,912	-43,340	-10,599
1999	330,809	299,941	-30,867	-10,291
2000	254,429	230,258	-24,171	-10,497
2001	214,267	192,993	-21,274	-11,023
2002	213,801	192,480	-21,322	-11,078
2003	202,703	182,453	-20,250	-11,099
2004	205,939	185,306	-20,633	-11,135
2005	228,353	205,506	-22,847	-11,117

2006	215,455	193,869	-21,586	-11,134
2007	214,530	192,916	-21,613	-11,203
2008	219,941	197,820	-22,120	-11,182
2009	168,831	151,786	-17,045	-11,230
2010	175,057	157,273	-17,784	-11,308

3.4.5.2.6 Source-specific planned improvements

No improvements are planned.

3.4.5.3 Military aviation (1.A.5.b)

3.4.5.3.1 Source category description

Military activity is defined here as those activities using fuel purchased by or supplied to the military authorities of the country.

3.4.5.3.2 Methodological issues

The 2006 *IPCC Guidelines* Tier 1 approach has been applied. Emission factors for aviation sources used in the Lithuanian national GHG inventory are provided in Table 3-36, 3-37, 3-38. Country specific CO_2 EF was developed in 2010 based on research data from the Lithuanian oil refinery (research protocols of UAB ORLEN Lietuva Quality Research Center). Jet kerosene used in the country is produced by the oil refinery UAB ORLEN Lietuva.

Activity data

Statistical reports are based on information provided by the fuel suppliers. No statistical data are available for fuel consumption for military mobile sources.

Emission factors

Emission factors used in the calculation of emissions from *Civil aviation* transportation are presented in Tables 3-36 – 3-38.

3.4.5.3.3 Uncertainties and time-series consistency

Uncertainty in activity data of aviation fuel consumption in military aviation is ±2%. According to expert judgment, CO_2 emission factors for fuels are generally well determined as they are primarily dependent on the carbon content of the fuel (EPA, 2004). CO_2 emission factor (uncertainty 2%) was estimated according physical characterization of used fuels in country based on average NCV and emission factors of jet kerosene reported by ORLEN Lietuva. CH_4 emission factor used in estimation of emissions was taken from IPCC (2006) so uncertainty was assigned about ±100% and 150% for N_2O. The time series for all data have been studied carefully in search for outliers.

3.4.5.3.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

3.4.5.3.5 Source-specific recalculation

Country specific EF based on "Greenhouse gas emissions characteristics of national energy sector" study, 2012 for avgas CO_2 was applied. The default emission factor for CH_4 and N_2O was applied and new activity data from Statistics Lithuania was revised.

3.4.5.3.6 Source-specific planned improvements

No improvements are planned.

3.5 Other sectors (CRF 1.A.4)

3.5.1 Commercial/institutional (CRF 1.A.4.a)

3.5.1.1 Source category description

Commercial and institutional sector encompasses the following activities in Lithuania: wholesale and retail trade, maintenance of motor vehicle and motorbikes, repairing of household equipments, hotels and restaurants, financial intermediation, real estate management and rent, public management and defence, mandatory social security, education, health treatment and social work, other public, social and individual services, as well private households related activities. Analysis of the structure of value added has showed that commercial and institutional sector creates more than half of the total value added created in the country. Since 1995 the share has been annually increasing from 57,6% (1995) till 60,3% (2009). In 2011 the share of value added in commercial / institutional sector reduced till 59,5%. Retail, wholesale trade, real estate management and rent are the largest sectors prescribed to this category. With reference to data of 2011, they correspondingly made 17,2% and 6,3%.

3.5.1.2 Methodological issues

CO_2 emissions were calculated applying Tier 2, CH_4 and N_2O were calculated applying Tier 1 or Tier 2 (as presented in Table 3-64) based on equation 1 (see chapter 3.2.6).

Emission factors and methods

Emission factors and methods used in the calculation of emissions from Commercial/institutional sector (1.A.4.a) are presented in Table 3-67.

Table 3-67. Emission factors and methods for category Commercial/institutional sector (1.A.4.a)

Fuel	CO_2			CH_4			N_2O		
	CO_2, kg/GJ	EF	Method	CH_4, kg/TJ	EF	Method	N_2O, kg/TJ	EF	Method
Shale oil	77,40	CS	T2	10,0	D	T1	0,6	D	T1
Residual fuel oil	77,60	CS	T2	10,0	D	T1	0,6	D	T1
LPG	65,42	CS	T2	10,0	D	T1	0,6	D	T1
Gasoil	72,89	CS	T2	10,0	D	T1	0,6	D	T1
Peat	104,34	CS	T2	10,0	CS	T2	1,4	CS	T2
Coking coal	94,90	CS	T2	10,0	D	T1	1,4	D	T1
Lignite	101,20	CS	T2	10,0	D	T1	1,4	D	T1
Natural gas	55,23	CS	T2	5,0	D	T1	0,1	D	T1
Wood/ wood waste	109,90	CS	T2	300,0	D	T1	4,0	D	T1
Other solid biomass	109,90	CS	T2	300,0	D	T1	4,0	D	T1
Charcoal	109,90	CS	T2	200,0	D	T1	1,0	D	T1
Biogas	58,45	CS	T2	5,0	CS	T2	0,1	CS	T2

Abbreviations: CS - country specific emission factors were developed in August 2012 based on the results of the study "Determination of national GHG emission factors for energy sector" prepared by Lithuanian Energy Institute; D - default emission factors (1996 IPCC); T1 - Tier 1; T2 - Tier 2.

Activity data

For calculation of GHG emissions in category Commercial/ institutional sector (1.A.4.a) activity data had been obtained from the Lithuanian Statistics database (http://www.stat.gov.lt/lt/). Activity data are provided in the Annex III.

Tendencies of fuel consumption and total GHG emissions in Commercial / institutional sector is presented in Figure 3-30.

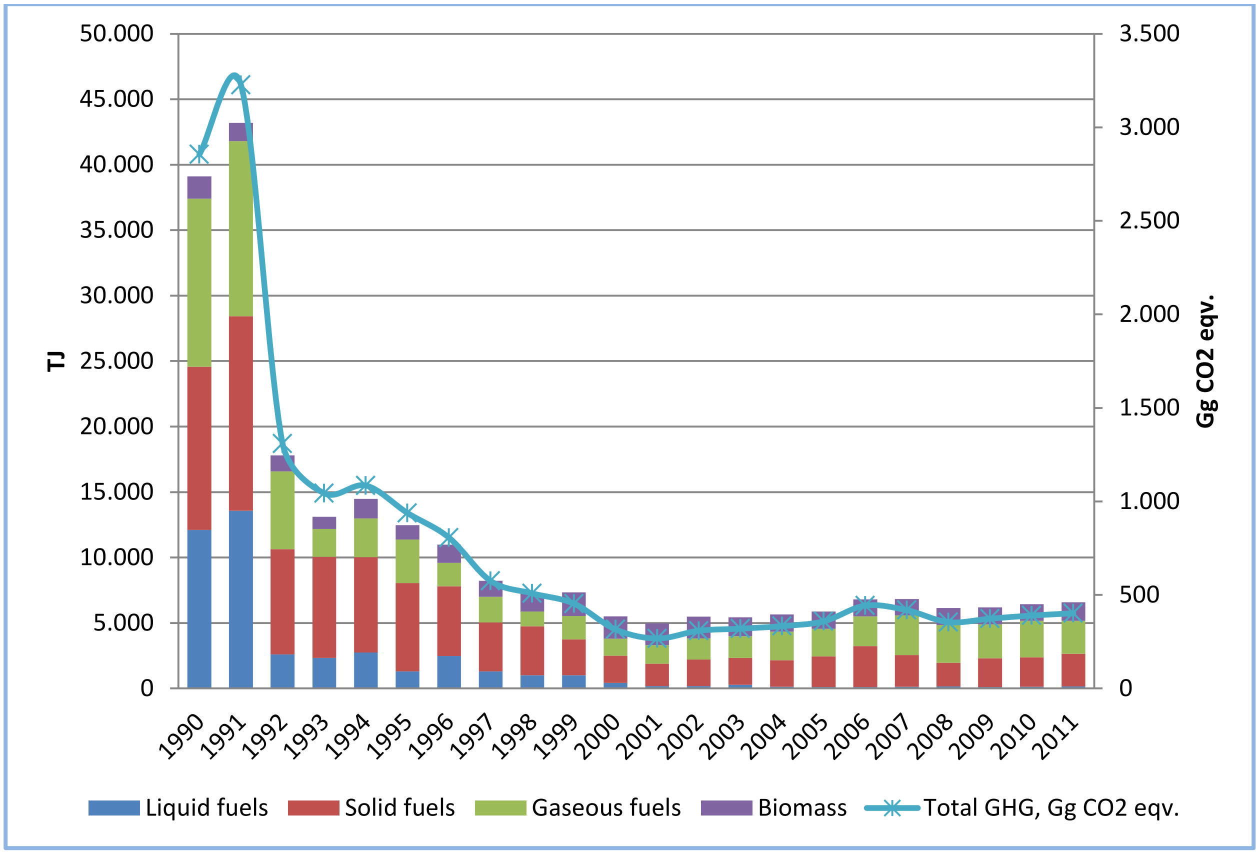

Figure 3-30. Tendencies of fuel consumption in Commercial / institutional sector during 1990-2011

After the drastically reduced fuel consumption volume in Commercial / institutional sector during 1990-2000, later (2001-2007) fuel consumption volumes was increasing by 5,5% a year. However, during the time of global economic crisis (2008-2009) fuel consumption volumes was further reduced by 4,8% a year. In 2011 there was consumed 6,6 PJ of fuel in Commercial / institutional sector. This was by 2,3% more than in 2010. In 2011, natural gas accounted 38,3% of fuel structure, solid fuels – 37,9%, biomass – 21,6% and liquid fuels – 2,2%.

In 2011, total GHG emissions from Commercial / institutional sector were even 7,1 times lower than in 1990 and amounted 401,8 Gg CO_2 eqv.

3.5.1.3 Uncertainties and time-series consistency

Uncertainty in activity data in Commercial/ institutional sector is ±2% taking into consideration recommendations provided by IPCC GPG 2000 and IPCC 2006 Guidelines for National GHG Inventories. Since data on biomass as fuel are not well developed as for fossil fuel, the uncertainty rage for biomass is ±50% as recommended by 2006 IPCC.

Uncertainties of CO_2 emission factors for liquid fuels (shale oil, residual fuel oil, LPG, and gasoil) and gaseous fuels (natural gas) are ±2,5% in Commercial / institutional sector. Uncertainties of CO_2 emission factors for solid fuels (peat, coking coal and lignite) are ±7%. Estimated uncertainties of CO_2 emission factors for biomass are ±50%. Uncertainties of all country specific CO_2 emission factors are derived in the study "Determination of national GHG emission factors for Lithuanian energy sector".

Uncertainties of CH_4 and N_2O emission factors for liquid, solid and gaseous fuels were assigned as very high about ±50%. Uncertainties were derived considering IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories 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. All emissions are estimated or reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.5.1.4 Source-specific QA/QC and verifications

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

The results are verified by calculating CO_2 emissions with the reference approach, and comparing results with the sectoral approach.

3.5.1.5 Source-specific recalculations

Following recalculations in this category has been done taking into account ERT recommendations:

- corrections of activity data of residual fuel oil, peat, coking coal and charcoal consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- addition of other solid biomass consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- correction of CO_2 emission factor for shale oil, residual fuel oil, peat, coking coal, natural gas, wood/wood waste, charcoal and biogas based on the country specific values that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- correction of N_2O emission factor for LPG and lignite based on default value provided in 1996 IPCC;
- correction of N_2O emission factor for peat based on the country specific value that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- corrections of CH_4 emission factors for LPG based on default value provided in 1996 IPCC.

Impact of these recalculations on GHG emissions from 1.A.4.a Commercial/institutional sector is presented in Table 3-68.

Table 3-68. Impact of recalculation on GHG emissions from 1.A.4.a Commercial/institutional sector

Year	Submission 2012, Gg CO2 eq.	Submission 2013, Gg CO2 eq.	Absolute difference, Gg CO2 eq.	Relative difference, %
1990	2920,2	2854,4	-65,8	-2,3
1991	3299,5	3226,6	-72,9	-2,2
1992	1329,3	1309,1	-20,3	-1,5
1993	1056,1	1043,4	-12,8	-1,2
1994	1100,5	1084,9	-15,6	-1,4
1995	948,9	938,0	-10,9	-1,2
1996	813,9	805,9	-8,0	-1,0

1997	581,5	574,5	-7,0	-1,2
1998	514,0	508,3	-5,7	-1,1
1999	460,5	453,6	-6,9	-1,5
2000	319,0	315,4	-3,6	-1,1
2001	270,2	267,2	-3,1	-1,1
2002	311,9	308,5	-3,4	-1,1
2003	323,3	319,6	-3,7	-1,1
2004	337,3	333,2	-4,1	-1,2
2005	362,4	358,5	-3,9	-1,1
2006	447,1	442,9	-4,2	-0,9
2007	415,4	418,4	3,0	0,7
2008	345,5	354,5	9,0	2,6
2009	393,0	373,1	-19,9	-5,1
2010	388,5	389,7	1,2	0,3

3.5.1.6 Source-specific planned improvements

Source-specific improvements are not planned.

3.5.2 Residential sector (CRF 1.A.4.b)

3.5.2.1 Source category description

The number of dwellings remains quite stable during last decade and on average there are 1,3 million dwellings in Lithuania. Increase of the number of dwellings in Lithuania depends very much on demographical situation in the country. Since 1992 the number of inhabitants has decreased in Lithuania. The useful floor area per each dwelling increases annually: in 2000, the average area of useful floor for each dwelling was 59,8 m^2, in 2011 – 66,3 m^2. With reference to data of 2011, 70% of all dwellings are situated in Lithuanian cities. This is because large multifamily buildings dominate in urban areas.

Taking into account actual heat consumption, Lithuanian District Heating Association grouped Lithuanian multifamily houses according to kWh/m^2 during a month into four categories:

- Multifamily houses of new construction and with high thermal isolation - 8 kWh/m^2/month
- Multifamily houses of old construction after full renovation - 15 kWh/m^2/month
- Multifamily houses of old construction and still not renovated - 25 kWh/m^2/month
- Multifamily houses of old construction and with poor thermal isolation - 35 kWh/m^2/month

90,8% of dwellings located in urban areas had central heating systems in 2009, while only 42,8% of Lithuanian dwellings set in rural territories can take advantage of this service. On average in 77% of Lithuanian dwellings piped water is installed, but only 62% can profit from convenience which hot water provides (Lithuanian Statistics, 2010).

3.5.2.2 Methodological issues

CO_2 emissions were calculated applying Tier 2, CH_4 and N_2O were calculated applying Tier 1 or Tier 2 (as presented in Table 3-67) based on equation 1 (see chapter 3.2.6).

Emission factors and methods

Emission factors and methods used in the calculation of emissions from Residential sector (1.A.4.b) are presented in Table 3-69.

Table 3-69. Emission factors and methods for category Residential sector (1.A.4.b)

Fuel	CO_2			CH_4			N_2O		
	CO_2, kg/GJ	EF	Method	CH_4, kg/TJ	EF	Method	N_2O, kg/TJ	EF	Method
Residual fuel oil	77,60	CS	T2	10,0	D	T1	0,6	D	T1
LPG	65,42	CS	T2	10,0	D	T1	0,1	D	T1
Gasoil	72,89	CS	T2	10,0	D	T1	0,6	D	T1
Peat	104,34	CS	T2	300,0	CS	T2	1,4	CS	T2
Coking coal	94,40	CS	T2	300,0	D	T1	1,4	D	T1
Lignite	101,20	CS	T2	300,0	D	T1	1,4	D	T1
Natural gas	55,23	CS	T2	5,0	D	T1	0,1	D	T1
Wood/ wood waste	109,90	CS	T2	300,0	D	T1	4,0	D	T1
Other solid biomass	109,90	CS	T2	300,0	D	T1	4,0	D	T1

Abbreviations: CS - country specific emission factors were developed in August 2012 based on the results of the study "Determination of national GHG emission factors for energy sector" prepared by Lithuanian Energy Institute; D - default emission factors (1996 IPCC); T1 - Tier 1; T2 - Tier 2.

Activity data

For calculation of GHG emissions in category Residential sector (1.A.4.b) activity data had been obtained from the Lithuanian Statistics database (http://www.stat.gov.lt/lt/). Activity data are provided in the Annex III.

Tendencies of fuel consumption and total GHG emissions in Residential sector are presented in Figure 3-31.

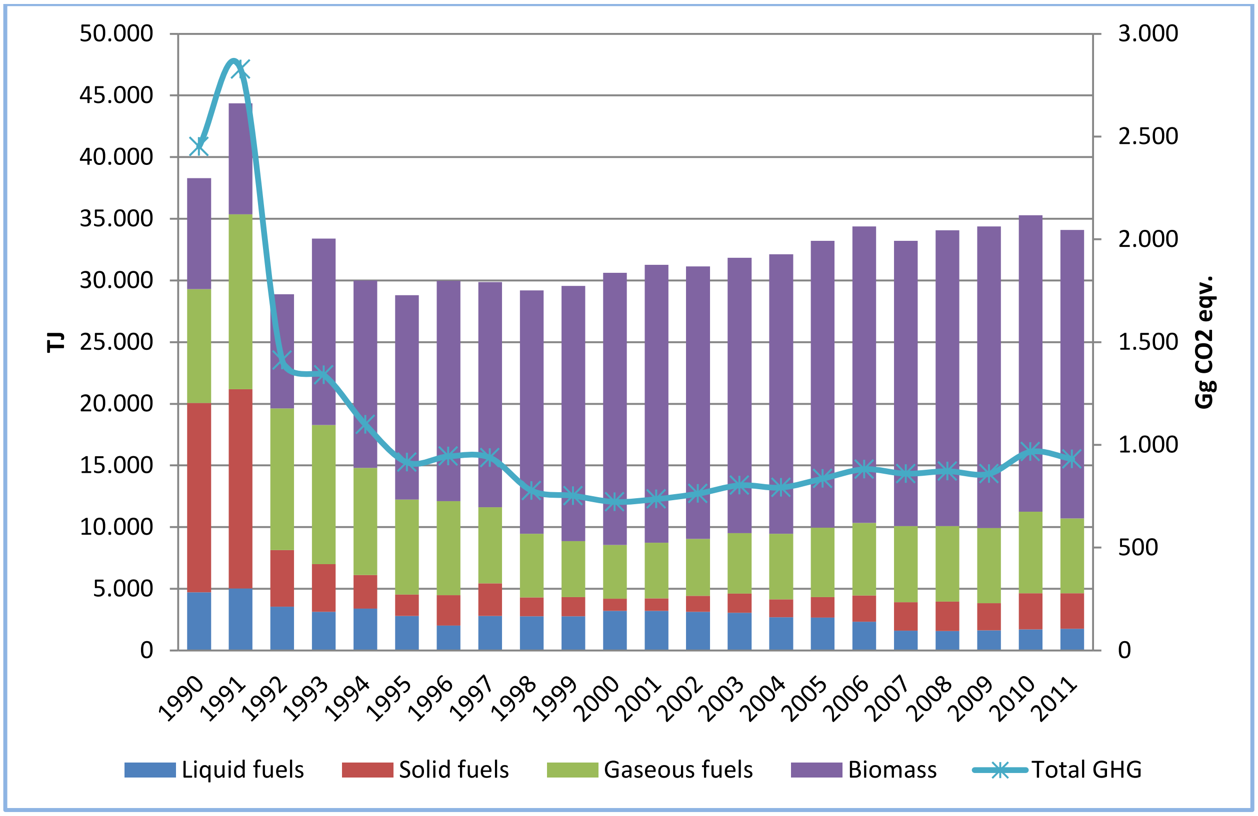

Figure 3-31. Tendencies of fuel consumption in Residential sector during 1990-2011

As it is seen from Figure 3-17, biomass dominates in the structure of fuel consumed in Residential sector. Biomass accounted 68,6%, natural gas - 17,8%, solid fuels - 8,5% of fuel structure in 2011. Natural gas volume has a tendency to increase by 3,1% a year. The share of liquid fuels is reducing and with reference to data of 2011, there were consumed 1,8 PJ (5,2% of fuel structure) of liquid fuels.

In 2011, total GHG emissions from Residential sector were 2,6 times lower than in 1990 and amounted 930,9 Gg CO_2 eqv.

3.5.2.3 Uncertainties and time-series consistency

Uncertainty in activity data in Residential sector is ±2% taking into consideration recommendations provided by IPCC GPG 2000 and IPCC 2006 Guidelines for National GHG Inventories. Since data on biomass as fuel are not well developed as for fossil fuel, the uncertainty rage for biomass is ±50% as recommended by 2006 IPCC.

Uncertainties of CO_2 emission factors for liquid fuels (residual fuel oil, LPG, and gasoil) and gaseous fuels (natural gas) are ±2,5% in Residential sector. Uncertainties of CO_2 emission factors for solid fuels (peat, coking coal and lignite) are ±7%. Estimated uncertainties of CO_2 emission factors for biomass are ±50%. Uncertainties of all country specific CO_2 emission factors are derived in the study "Determination of national GHG emission factors for Lithuanian energy sector".

Uncertainties of CH_4 and N_2O emission factors for liquid, solid and gaseous fuels were assigned as very high about ±50%. Uncertainties were derived considering IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories 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. All emissions are estimated or reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.5.2.4 Source-specific QA/QC and verifications

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

The results are verified by calculating CO_2 emissions with the reference approach, and comparing results with the sectoral approach.

3.5.2.5 Source-specific recalculations

Following recalculations in this category has been done:

- corrections of activity data of residual fuel oil, LPG, peat, coking coal and wood/wood waste consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- correction of CO_2 emission factor for residual fuel oil, peat, coking coal, natural gas, wood/wood waste and other solid biomass based on the country specific values that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- correction of N_2O emission factor for LPG and lignite based on default value provided in 1996 IPCC;
- correction of N_2O emission factor for peat based on the country specific value that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- corrections of CH_4 emission factors for LPG based on default value provided in 1996 IPCC.

Impact of these recalculations on GHG emissions from 1.A.4.b Residential sector is presented in Table 3-70.

Table 3-70. Impact of recalculations on GHG emissions from 1.A.4.b Residential sector

Year	Submission 2012, Gg CO2 eq.	Submission 2013, Gg CO2 eq.	Absolute difference, Gg CO2 eq.	Relative difference, %
1990	2556,8	2451,4	-105,4	-4,1
1991	2931,3	2827,6	-103,7	-3,5
1992	1472,0	1410,8	-61,2	-4,2
1993	1390,6	1339,9	-50,7	-3,6
1994	1183,3	1098,7	-84,6	-7,1
1995	943,7	914,7	-29,0	-3,1
1996	957,8	944,2	-13,6	-1,4
1997	948,3	937,1	-11,2	-1,2
1998	786,2	777,0	-9,2	-1,2

1999	760,7	752,5	-8,2	-1,1
2000	729,7	722,5	-7,2	-1,0
2001	743,6	736,2	-7,4	-1,0
2002	770,2	762,5	-7,8	-1,0
2003	811,7	803,2	-8,5	-1,0
2004	801,7	792,5	-9,2	-1,1
2005	845,9	835,9	-10,0	-1,2
2006	892,1	881,5	-10,6	-1,2
2007	853,5	859,9	6,4	0,8
2008	850,5	871,7	21,2	2,5
2009	792,0	859,1	67,1	8,5
2010	933,6	966,3	32,8	3,5

3.5.2.6 Source-specific planned improvements

Source-specific improvements are not planned.

3.5.3 Agriculture/forestry/fisheries sector (CRF 1.A.4.c)

3.5.3.1 Source category description

Agricultural, forestry and fisheries sector has developed at very moderate rates in Lithuania during 1995-2008. Value added created has been increasing by 1,0% a year. The global economic crisis adjusted growth rates at a negative direction. i.e. value added has decreased by 6,8% in 2010. Value added in agricultural, forestry and fisheries sector increased by 7,2% in 2011.

3.5.3.2 Methodological issues

CO_2 emissions were calculated applying Tier 2, CH_4 and N_2O were calculated applying Tier 1 or Tier 2 (as presented in Table 3-68) based on equation 1 (see chapter 3.2.6).

Emission factors and methods

Emission factors and methods used in the calculation of emissions from Agriculture/forestry/fisheries sector (1.A.4.c) are presented in Table 3-71.

Table 3-71. Emission factors and methods for category Agriculture/forestry/fisheries sector (1.A.4.c)

Fuel	CO_2			CH_4			N_2O		
	CO_2, kg/GJ	EF	Method	CH_4, kg/TJ	EF	Method	N_2O, kg/TJ	EF	Method
Shale oil	77,40	CS	T2	10,0	D	T1	0,6	D	T1
Residual fuel oil	77,60	CS	T2	10,0	D	T1	0,6	D	T1
LPG	65,42	CS	T2	10,0	D	T1	0,6	D	T1

Gasoil	72,89	CS	T2	10,0	D	T1	0,6	D	T1
Peat	104,34	CS	T2	300,0	CS	T2	1,4	CS	T2
Coking coal	94,90	CS	T2	300,0	D	T1	1,4	D	T1
Natural gas	55,23	CS	T2	5,0	D	T1	0,1	D	T1
Wood/ wood waste	109,90	CS	T2	300,0	D	T1	4,0	D	T1
Other solid biomass	109,90	CS	T2	300,0	D	T1	4,0	D	T1
Biogas	58,45	CS	T2	5,0	CS	T2	0,1	CS	T2

Abbreviations: CS - country specific emission factors were developed in August 2012 based on the results of the study "Determination of national GHG emission factors for energy sector" prepared by Lithuanian Energy Institute; D - default emission factors (1996 IPCC); T1 - Tier 1; T2 - Tier 2.

Activity data

For calculation of GHG emissions in category Agriculture/forestry/fisheries sector (1.A.4.c) activity data had been obtained from the Lithuanian Statistics database (http://www.stat.gov.lt/lt/). Activity data are provided in the Annex III.

Tendencies of fuel consumed and total GHG emission in Agriculture/forestry/fisheries sector are presented in Figure 3-32.

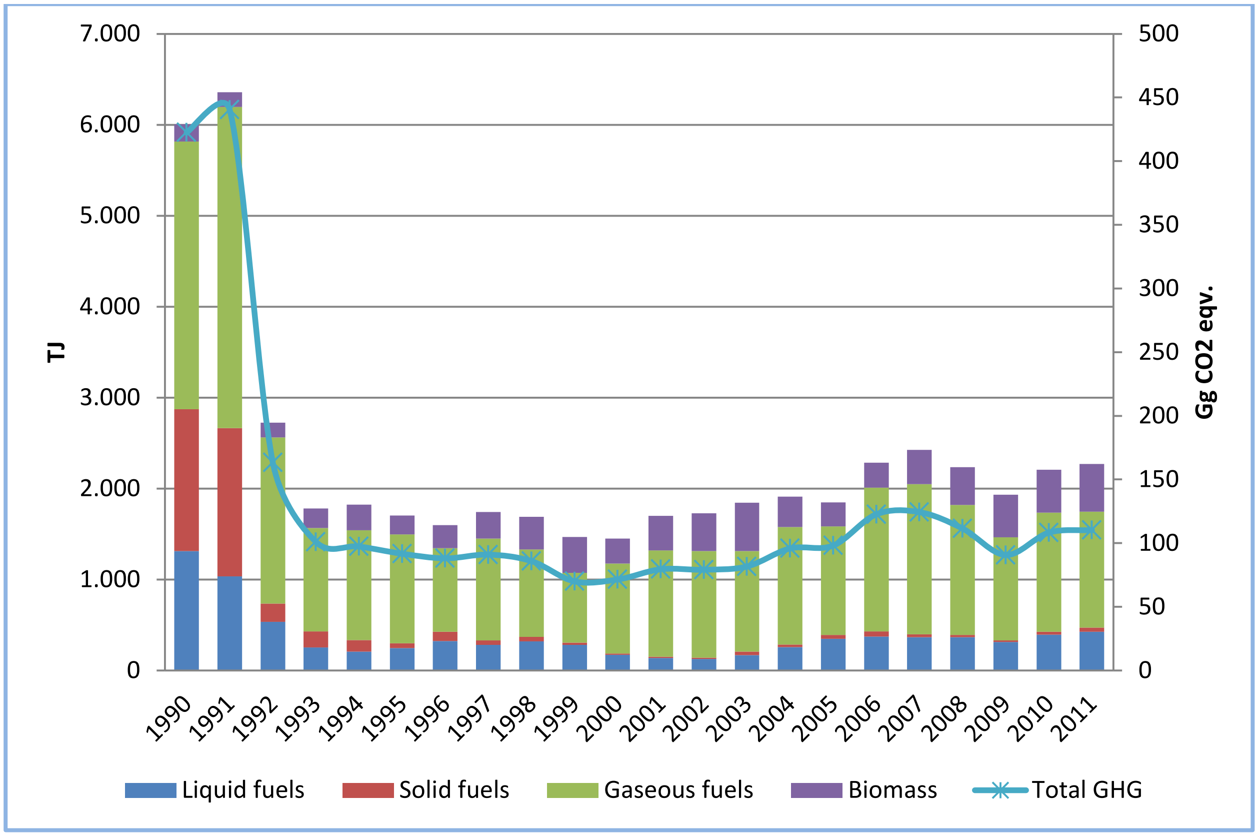

Figure 3-32. Tendencies of fuel consumed and total GHG emissions in Agriculture/forestry/fisheries sector during 1990-2011

Figure 3-32 showed that during the rapid economy development period (2000-2007) fuel consumption had a tendency to increase by 7,6% a year. During the time of global economic crisis (2008-2009) fuel consumption in Agriculture/forestry/fisheries sector reduced by 10,8%. Since 2010 fuel consumption increased by 8,4%. Natural gas made the largest share in the structure of fuel – 56,1%. The share of biomass was 23,1%, liquid fuel – 18,8 and solid fuel – 2%.

In 2011, total GHG emissions from Agriculture/forestry/fisheries sector were 3,8 times lower than in 1990 and amounted 110,3 Gg CO_2 eqv.

3.5.3.3 Uncertainties and time-series consistency

Uncertainty in activity data in Agriculture/forestry/fisheries sector is ±2% taking into consideration recommendations provided by IPCC GPG 2000 and IPCC 2006 Guidelines for National GHG Inventories. Since data on biomass as fuel are not well developed as for fossil fuel, the uncertainty rage for biomass is ±50% as recommended by 2006 IPCC.

Uncertainties of CO_2 emission factors for liquid fuels (shale oil, residual fuel oil, LPG, and gasoil) and gaseous fuels (natural gas) are ±2,5% in Agriculture/forestry/fisheries sector. Uncertainties of CO_2 emission factors for solid fuels (peat, coking coal) are ±7%. Estimated uncertainties of CO_2 emission factors for biomass are ±50%. Uncertainties of all country specific CO_2 emission factors are derived in the study "Determination of national GHG emission factors for Lithuanian energy sector".

Uncertainties of CH_4 and N_2O emission factors for liquid, solid and gaseous fuels were assigned as very high about ±50%. Uncertainties were derived considering IPCC Good Practice Guidance and Uncertainty Management in National GHG Inventories 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. All emissions are estimated or reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.5.3.4 Source-specific QA/QC and verifications

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

The results are verified by calculating CO_2 emissions with the reference approach, and comparing results with the sectoral approach.

3.5.3.5 Source-specific recalculations

Following recalculations in this category has been done:

- corrections of activity data of residual fuel oil, peat and biogas consumption based on the newest statistical information provided by Lithuanian Statistics in November 2012;
- correction of CO_2 emission factor for shale oil, residual fuel oil, peat, coking coal, natural gas, wood/wood waste, other solid biomass and biogas based on the country specific values that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- correction of N_2O emission factor for LPG based on default value provided in 1996 IPCC;
- correction of N_2O emission factor for peat based on the country specific value that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- corrections of CH_4 emission factors for LPG based on default value provided in 1996 IPCC.

Impact of these recalculations on GHG emissions from 1.A.4.c Agriculture/forestry/fisheries sector is presented in Table 3-72.

Table 3-72. Impact of recalculations on GHG emissions from 1.A.4.c Agriculture/forestry/fisheries sector

Year	Submission 2012, Gg CO2 eq.	Submission 2013, Gg CO2 eq.	Absolute difference, Gg CO2 eq.	Relative difference, %
1990	431,5	422,4	-9,0	-2,1
1991	449,3	440,3	-9,0	-2,0
1992	168,0	163,3	-4,7	-2,8
1993	103,6	101,0	-2,6	-2,5
1994	100,0	97,4	-2,6	-2,6
1995	94,4	91,7	-2,7	-2,9
1996	90,6	88,0	-2,6	-2,8
1997	93,7	91,0	-2,8	-2,9
1998	88,6	85,9	-2,8	-3,1
1999	72,3	69,9	-2,3	-3,2
2000	73,6	71,4	-2,1	-2,9

2001	81,9	79,5	-2,4	-2,9
2002	81,4	79,1	-2,3	-2,9
2003	83,9	81,7	-2,2	-2,6
2004	98,2	95,8	-2,4	-2,4
2005	99,6	98,1	-1,5	-1,5
2006	125,5	122,6	-2,8	-2,3
2007	127,3	124,3	-3,0	-2,3
2008	114,0	111,5	-2,5	-2,2
2009	92,5	90,7	-1,9	-2,0
2010	108,9	108,2	-0,7	-0,6

3.5.3.6 Source-specific planned improvements

Source-specific improvements are not planned.

3.5.4 Other stationary (CRF 1.A.5.a)

Data on fuel consumption for military stationary combustion are not available. The statistical reports are based on information provided by the fuel suppliers therefore data on fuel used for military stationary combustion is included in Commercial/institutional category. Emissions are reported as "IE", i.e. emissions from military stationary combustion (1.A.5.a) are included in Commercial/institutional category (1.A.4.a).

3.6 Fugitive emissions (CRF 1.B)

3.6.1 Fugitive emissions from solid fuels (CRF 1.B.1)

There are no mining activities in Lithuania and hence no fugitive emissions from coal mines occur. All emissions are reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.6.2 Oil and natural gas (CRF 1.B.2)

3.6.2.1 Source category description

Fugitive emissions from oil and natural gas activities include all emissions from the exploration, production, processing, transport, and use of oil and natural gas and from non-productive combustion. Fugitive emissions consist mainly of emissions of methane, carbon dioxide and nitrous oxide.

3.6.2.2 Methodological issues

GHG emissions were calculated applying a Tier 1. The application of a Tier 1 is done using equation presented below:

$$E_{oil,gas\,industry segment} = A_{industry segment} \cdot EF_{industry segmentl}$$

where:

$E_{oil,gas\,industry segment}$ - annual emissions, Gg;

$A_{industrysegment}$ - activity value, units of activity;

$EF_{industrysegmentl}$ - emission factor, Gg/unit of activity.

Emissions from natural gas distribution were calculated by using emission factors provided in the IPCC GPG 2000-table 3-28 and based on pipeline length. As noted in the IPCC GPG (p. 2.84), "fugitive emissions from gas transmission and distribution systems do not correlate well with throughput, and are better related to lengths of pipeline". It should be assumed that emissions from natural gas distribution cover emissions at residential and commercial sectors and in industrial plants and power stations. Therefore these emissions were not calculated separately and marked with notation key "IE".

Emission from natural gas storage was not estimated due to there are no natural gas storage facilities in Lithuania. Lithuania uses storage facilities located in Latvia.

Emission factors

Emission factors used in the calculation of fugitive emissions from oil and natural gas systems (1.B.2) are presented in Table 3-73. As country-specific emission factors are not available, emissions of CH_4 and CO_2 from natural gas distribution and transmission were calculated using default emission factors provided in IPCC GPG 2000.

Table 3-73. Emission factors for fugitive emissions from oil and natural gas systems (1.B.2), kg/TJ

Category	Subcategory	Emission type	Emission factors			Units of measure
			CH_4	CO_2	N_2O	
Wells	Drilling	All	4,3E-07	2,8E-08	0	Gg per number of wells drilled
	Testing	All	2,7E-04	5,7E-03	6,8E-08	Gg per number of wells drilled
	Servicing	All	6,4E-05	4,8E-07	0	Gg/yr per number of producing and capable wells
Gas transmission	All	Fugitive	2,5E-03	1,6E-05	0	Gg per year per km of transmission pipeline
		Venting	1,0E-03	8,5E-06	0	Gg per year per km of transmission pipeline
Gas distribution	All	All	6,15E-04	0	0	Gg per year per km of transmission pipeline
Oil production	Conventional oil	Fugitives	1,45E-03	2,7E-04	0	Gg per 10^3 m^3 conventional oil production
		Venting	138,1E-05	1,2E-05	0	Gg per 10^3 m^3 conventional oil production
		Flaring	13,75E-05	6,7E-02	6,4E-07	Gg per 10^3 m^3 conventional oil

						production
Oil transport	Pipelines	All	5,4E-06	4,9E-07	0	Gg per 10^3 m^3 oil transported by pipeline
Crude oil refining	All	All	745	0	0	Kg per PJ oil refined

Activity data

Activity data have been obtained from various sources: oil production and refining data from the Lithuanian Statistics database (see Annex III), number of drilling, testing, servicing wells from the Lithuanian Geological Survey, length of transmission and distribution pipelines from UAB Lietuvos dujos (http://www.dujos.lt/). In addition to energy balance the data on transportation of crude oil and oil products in pipelines from database of the Lithuanian Statistics[13] have been used.

3.6.2.3 Uncertainties and time-series consistency

Uncertainty in activity data for fugitive emissions is ±5% taking into consideration recommendations provided by IPCC 2006 Guidelines for National GHG Inventories.

CO_2, CH_4 and N_2O emission factors used in estimation of emissions were taken from IPCC GPG 2000 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. All emissions are estimated or reported as not occurring/not applicable therefore there are no "not estimated" sectors.

3.6.2.4 Source-specific QA/QC and verifications

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

3.6.2.5 Source-specific recalculations

For this category following recalculations has been done:

- corrections of activity data of oil production, oil transportation and oil refined based on the newest statistical information provided by Lithuanian Statistics in November 2012.
- Emissions from natural gas transmission and distribution were allocated under 1.B.2.D Other in the previous submission. Taking into consideration comment provided by the ERT during review week fugitive emissions were reallocated to the appropriate category (1.B.2.B) in accordance with the IPCC good practice guidance in this submission. Reallocation of emissions did not have impact on total GHG emissions.

The impact of this recalculations on total fugitive GHG emissions from oil and natural gas sector (1.B.2) for 1990-2010 period is insignificant as presented in Table 3-74.

[13] http://www.stat.gov.lt

Table 3-74. Impact of recalculations on GHG emissions from 1.B.2 Oil and natural gas sector

Year	Submission 2012, Gg CO2 eq.	Submission 2013, Gg CO2 eq.	Absolute difference, Gg CO2 eq.	Relative difference, %
1990	150,4	150,4	-0,1	-0,1
1991	159,5	159,4	-0,1	-0,1
1992	160,9	159,9	-1,0	-0,6
1993	168,6	168,5	-0,2	-0,1
1994	177,3	177,2	-0,2	-0,1
1995	191,9	191,9	0,0	0,0
1996	199,9	199,3	-0,6	-0,3
1997	215,6	214,8	-0,9	-0,4
1998	238,6	238,2	-0,4	-0,2
1999	233,4	232,4	-0,9	-0,4
2000	250,2	248,9	-1,3	-0,5
2001	279,6	277,4	-2,2	-0,8
2002	274,1	272,1	-2,0	-0,7
2003	269,1	267,5	-1,6	-0,6
2004	259,3	258,3	-1,0	-0,4
2005	263,4	262,9	-0,5	-0,2
2006	262,2	261,1	-1,0	-0,4
2007	258,9	258,1	-0,9	-0,3
2008	262,7	262,0	-0,7	-0,3
2009	269,8	269,2	-0,7	-0,2
2010	270,5	269,8	-0,6	-0,2

3.6.2.6 Source-specific planned improvements

Source-specific improvements are not planned.

3.7 Comparison of the verified CO_2 emission in GHG Registry and NIR

The Lithuanian Greenhouse Gas Emission Allowance Registry was established in 2005 and re-established as the State Greenhouse Gas Registry by the Government Resolution No 1072 On the establishing Greenhouse Gas Registry and approval of the regulation of the Greenhouse Gas Registry, adopted on 14 July 2010. The managing institution (competent authority) of the Registry is the Ministry of Environment and administrating institution - the Lithuanian Environment Investment Fund.

In 2011 the Fund provided information on verified CO_2 emissions for 101 fuel combustion installations[14] (see Annex V). CO_2 emissions from fuel combustion and production process are included in the registry for the installations, covered by activities, listed in Annex 1 of the EU Directive 2003/87/EC (mineral oil refinery, production of cement clinker, manufacture of glass, ceramic and paper, rockwool).

[14] http://www.laaif.lt/index.php?-130096284

For the purpose of comparison of verified emissions of the Greenhouse Gas Registry with the CO_2 emissions in the NIR, installations were allocated to a certain CRF sector (sectoral approach). Comparison of the verified CO_2 emissions and NIR is provided in Table 3-75.

Table 3-75. Comparison of the verified CO2 emissions and NIR (sectoral approach), 2011

	Verified CO_2 emissions, Gg	**Calculated CO_2 emissions, Gg**	**Absolute difference, Gg**	**Relative difference, %**
1.AA.1.A Public Electricity and Heat Production	2569,42	2877,76	308,3	10,7
1.AA.1.B Petroleum Refining	1903,48	1517,91	-385,57	-25,4
1.AA.2.C Chemicals	217,67	152,48	-65,2	-42,8
1.AA.2.D Pulp, Paper and Print	49,02	88,82	39,80	44,8
1.AA.2.E Food Processing, Beverages and Tobacco	51,34	288,52	237,18	82,2
1.AA.2.F Other	768,82	622,78	-146,0	-23,4
1.AA.4.C Agriculture/ Forestry/ Fisheries	46,63	105,70	59,1	55,9
Total	5606,38	5653,97	47,6	0,8

Total CO_2 emissions calculated in NIR sectoral approach are only 0,8% higher as compared to verified fuel combustion emissions in the Greenhouse Gas Registry. The differences mainly occur due to accuracy of emission factors and due to different coverage and thresholds in EU ETS.

4 INDUSTRIAL PROCESSES (CRF 2)

4.1 Overview of the Sector

After the economic recession in early 1990's, Lithuania's industrial production and economy started to grow, as reflected by the growth of the GDP. Lithuania was struck by the global economic crisis causing significant reduction in industrial production in 2009. Dominating industry in Lithuania is manufacturing. Manufacturing constituted 89% of the total industrial production (excluding construction) in 2011 (Figure 4-1).

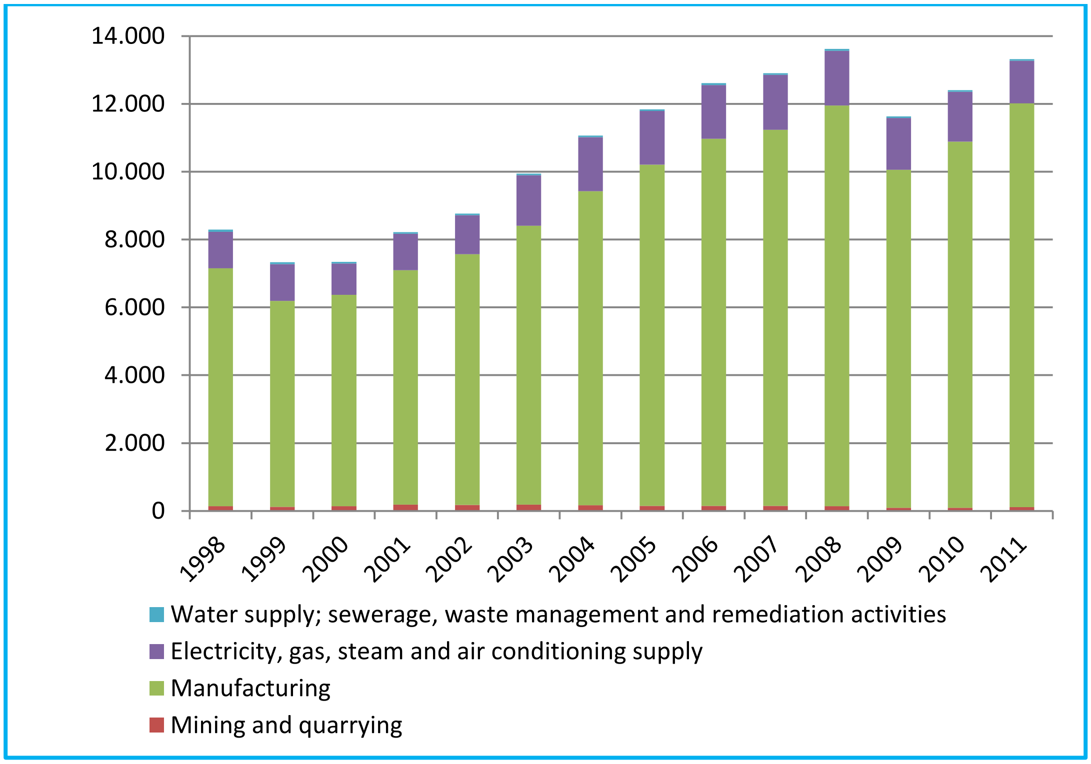

Figure 4-1. Industrial production at constant prices (except construction) in millions Euro

Four most important sectors within Manufacturing cumulatively produced 66% of production:

- Manufacture of refined petroleum products (27%);
- Manufacture of food products and beverages (18%);
- Manufacture of wood products and furniture (12%);
- Manufacture of chemicals and chemical products (10%).

Share of the main sectors in production of manufacturing products in Lithuania is presented in Figure 4-2.

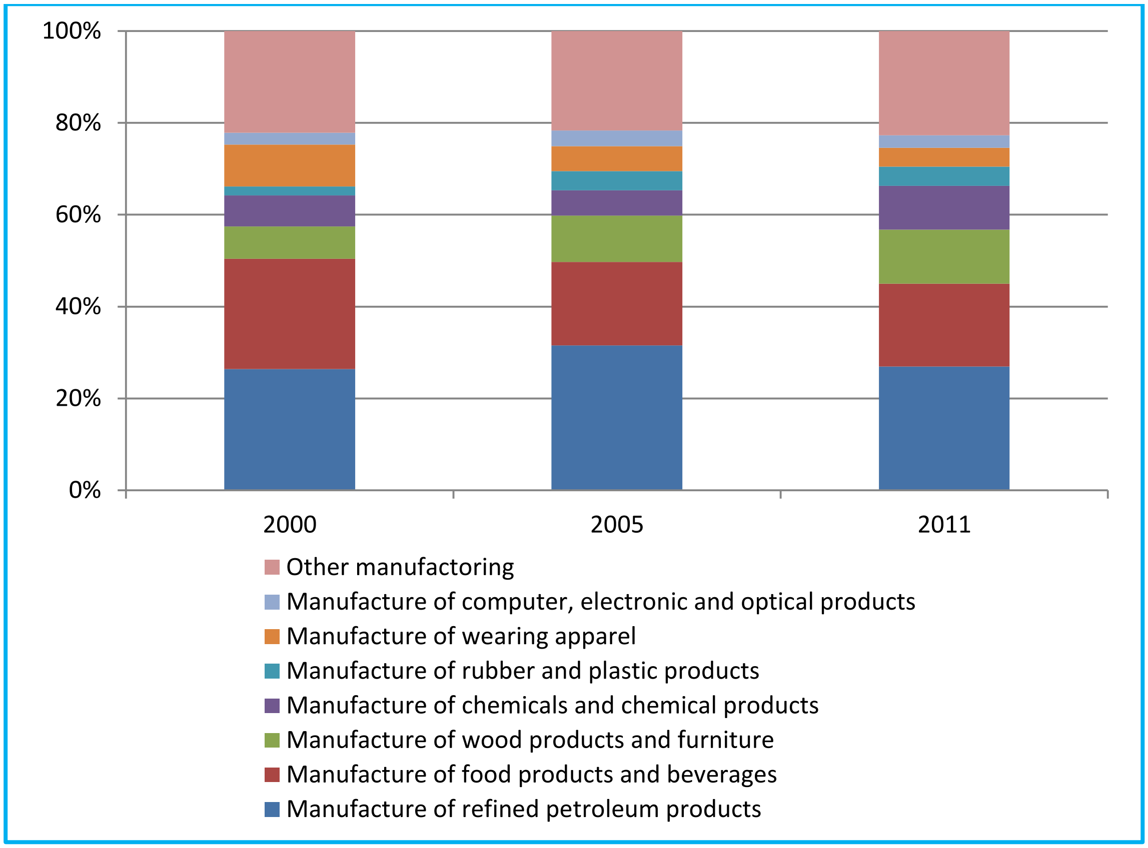

Figure 4-2. Share of the main sectors in production of manufacturing products in Lithuania (at constant prices)

Greenhouse gas emissions from Industrial processes contributed 11% to the total anthropogenic greenhouse gas emissions in Lithuania in 2011, totalling 2625,22 Gg CO_2 equivalent (Figure 4-3.).

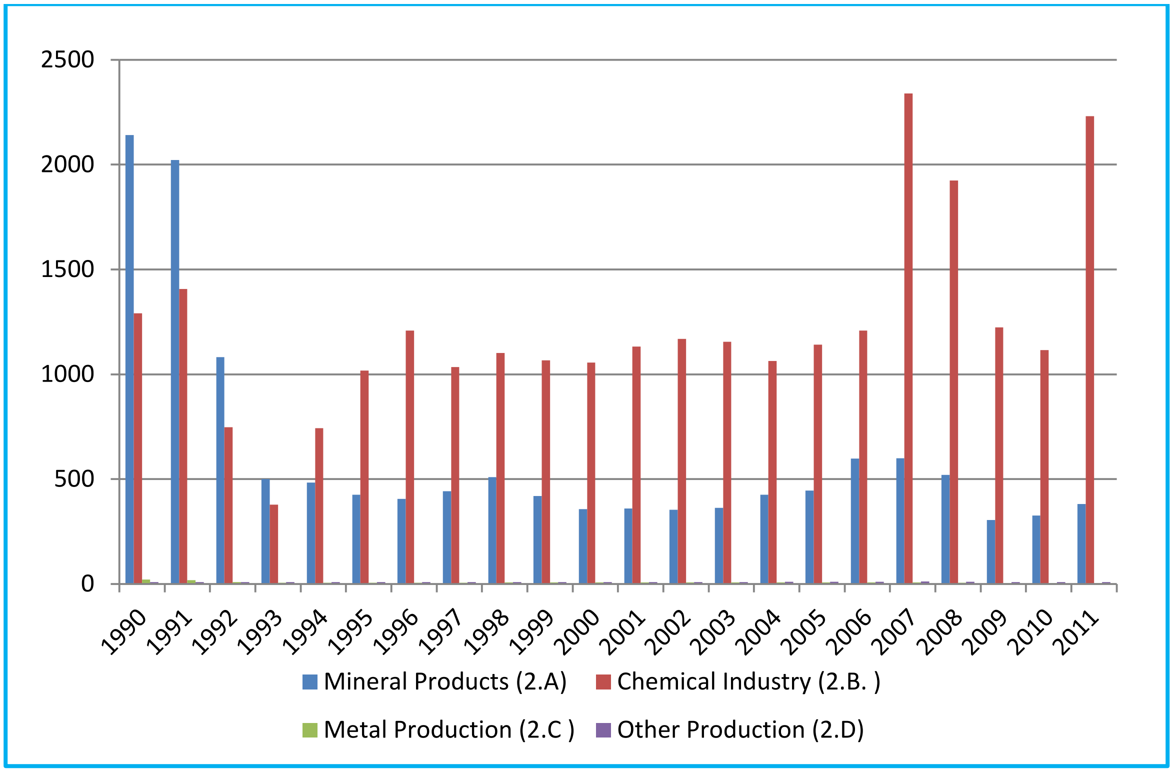

Figure 4-3. CO_2 emissions from industrial processes, Gg CO_2 eq. in 1990-2011

Lithuanian greenhouse gas emissions from Industrial processes consist from the following emission categories:

- Mineral products (CRF 2.A) include CO_2 emissions from:
  - cement production (CRF 2.A.1);
  - lime production (CRF 2.A.2);
  - limestone and dolomite use (CRF 2.A.3);
  - soda ash use (CRF 2.A.4.2);
  - asphalt roofing (CRF 2.A.5);
  - other: glass (CRF 2.A.7.1), mineral wool, bricks and tiles production.
- Chemical industry (CRF 2.B) include:
  - CO_2 emissions from ammonia production (CRF 2.B.1);
  - N_2O emissions from nitric acid production (CRF 2.B.2);
  - CH_4 emissions from methanol production (CRF 2.B.5.5)
- Metal production (CRF 2.C) include CO_2 emissions from coke used in blast furnaces (CRF 2.C.1.2).
- Other production (CRF 2.D) include:
  - SO_2 emissions from pulp production (CRF 2.D.1); NMVOC and CO_2 emissions from food and drink production (CRF 2.D.2).
- Consumption of halocarbons and SF_6 (CRF 2.F) covers emissions of F-gases from:
  - refrigeration and air conditioning equipment (CRF 2.F.1);
  - foam blowing (CRF 2.F.2);
  - fire extinguishers (CRF 2.F.3);
  - metered dose inhalers (CRF 2.F.4);
  - other applications using ODS substitutes (CRF 2.F.6);
  - semiconductor manufacture (CRF 2.F.7).
  - electrical equipment (CRF 2.F.8).

Several emission sources in the Industrial processes sector are key categories. The key categories in 2011 by level and trend, excluding LULUCF are listed in Table 4-1.

Table 4-1. Key category from Industrial processes in 2011 by Level and Trend excluding LULUCF

IPCC source categoty	Gas	Identification criteria	Approach used
2.A.1 Cement Production	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
2.A.7 Bricks and Tiles (decarbonizing)	CO_2	Level	-
		Trend	Tier 1
2.B.1 Ammonia Production	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
2.B.2 Nitric Acid Production	N_2O	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
2.F.1 Refrigeration and Air Conditioning Equipment	HFC	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2

4.2 Mineral Products (CRF 2.A)

CO_2 emissions from cement and lime production and from limestone and dolomite use as well as emissions from soda ash use, asphalt roofing and other production are reported in this category (Table 4-2). Cement production is a key source category in Lithuanian GHG inventory. Soda ash is not produced in Lithuania. Limestone and dolomite use comprises the use in the production of iron, bricks and tiles, and mineral wool. Emissions from glass production are reported under their own source category (2.A.7.1).

Table 4-2. Reported emissions under the subcategory mineral products

CRF	Source	Emissions reported
2.A 1	Cement production	CO_2
2.A 2	Lime production	CO_2
2.A 3	Limestone and dolomite use	CO_2
2.A 4	Soda ash use	CO_2
2.A 5	Asphalt roofing	CO_2
2.A 7	Other production (glass, mineral wool, bricks and tiles)	CO_2

In the production of cement, CO_2 is emitted when an intermediate product - clinker is produced. In that process limestone is heated to a high temperature, which results in emissions, as the main component of limestone, calcium carbonate, breaks down and calcinates into calcium oxide and carbon dioxide. Limestone also contains small amounts of magnesium carbonate ($MgCO_3$), which will calcinate in the process causing CO_2 emissions. CO_2 emissions from lime production and limestone and dolomite use are also due to calcination of calcium and magnesium carbonates at high temperatures.

In addition, carbon dioxide is released when soda ash (Na_2CO_3), is heated to high temperatures. Emissions of the category Mineral products were 61,8% of the emissions of the Industrial processes sector in 1990 and 14,5% in 2011. Amount of emissions were 2141,7 Gg (CO_2 eq.) in 1990 and 381,6 Gg in 2011 (Figure 4-4, 4-5).

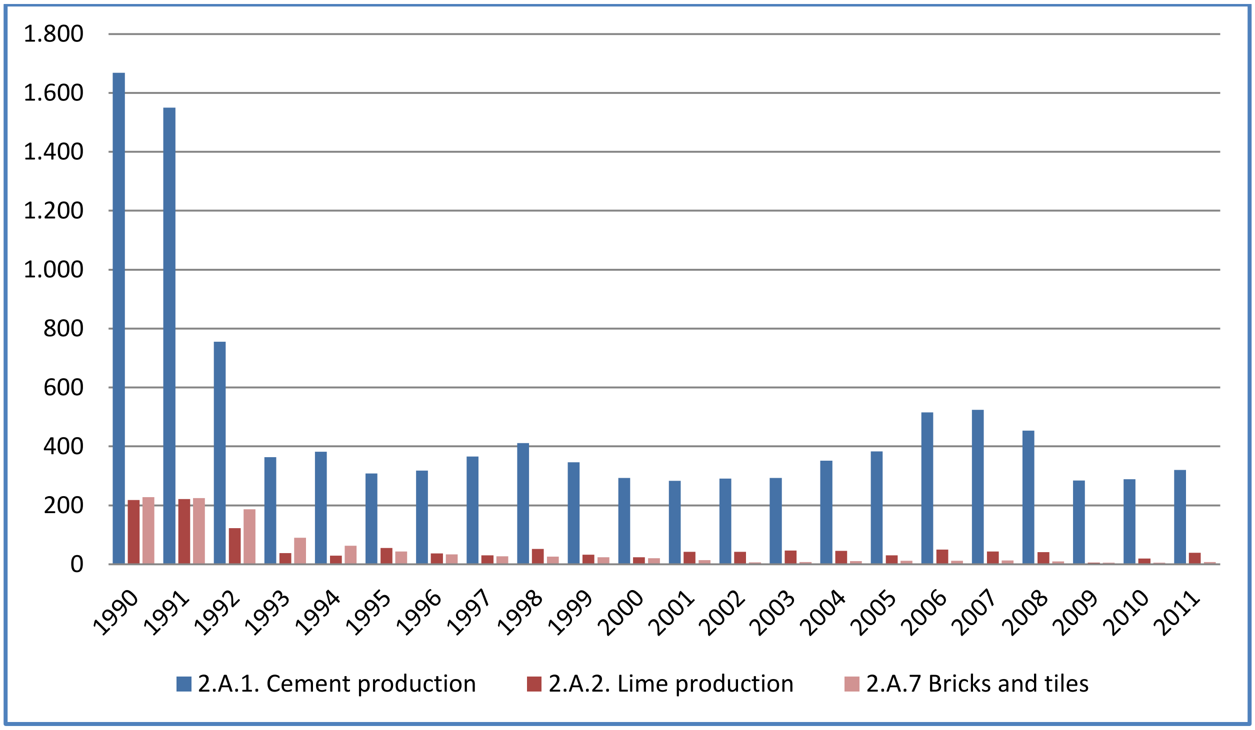

Figure 4-4. Greenhouse gas emission from Mineral products, Gg CO_2 eq. in 1990-2011: production of cement, lime and bricks and tiles

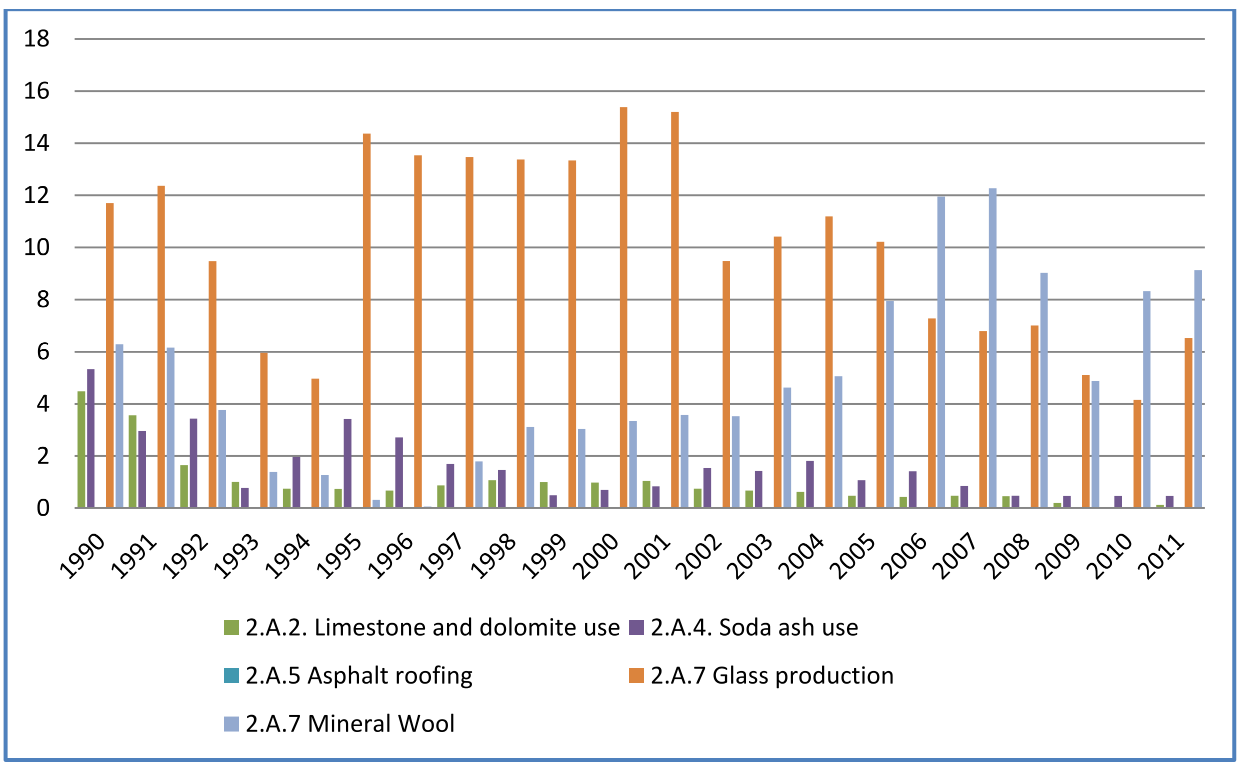

Figure 4-5. Greenhouse gas emission from Mineral products, Gg CO_2 eq. in 1990-2011: limestone and dolomite use, soda ash use, asphalt roofing, glass and mineral wool production

Cement production is the biggest source of greenhouse gas emissions in the Mineral products category, being 319,84 Gg in 2011 (83,8%). Emissions from cement production were 48,2% in 1990 and 12,2% in 2011 of the emissions in the Industrial processes sector. There was a rapid decrease in the production volume in 1990-1993 after gaining independence from Soviet Union. The output has had a slight growing trend in 2003-2007 fuelled by the boost in construction industry. Emissions from other mineral processes are a minor source in the category Mineral products.

4.2.1 Cement Production (CRF 2.A.1)

4.2.1.1 Source Category Description

Category 2.A.1 covers CO_2 emissions from cement production. Emissions of CO_2 occur during the production of clinker that is an intermediate component in the cement manufacturing process. High temperatures in cement kilns chemically change calcium carbonate into lime and CO_2. The conversion of the lime into cement clinker then results in the release of further CO_2.

Cement is produced in a single company - AB Akmenės Cementas, which is situated in the North Western part of Lithuania. The factory was constructed in soviet times (1947-1974), cement produced in the factory was exported to other Republics of USSR, Hungary, Cuba and Yugoslavia. The total nominal capacity of the plant is about 5 million tonnes cement per year. The data on clinker production and composition were provided by the AB Akmenės Cementas. Activity data is collected on company level.

Clinker production has fallen sharply after the declaration of independence from more than 3 million tonnes annually in 1990 to about 500 to 600 k tonnes in 2000 (Figure 4-6.). Sharp decline in cement production in 1990-1993 is mainly due to loss of market in former USSR. Demand of the cement in the local market has also dropped due to structural changes in industry and economy. Increase in clinker production in 2005-2008 reflects the boom in construction industry.

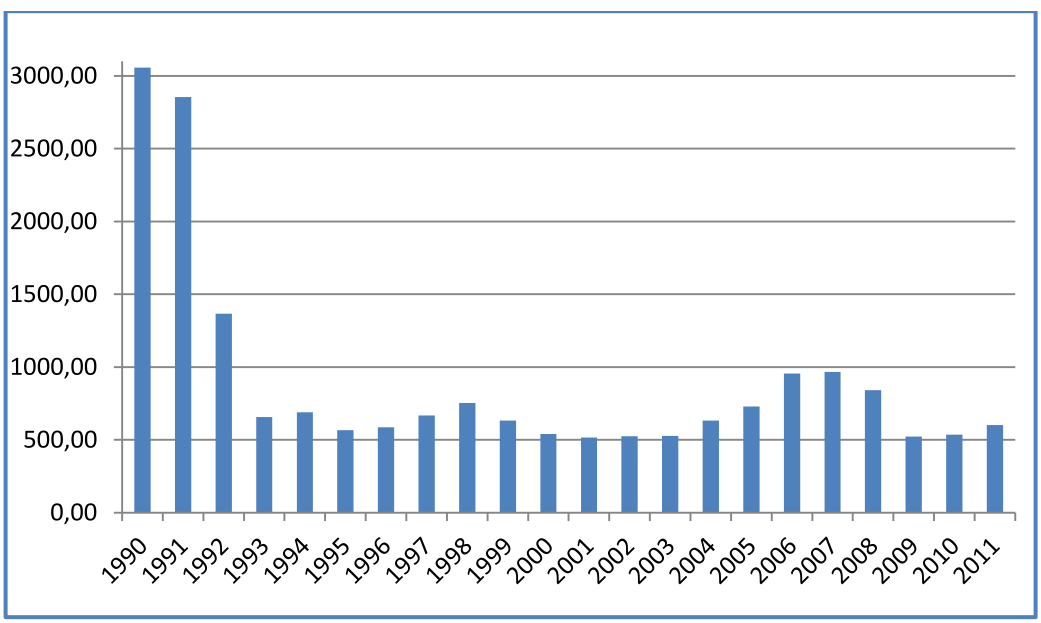

Figure 4-6. Clinker production, k tonnes in 1990-2011

4.2.1.2 Methodological issues

For the period 1990-2004 CO_2 emission was calculated using Tier 2 method using specific production data provided by the production company. CO_2 emissions were calculated from material mass balance assuming that all carbon contained in raw materials (limestone) was released to the atmosphere as CO_2. Actual CO_2 emission was calculated from the data on clinker production and composition. In addition, it was assumed that CO_2 was released from calcinated fraction of kiln dust. According to the AB Akmenės Cementas, only about 5% of the CKD is calcinated.

CO_2 emission was calculated using the following equation:

$$Emission = CP\times (C_{CaO}\times (M_{CO2}/M_{CaO}) + C_{MgO}\times (M_{CO2}/M_{MgO})) +$$
$$+ CKD\times CF\times (C_{CaO}\times (M_{CO2}/M_{CaO}) + C_{MgO}\times (M_{CO2}/M_{MgO})),$$

where:

CP - clinker production, Gg;
CKD - cement kiln dust generation, Gg;
CF - calcinated fraction of the CKD, the time-series of the CKD correction factor is provided in Table 4-3;
C_{CaO} and C_{MgO} - CaO and MgO fractions in clinker;
M_{CO2}, M_{CaO}, M_{MgO} - molecular weights of CO_2, CaO and MgO.

For the period 2005-2011 CO_2 emission data have been accessed via the verified EU ETS reports of the production plant. CO_2 emissions were caclulated using plant specific data on production of clinker and CKD, and plant specific emission factors (t CO_2/ t clinker, t CO_2/ t CKD).

Estimated CO_2 emissions from cement production are shown in Table 4-3.

Table 4-3. Estimated CO_2 emissions (Gg/year) from Cement production

Year	Emission	CKD fraction
1990	1668,1	1,3 %
1991	1550,0	1,3 %
1992	755,0	1,3 %
1993	363,9	1,3 %
1994	381,6	1,3 %
1995	308,0	1,3 %
1996	317,5	1,3 %
1997	366,1	1,3 %
1998	411,7	1,3 %
1999	345,8	1,3 %
2000	292,5	1,3 %
2001	283,4	1,3 %
2002	290,5	1,3 %
2003	292,5	1,3 %
2004	351,0	1,3 %

2005	383,3	2,3 %
2006	515,3	0,5 %
2007	524,1	1,0 %
2008	453,8	1,4 %
2009	284,0	0,8 %
2010	289,0	0,2 %
2011	319,8	0,3 %

4.2.1.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- Activity data uncertainty is assumed to be 2%. Data on clinker production provided by the single production company is considered reliable;
- Emission factor uncertainty is assumed to be 5%;
- Combined uncertainty is 5,4%.

CaO content in clinker fluctuated from 62,3% to 65,3% (1990 to 2010), the average value being 64,3%, standard deviation 0,8%.

Data on MgO content in clinker were available only for the period 2000 to 2010 (provided by the producer). MgO content fluctuated in the range from 3,33% to 4,13%, average value was 3,84%, standard deviation 0,27%. For GHG calculation for the period 1990 to 1999 average MgO content value was used.

Data on generation of cement kiln dust (CKD) (fraction not recycled to the kiln) were provided only for 2005-2011 (fluctuation from 0,5% to 2,3% of clinker production (average value 1,3%), Table 4-3). Average value was used for the period when specific data were not available.

4.2.1.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

As the producer reports CO_2 emissions for EU ETS, it was decided to perform a quality control quality by comparing the two estimates (IPCC Tier 2 versus EU ETS). Comparison of CO_2 emissions (Tier 2 versus EU ETS) for 2005-2009 is provided below:

Table 4-4. Comparison of CO2 emissions from Cement production 2005-2009 (Tier 2 versus EU ETS)

	2005	**2006**	**2007**	**2008**	**2009**
CO_2 emissions TIER 2, Gg	383,4	516,4	523,8	454,1	283,7
CO_2 emissions EU ETS, Gg	383,3	515,3	524,1	453,8	284,0
ETS share, %	99,97%	99,78%	100,04%	99,94%	100,11%

The difference between the Tier 2 estimations based on plant-specific data (annual clinker and CKD data, CaO and MgO content in clinker) and EU ETS data was less than 1%. Therefore, it is concluded that the estimates for the period 1990-2004 and 2005-2011 are consistent.

4.2.1.5 Source-specific recalculations

No source-specific recalculations were done.

4.2.1.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.2.2 Lime Production (CRF 2.A.2)

4.2.2.1 Source Category Description

After restoration of independence lime production decreased from approximately 300 thous tonnes annually to 50 thous tonnes in 1993 and is fluctuating about this value. Exceptionally low production of lime – only 5,6 kilo tonnes was observed in 2009. (Figure 4-7). Data on lime production were provided by Statistics Lithuania[15] covering the whole reporting period.

Data on hydrated lime production are provided by Statistics Lithuania for the period 1999 - 2011. The fraction of hydrated lime fluctuated from 0% to 4%.

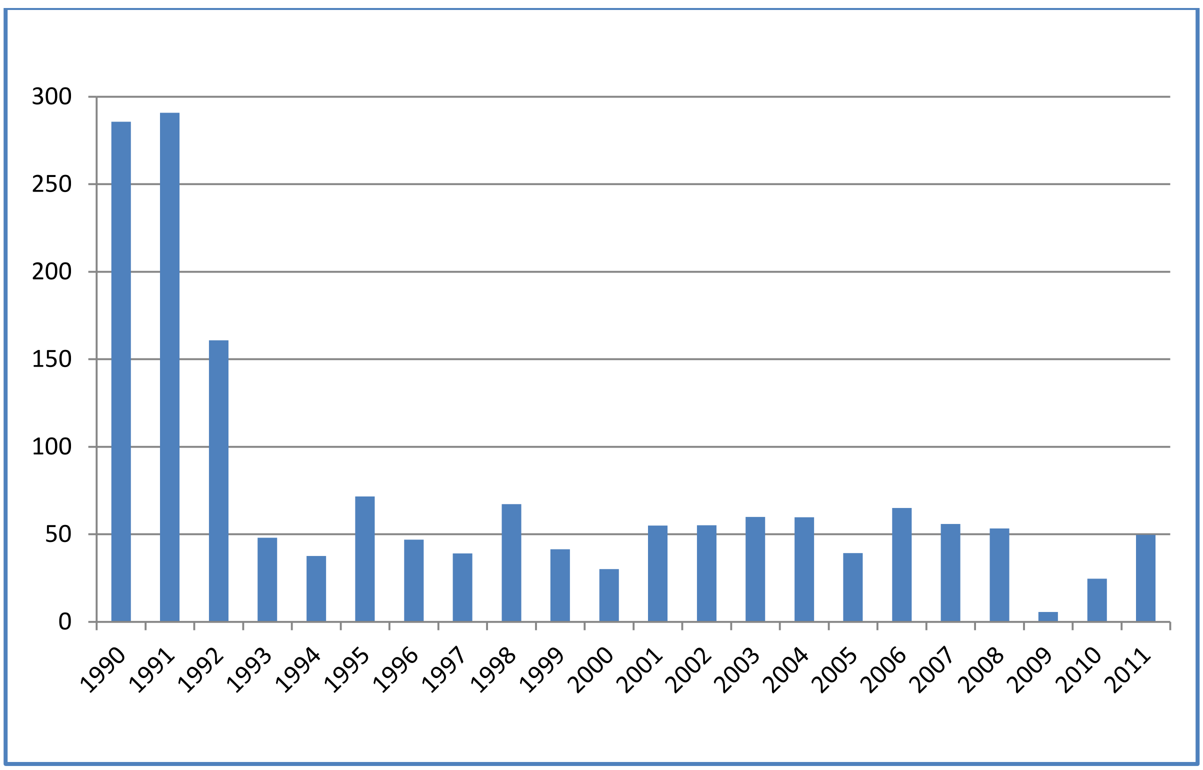

Figure 4-7. Lime production, Gg in 1990-2011 in Lithuania

[15] http://db1.stat.gov.lt/statbank/default.asp?w=1440

Lime production in sugar industry

Following the request of the TERT to provide more information about lime production in sectors which are auto producers and which consume the lime themselves, Lithuania has collected data on lime production in sugar industry (survey carried out in 2012). Lime auto produced by the sugar producing companies is not covered by the national statistics and therefore CO_2 emissions from lime production were underestimated in the previous submissions.

The quantities of the lime produced were obtained directly from the sugar producing companies for the years 1990-2011.

4.2.2.2 Methodological issues

CO_2 emission from lime production was calculated by Tier 2 method using production data provided by Statistics Lithuania and limestone composition data provided by AB Naujasis Kalcitas. According to the data provided by AB Naujasis Kalcitas company, which is the main lime producer in Lithuania, limestone used for lime production contains 90% to 92% of $CaCO_3$ and 4% to 5% of $MgCO_3$. Based on these data it was assumed that products contain 91,1% of CaO, 3.9% of MgO and 5% of impurities. Actual hydrated lime production data were used for emission calculation in 1999-2010 and it was assumed that during 1990-2001 there was no hydrated lime production. Hydrated lime data were converted to quicklime using default water content correction factor 0,28 (IPCC GPG 2000, p. 3.22-23).

CO_2 emissions were calculated from material mass balance assuming that all carbon contained in raw materials (limestone) was released to the atmosphere as CO_2.

CO_2 emission was calculated using the following equation:

$$Emission = LP \times (C_{CaO} \times (M_{CO2}/M_{CaO}) + C_{MgO} \times (M_{CO2}/M_{MgO}))$$

where:

LP - lime production, Gg;

C_{CaO} and C_{MgO} - CaO and MgO fractions in lime;

M_{CO2}, M_{CaO}, M_{MgO} - molecular weights of CO_2, CaO and MgO.

Lime production in sugar industry

For determining activity data and emissions of CO_2 within the sugar industry, the amounts of limestone for the production of quicklime are used. The quantities were obtained directly from the sugar producing companies for the years 1990-2011.

According to the producers the used limestone consists to 97% of $CaCO_3$. In the production of sugar, lime is used for purification of the juice. Lime is added to the raw juice and some impurities are precipitated. In the carbonisation step CO_2 is bubbled through the juice and most of the remaining lime is precipitated as $CaCO_3$. The precipitated "limestone" is sold and used within agricultural activities.

It is assumed that around 90% of the lime used were precipitated as $CaCO_3$ in the carbonation process[16]. Only the part of CaO which is not recovered as $CaCO_3$ is reported as activity data.

In Table 4-5 the used amounts of limestone, the amounts of produced lime and emitted CO_2, the precipitated $CaCO_3$, and the reported activity data and CO_2 emissions from lime production within the sugar industry is presented.

Table 4-5. Lime production and estimated CO_2 emissions from sugar industry

Year	Used amount of limeston e, Gg	Amount of lime produced, Gg	CO_2 from lime productio n, Gg	Precipitat ed share of lime, %	Precipitat ed amount of lime, Gg	Reported activity data (lime), Gg	Reported CO_2 emissions, Gg
1990	34,2	17,6	13,8	90%	15,8	1,8	1,4
1991	29,0	14,9	11,7	90%	13,4	1,5	1,2
1992	25,6	13,2	10,3	90%	11,8	1,3	1,0
1993	27,5	14,1	11,1	90%	12,7	1,4	1,1
1994	21,5	11,0	8,7	90%	9,9	1,1	0,9
1995	24,2	12,4	9,8	90%	11,2	1,2	1,0
1996	24,8	12,7	10,0	90%	11,5	1,3	1,0
1997	21,5	11,0	8,7	90%	9,9	1,1	0,9
1998	23,7	12,2	9,6	90%	11,0	1,2	1,0
1999	21,7	11,2	8,8	90%	10,1	1,1	0,9
2000	17,3	8,9	7,0	90%	8,0	0,9	0,7
2001	15,1	7,8	6,1	90%	7,0	0,8	0,6
2002	17,7	9,1	7,1	90%	8,2	0,9	0,7
2003	15,7	8,1	6,3	90%	7,3	0,8	0,6
2004	15,4	7,9	6,2	90%	7,1	0,8	0,6
2005	14,7	7,6	5,9	90%	6,8	0,8	0,6
2006	12,6	6,5	5,1	90%	5,8	0,6	0,5
2007	14,1	7,2	5,7	90%	6,5	0,7	0,6
2008	9,1	4,7	3,7	90%	4,2	0,5	0,4
2009	18,8	9,7	7,6	90%	8,7	1,0	0,8
2010	19,2	9,9	7,8	90%	8,9	1,0	0,8
2011	22,4	11,5	9,0	90%	10,3	1,1	0,9

Estimated CO_2 emissions from lime production are provided in Table 4-6 (total, including sugar industry).

Table 4-6. Estimated CO_2 emissions (Gg/year) from lime production.

Year	Reported CO_2 emissions from lime production, Gg	Reported CO_2 emissions from sugar industry, Gg	Total CO_2 emissions, Gg
1990	216,4	1,4	217,8
1991	220,4	1,2	221,5

[16] This assumption is supported by the NIR Sweden 2010

1992	121,9	1,0	122,9
1993	36,4	1,1	37,5
1994	28,5	0,9	29,3
1995	54,3	1,0	55,3
1996	35,6	1,0	36,6
1997	29,6	0,9	30,5
1998	51,0	1,0	51,9
1999	31,4	0,9	32,3
2000	22,8	0,7	23,5
2001	41,7	0,6	42,3
2002	41,7	0,7	42,5
2003	45,3	0,6	46,0
2004	45,3	0,6	45,9
2005	29,7	0,6	30,3
2006	49,2	0,5	49,8
2007	42,3	0,6	42,9
2008	40,3	0,4	40,7
2009	4,2	0,8	5,0
2010	18,6	0,8	19,4
2011	37,6	0,9	38,5

4.2.2.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- Activity data uncertainty is assumed to be 5%. Data on lime production was taken from Statistics Lithuania publications;
- Emission factor uncertainty is assumed to be 5%;
- Combined uncertainty is 7,1%.

CO_2 emission was calculated using production data provided by Statistics Lithuania and limestone composition data provided by AB Naujasis Kalcitas. Data is consistent over the time series.

4.2.2.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

In addition, source category-specific quality control procedures have been carried out in this submission. Emission data for years 2008-2011 have been verified with EU ETS data. The calculated emissions are significantly higher than reported in EU ETS for all four years (26% in 2008, 17% in 2009, 27% in 2010 and 25% in 2011). This difference in estimated CO_2 emission is due to:

- activity data: GHG inventory also covers CO_2 emissions from lime production in sugar industry;
- methodology. In GHG inventory CO_2 emissions from lime production were calculated by Tier 2 method using plant specific limestone composition data. In EU ETS emissions were estimated

using Tier 1 method. The default EFs used in the EU ETS are lower than EFs used in GHG inventory.

4.2.2.5 Source-specific recalculations

CO_2 emissions from lime production were revised in 2012 to take into account the lime production in sugar industry. Emissions were recalculated for the whole reporting period.

4.2.2.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.2.3 Limestone and Dolomite Use (CRF 2.A.3)

4.2.3.1 Source Category Description

Specific CO_2 emissions caused by thermal degradation of limestone and dolomite are covered in sections dealing with cement, lime, glass, mineral wool, brick and tile production. This section covers limestone flux use in iron foundries. Consumption of limestone flux in iron foundries was calculated as one tenth of iron production according to the information provided by the foundries.

4.2.3.2 Methodological issues

CO_2 emission was calculated by Tier 2 method. Iron production data provided by Statistics Lithuania. Consumption of limestone flux in iron foundries was calculated as one tenth of iron production in accordance with the information provided by the foundries. CO_2 emissions were calculated from material mass balance assuming that all carbon contained in raw materials (limestone) used as flux was released to the atmosphere as CO_2.

CO_2 emission was calculated using the following equation:

$$Emission = LC \times (C_{CaO} \times (M_{CO2}/M_{CaCO3}) + C_{MgO} \times (M_{CO2}/M_{MgCO3}))$$

where:
LC - lime consumption, Gg;
C_{CaO} and C_{MgO} - CaO and MgO fractions in lime;
M_{CO2}, M_{CaCO3}, M_{MgCO3} - molecular weights of CO_2, $CaCO_3$ and $MgCO_3$.

Estimated CO_2 emissions from lime and dolomite use are provided in Table 4-7.

Table 4-7. Estimated CO_2 emissions (Gg/year) from lime and dolomite use

Year	Emission
1990	4,5
1991	3,6
1992	1,6
1993	1,0
1994	0,7
1995	0,7

1996	0,7
1997	0,9
1998	1,1
1999	1,0
2000	0,98
2001	1,04
2002	0,74
2003	0,67
2004	0,62
2005	0,48
2006	0,42
2007	0,48
2008	0,46
2009	0,19
2010	0,03
2011	0,13

4.2.3.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- Limestone and dolomite use was evaluated only for iron production. Bearing in mind that some other uses may not been taken into account, it was assumed that uncertainty limestone and dolomite use activity data is 10%.
- Emission factor uncertainty is assumed to be 5%;
- Combined uncertainty is 11,2%.

Iron production data was provided by Statistics Lithuania. Data is consistent over the time-series.

4.2.3.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

4.2.3.5 Source-specific recalculations

No source-specific recalculations were done.

4.2.3.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.2.4 Soda Ash Use (CRF 2.A.4)

4.2.4.1 Source Category Description

CO_2 emissions from soda ash consumed in glass production is covered under CRF 2.A.7. This chapter covers other uses of soda ash. The data on overall use of soda ash were obtained from the publications of Statistics Lithuania[17]. Soda ash consumed in the glass production industry was subtracted from the overall use of soda ash.

In 2010 the Statistics Lithuania has stopped collection of statistical data on the overall use of soda ash. Therefore for the years 2010 and 2011, average figure of soda ash use (2008-2009) was used (overall use of soda ash minus soda ash use in glass industry).

Soda ash consumption by the glass companies was calculated on the data on consumption of carbonates by the production companies:

- AB Warta Glass Panevėžys 1999-2011. For the period 1990-1998 average soda ash consumption (1990-1998) per tonne of glass was used. Cullet was excluded from the calculation.
- Kauno stiklas 2004-2011. For the period 1990-2003 average soda ash consumption (1990-2002) per tonne of glass was used. Cullet was excluded from the calculation.
- Ekranas 2005-2006. The plant got bankrupt in 2006. For the period 1990-2004 average soda ash consumption (1990-2003) per tonne of glass was used. Cullet was excluded from the calculation.

Variations of soda ash use are shown in Figure 4-8.

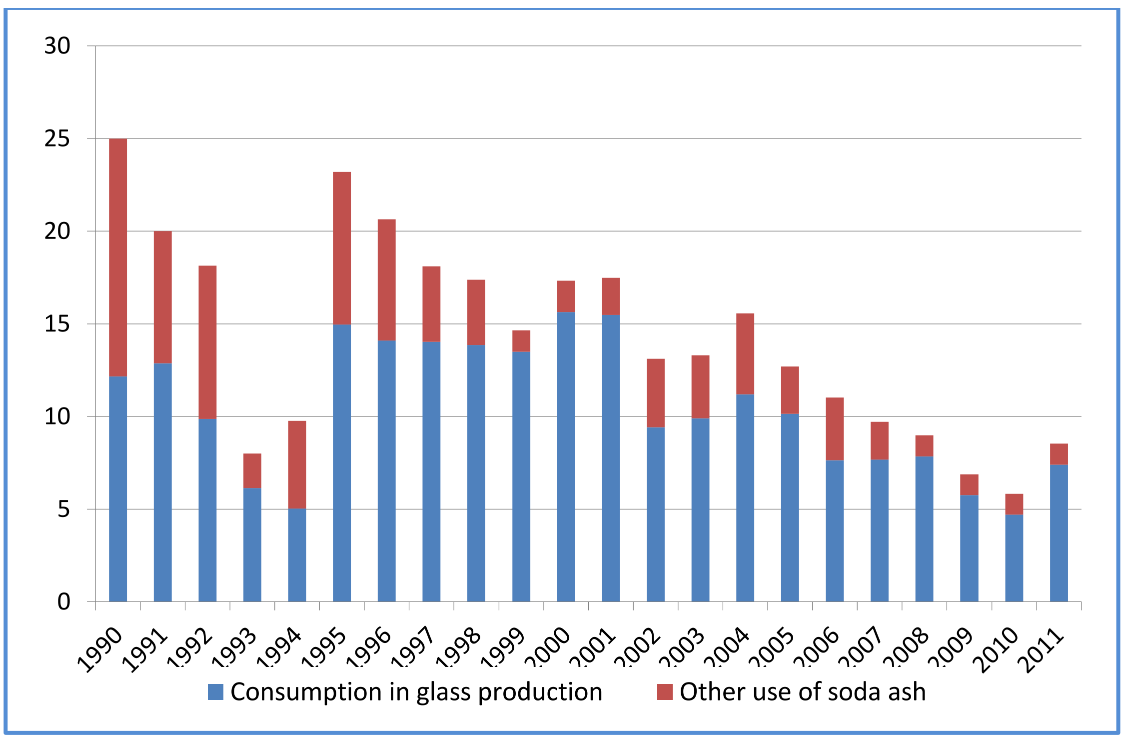

Figure 4-8. Evaluated use of soda ash in 1990-2011, k tonnes

[17] Statistic Lithuania publication "Raw Materials"

4.2.4.2 Methodological issues

CO_2 emissions were calculated from mass balance assuming that all carbon contained in soda ash was released to the atmosphere after use as CO_2. The following equation was used:

$$Emission = SA \times M_{CO2}/M_{Na2CO3},$$

where:

SA - other use of soda ash, Gg;

M_{CO2} and M_{Na2CO3} - molecular weights of CO_2 and Na_2CO_3.

Estimated CO_2 emissions from other use of soda ash are provided in Table 4-8.

Table 4-8. Estimated CO_2 emissions (Gg/year) from soda ash use

Year	CO_2 Emission, Gg
1990	5,3
1991	3,0
1992	3,4
1993	0,8
1994	2,0
1995	3,4
1996	2,7
1997	1,7
1998	1,5
1999	0,5
2000	0,7
2001	0,8
2002	1,5
2003	1,4
2004	1,8
2005	1,1
2006	1,4
2007	0,8
2008	0,5
2009	0,5
2010	0,5
2011	0,5

4.2.4.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- Soda ash use was evaluated as difference of data provided by Statistics Lithuania and evaluated other uses (namely glass production). As each of these components contains certain uncertainty, the total uncertainty in soda ash use activity data was assumed to be 10%.
- Emission factor uncertainty is assumed to be 5%;

- Combined uncertainty is 11,2%.

Data on overall use of soda ash were taken from the publications of Statistics Lithuania[18]. Data on use of soda ash was not available for 2010-2011 and was extrapolated (average consumption in 2008 – 2009). Issues related to time-series consistency of the soda ash use by glass production is covered in section Other (CRF 2.A.7).

4.2.4.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

4.2.4.5 Source-specific recalculations

Soda ash use was recalculated for the whole time series due to recalculations related to glass industry:

- Use of plant specific data on consumption of soda ash when available;
- For other periods plant specific average soda ash consumption per tonne of glass was used.

4.2.4.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.2.5 Asphalt Roofing (CRF 2.A.5)

4.2.5.1 Source Category Description

UAB Mida LT is a single company in Lithuania producing asphalt roofing materials. The company started operation in 2001 after reorganisation of Soviet construction materials production company. Company produces bitumen tiles as well as roll roofing materials. Data on production of roofing materials was provided by the producer and is available for the period 2001-2011 (Table 4-9).

Table 4-9. Production of asphalt roofing materials in Lithuania 2001-2011 (thous m^2)

Year	Bitumen tiles	Roll roofing materials
2001	253	2087
2002	403	3352
2003	975	5526
2004	1,67	6124
2005	3157	4488
2006	2356	4322
2007	3842	5948
2008	3451	6424
2009	367	0
2010	3681	477
2011	3265	573

[18] Statistic Lithuania publication "Raw Materials"

According to the producer, asphalt roofing materials were also produced in 1990-2000 prior to reorganisation of the company in 2001, but data for this period is not available.

Asphalt roofing production is provided in Figure 4-9.

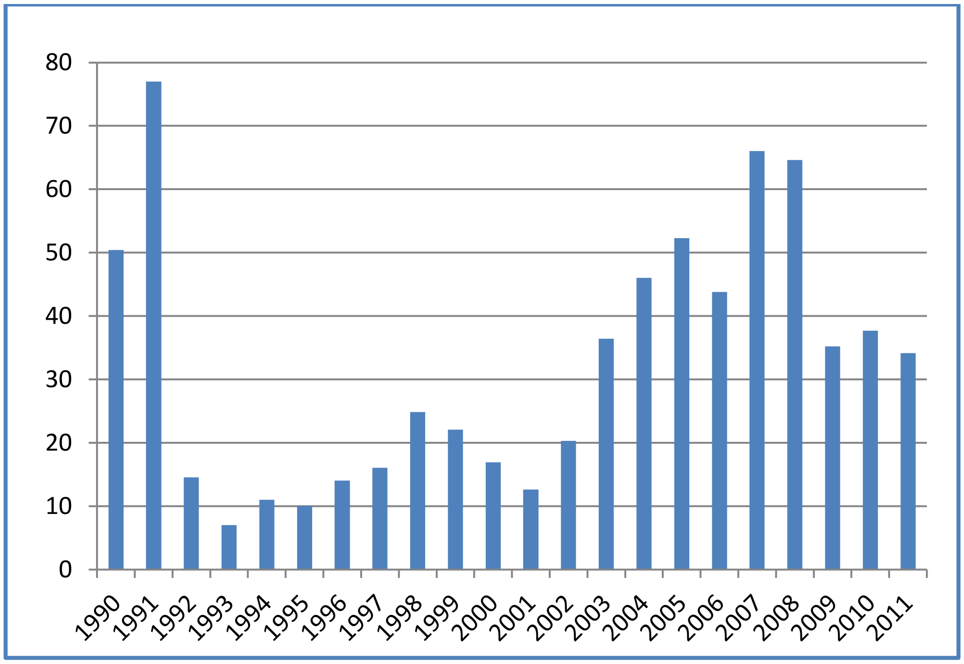

Figure 4-9. Production of asphalt roofing in 1990-2011, k tonnes

4.2.5.2 Methodological issues

Weight of the asphalt roofing material was calculated using area to weight ratio provided by the production company: 9,6 kg/m^2 for bitumen tiles and 4,9 kg/m^2 for roll roofing material. Amount of bitumen used for production of asphalt roofing is 2 kg/m^2 for bitumen tiles and 2,6 kg/m^2 for roll roofing.

Production of the asphalt roofing materials in 1990-2000 was estimated based on annual average use of bitumen. During the period between 2001 and 2010 production of asphalt roofing materials annually consumed on average 13% of the bitumen used for non energy uses. Data on bitumen use for non energy uses was obtained from energy balance by Statistics Lithuania. It was also assumed that only roll roofing was produced in 1990-2000.

Emissions of non-methane volatile organic compounds (NMVOC) from asphalt roofing were calculated from the national data on the total mass of production. Default emission factor of 0,16 kg NMVOC per tonne product was used (Revised IPCC Guidelines 1996, Table 2-3, p. 2-13).

Estimated NMVOC emissions form asphalt roofing production were converted to CO_2 equivalent assuming that NMVOC contain 80% carbon by weight (IPCC Guidelines 2006, page 5.16). Estimated NMVOC and CO_2 eq. emissions from asphalt roofing production are shown in Table 4-10.

Table 4-10. Estimated NMVOC emissions from asphalt roofing production

Year	NMVOC, Gg	CO_2 eq, Gg
1990	0,0081	0,0237
1991	0,0123	0,0361
1992	0,0023	0,0068
1993	0,0011	0,0033
1994	0,0018	0,0052
1995	0,0016	0,0047
1996	0,0022	0,0066
1997	0,0026	0,0075
1998	0,0040	0,0117
1999	0,0035	0,0104
2000	0,0027	0,0079
2011	0,0020	0,0059
2002	0,0032	0,0095
2003	0,0058	0,0171
2004	0,0074	0,0216
2005	0,0084	0,0245
2006	0,0070	0,0206
2007	0,0106	0,0310
2008	0,0103	0,0303
2009	0,0056	0,0165
2010	0,0060	0,0177
2011	0,0055	0,0160

4.2.5.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- The data on production of asphalt roofing materials and raw materials consumption obtained from the production company are reliable and precise. However, they cover only the period after reconstruction of the plant (from 2001). Historic data for 1990-2000 are expert evaluation and may be less reliable. It was assumed that overall uncertainty of asphalt roofing activity data is 5%.
- Emission factor uncertainty is assumed to be 25%;
- Combined uncertainty is 25,4%.

Data on production of roofing materials was provided by the producer and is available for the period 2001-2010. Production of the asphalt roofing materials in 1990-2000 was estimated based on annual average use of bitumen.

4.2.5.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

4.2.5.5 Source-specific recalculations

No source-specific recalculations were done.

4.2.5.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.2.6 Other (CRF 2.A.7)

Other production under the Mineral products covers production of glass, mineral wool and bricks and tiles.

4.2.6.1 Glass Production (CRF 2.A.7.1)

4.2.6.1.1 Source Category Description

There were three glass production plants in Lithuania. One of them (AB Ekranas producing cathode ray tubes) got bankrupt in 2006 and currently there are only two plants in operation.

AB Warta Glass Panevėžys is the largest overall glass producer manufacturing both sheet glass and container glass. Its production has fallen down substantially in early nineties following the declaration of independence, but increased again later even exceeding pre-independence level. However, sheet glass production was stopped in 2002 causing again substantial reduction in production to approximately 40 thousand tonnes per year.

UAB Kauno stiklas is the oldest glass production plant in Lithuania and produces container glass. In the whole period 1990 to 2011, its production was comparatively stable averaging about 20 thousand tonnes annually.

Glass production in CRT manufacturer AB Ekranas decreased slightly in the very beginning of the period, but then was increasing continuously from 1993 to 2004. However, changing market conditions and sharp reduction of demand for CRTs caused sudden bankruptcy of the company and production was stopped completely in 2006.
Glass production in 1990-2011 is shown in Figure 4-10.

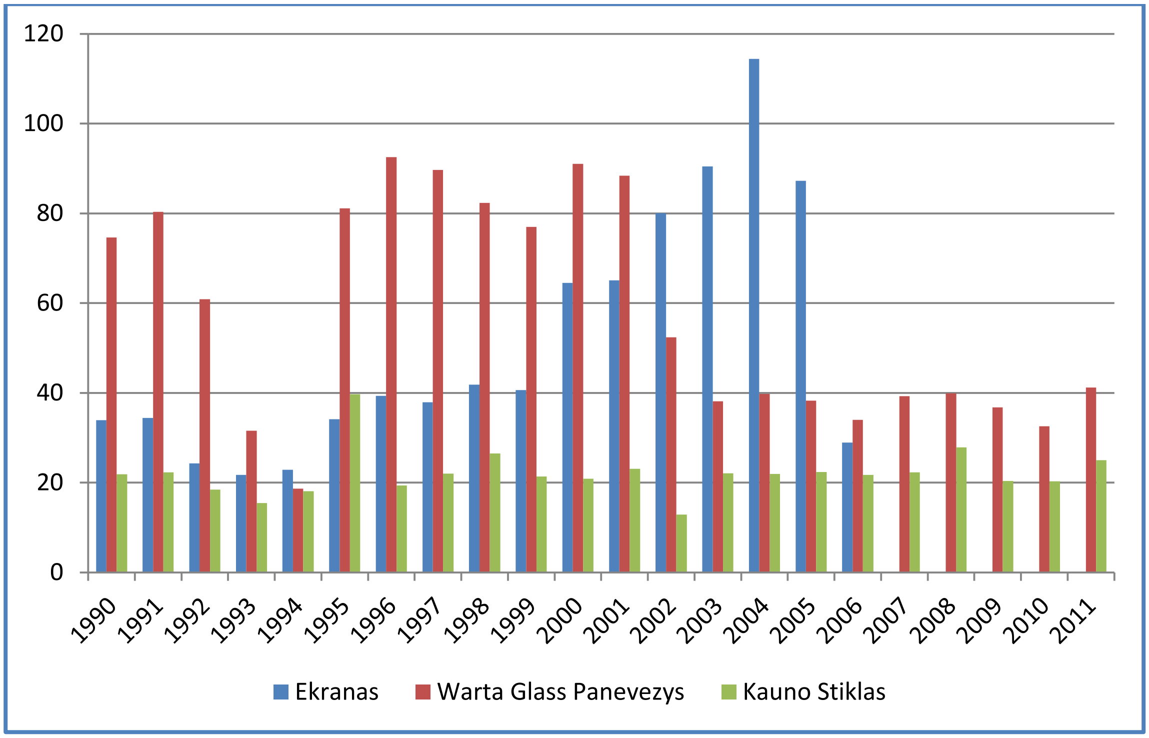

Figure 4-10. Glass production, kilo tonnes

4.2.6.1.2 Methodological issues

In 2012 submission available data was revised and calculations were updated to comply with Tier 3 method. CO_2 emissions were calculated using the following equation (2006 IPCC Guidelines for National Greenhouse Gas Inventories):

$$CO_2\ Emissions = \sum(M_i \times EF_i \times F_i) + M_c \times EF_c$$

where:

CO_2 Emissions - emissions of CO_2 from glass production, tonnes;
EF_i - emissions factor for the particular carbonate i, tonnes CO_2/tonne carbonate
Mi - mass of the carbonate i consumed, tonnes
Fi - fraction calcination achieved for the carbonate i, fraction. It was assumed that the fraction calcination is equal to 1.00 for all carbonate types.
EF_c - emissions factor for carbon oxydised in glass furnace, tonnes CO_2/tonne carbon;
Mc - mass of the carbon oxydised in glass furnace, tonnes.

Default emission factors for the particular carbonate (tonnes CO_2/tonne carbonate) were used, as provided in 2006 IPCC Guidelines for National Greenhouse Gas Inventories (table 2.1, page 2.7). According to EU ETS report of Kauno stiklas, small quantity of carbon is oxidised directly in glass furnace. The factory uses natural gas as a fuel.

CO_2 emissions were calculated for each production plant based on plant specific data on use of particular carbonates. Summary for each production plant is provided below.

AB Ekranas

The production plant produced cathode ray tubes, but got bankrupt in 2006. Production data (number of cathode ray tubes produced) is available for 1990-2006. EU ETS reports provide data on consumption of particular carbonates: Na_2CO_3, K2 CO_3, Ba CO_3, Ca CO_3, Sr CO_3 and dolomite in 2005 and 2006. Average plant specific emission factor (t CO_2 / t glass produced, excluding cullet) was calculated based on available 2005-2006 data. The emission factor was used for extrapolation of emissions in 1990-2004.

UAB Warta Glass Panevėžys

CO_2 emissions were calculated using plant specific data provided by the production company:

- Glass production data is available for 1990-2011 (tonnes of glass produced).
- Data on cullet use is available for the period 1999-2011.
- Data on consumption of particular carbonates: dolomite, soda ash and chalk is available for 1999-2009. In 1999 -2002 company has also used small quantities of potash and carbon.
- Data on composition of dolomite and chalk is available for the period 2005-2009.
- Since 2005 the company is reporting under EU ETS, thus data on consumption of $MgCO_3$, $CaCO_3$ and Na_2CO_3 is available for the period 2005-2011.

Plant specific emission factor (t CO_2 / t glass produced, excluding cullet) was calculated based on available data outlined above. The emission factor was used for extrapolation of emissions in 1990-1998.

UAB Kauno stiklas

CO_2 emissions were calculated using plant specific data provided by the production company:

- Glass production data is available for 1990-2011 (tonnes of glass produced).
- Data on cullet use is available for the period 2004-2011;
- Data on consumption of particular carbonates: dolomite and soda ash is available for 2004-2006;
- Data on composition of dolomite is available for 2004-2009;
- Since 2007 the company is reporting under EU ETS, thus data on consumption of $MgCO_3$, $CaCO_3$, Na_2CO_3 and Carbon oxidised directly in glass furnace is available for the period 2007-2011.

Plant specific emission factor (t CO_2 / t glass produced, excluding cullet) was calculated based on available data outlined above. The emission factor was used for extrapolation of emissions in 1990-2003.

Estimated CO_2 emissions from glass production are provided in Table 4-11. CH_4 and N_2O emissions from glass production were not estimated due to lack of IPCC methodology.

Table 4-11. Estimated CO_2 emissions (Gg/year) from glass production

Year	CO_2 emission, Gg
1990	11,70
1991	12,36
1992	9,47
1993	5,96

1994	4,96
1995	14,36
1996	13,53
1997	13,47
1998	13,37
1999	13,33
2000	15,38
2001	15,20
2002	9,48
2003	10,41
2004	11,18
2005	10,22
2006	7,28
2007	6,79
2008	7,00
2009	5,10
2010	4,16
2011	6,53

4.2.6.1.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- CO_2 emissions in glass production were calculated from the data on use of raw materials containing carbonates. Data were obtained from the production companies, but only for the second half of the period under consideration (1999-2010). Detailed data on composition of raw materials were available only for the last 6 years. In addition, only very limited data were obtained from cathode ray tubes producer AB Ekranas which got bankrupt in 2006. In view of these considerations, it was assumed that activity data uncertainty for glass production is 7%.
- Emission factor uncertainty is assumed to be 5%;
- Combined uncertainty is 8,6%.

Activity data is not fully consistent over the time-series. Starting from 2005 data is fully consistent and reliable.

4.2.6.1.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

Source category-specific quality control procedures have been carried out in this submission. Emission data for years 2007-2011 have been verified with EU ETS data. The difference between the GHG inventory and the EU ETS data is less than 0,4%, as illustrated in the Table 4-12 below:

Table 4-12. Estimated CO_2 emissions (Gg/year) from glass production. Comparison of GHG inventory and EU ETS data.

EU ETS, Gg CO_2	**2007**	**2008**	**2009**	**2010**	**2011**
Kauno stiklas	2,67	2,95	1,60	1,26	2,45
Panevezio stiklas	4,13	4,04	3,51	2,90	4,10
Glass production, total	6,79	7,00	5,11	4,16	6,55
CRF, Gg CO_2					
Kauno stiklas	2,66	2,97	1,60	1,26	2,45
Panevezio stiklas	4,12	4,03	3,51	2,90	4,08
Glass production, total	6,79	7,00	5,10	4,16	6,53
EU ETS/ CRF					
Kauno stiklas	100,02%	99,50%	100,03%	100,13%	100,03%
Panevezio stiklas	100,12%	100,28%	100,05%	99,93%	100,48%
Glass production, total	100,08%	99,95%	100,04%	99,99%	100,31%

4.2.6.1.5 Source-specific recalculations

CO_2 emissions were recalculated for entire time series:

- New data was obtained on use of carbonates for Ekranas production plant in 2005-2006 (bankrupt in 2006);
- Glass production data was revised for Ekranas production plant (1990-2006), after quality assurance of plant specific emission factors.
- Plant specific emission factors were developed and used for calculation of CO_2 emissions from particular production plant (1990-1998 Warta glass, 1990-2003 Kauno stiklas, 1990-2004 Ekranas).
- Cullet used for glass production was excluded from CO_2 emission calculations;
- More precise EF for carbonates were introduced and used consistently for entire time series.

4.2.6.1.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.2.6.2 Mineral Wool Production

4.2.6.2.1 Source Category Description

Two mineral wool plants were in operation in Lithuania in 1990. The Alytus plant was closed soon after independence. AB Silikatas continued operation but production was constantly decreasing. Finally it was bought by the Finnish company Paroc which performed major upgrading of the plant in 1996 when production fell down actually to zero.

It was not possible to find actual data on mineral wool production from 1990 to 1997. Evaluation of production figures for that period based on remaining data was performed by prof. A. Kaminskas who was the director of the Institute of Thermal Insulation in Vilnius in eighties and nineties. Production data for the period 1998-2011 were provided by the UAB Paroc company.

Mineral wool production during 1990- 2011 is shown in Figure 4-11.

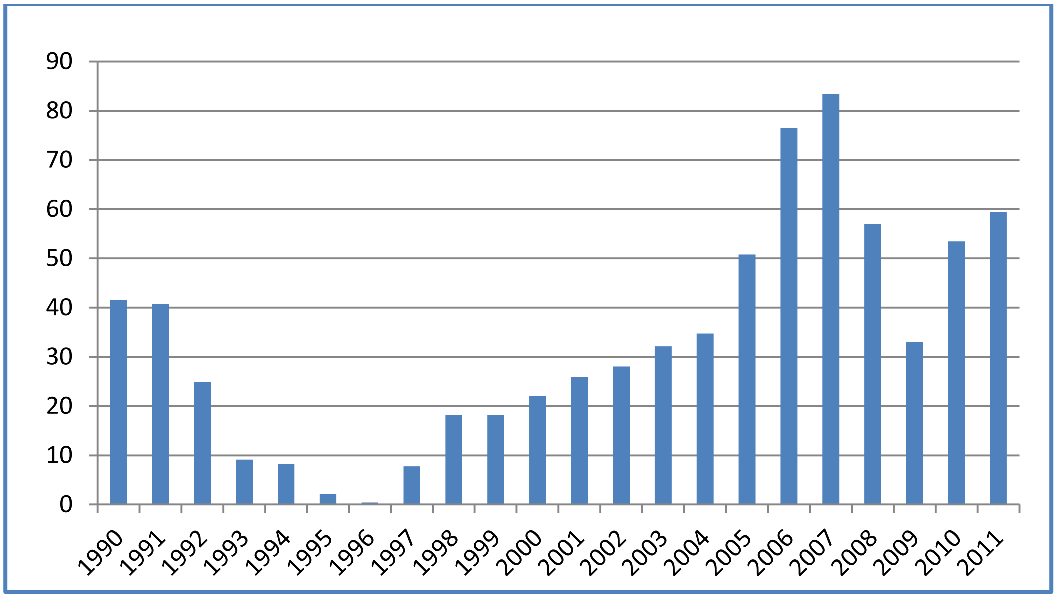

Figure 4-11. Mineral wool production in 1990-2011, Gg

In mineral wool production CO_2 is formed by decomposition of dolomite. Data on consumption of dolomite for production of the mineral wool was provided by the Paroc company (1997-2011).

4.2.6.2.2 Methodological issues

CO_2 emissions from mineral wool production were recalculated using new more accurate and reliable data provided by the production company UAB Paroc.

The production company has provided data on:

- total production 1998 – 2011;
- dolomite consumption 1997 – 2011;
- CO_2 emission factors (t CO_2/t dolomite) 2008 – 2011.

Difference in emission factor for dolomite is due to moisture of the raw material.

CO_2 emissions in 1997-2010 were calculated using data on consumption of dolomite and emission factor provided by the production company (for the period 1997-2007 average emission factors was used 0,43 t CO_2/t dolomite).

Based on the results, average emission factor for CO_2 emission from mineral wool production was calculated as 0,15 tonnes CO_2 per tonne mineral wool produced. This emission factor was used for calculation on CO_2 emission in 1990-1996.

Estimated CO_2 emissions from mineral wool production are provided in Table 4-13.

Table 4-13. Estimated CO_2 emissions (Gg/year) from mineral wool production

Year	Emission
1990	6,3
1991	6,2
1992	3,8

1993	1,4
1994	1,3
1995	0,3
1996	0,1
1997	1,8
1998	3,1
1999	3,0
2000	3,3
2001	3,6
2002	3,5
2003	4,6
2004	5,1
2005	8,0
2006	12,0
2007	12,3
2008	9,0
2009	4,9
2010	8,3
2011	9,1

4.2.6.2.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- The data on mineral wool production and raw materials consumption obtained from the production company are reliable and precise, however, they cover only the period after reconstruction of the plant (from 1997). Historic data for 1990-1996 are expert evaluation and is less reliable. It was assumed that overall uncertainty of mineral wool production activity data is 7%.
- Emission factor uncertainty is assumed to be 5%;
- Combined uncertainty is 8,6%.

Production data for the period 1998-2011 were provided by the producer company. Activity data is not available for the period 1990-1997 and was extrapolated.

4.2.6.2.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.
Source category-specific quality control procedures have been carried out in this submission. The recalculated emission data based on updated activity data and plant-specific emission factors provided by the producer for years 2008-2011 have been verified with ETS data and the correspondence between these data is 100%.

4.2.6.2.5 Source-specific recalculations

No source-specific recalculations were done.

4.2.6.2.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.2.6.3 Bricks and Tiles Production

4.2.6.3.1 Source Category Description

Data on ceramic bricks, tiles and vitrified clay pipes production were taken from Statistics Lithuania publications[19]. Production of bricks, tiles and clay pipes has fallen down dramatically from 1990. Tiles are not produced since 2004 and vitrified clay pipes are not produced since 2007.

Ceramic bricks production data from Statistics Lithuania publications for various periods are provided in different units. The data for 1990-2001 are provided in millions of bricks, while the data for the following years are in thousands cubic metres. Recalculation of data to mass units was made by applying average conversion factors based on information provided by the largest ceramic bricks and pipes producer in Lithuania AB Palemono Keramika[20]. It was assumed that average brick mass is 2,7 kg and average volume weight of bricks is 1,6 t/m^3.

Vitrified clay pipes production data from Statistics Lithuania publications are provided in thousands of kilometres for the period 1990-2001 and in tonnes for the remaining period. Production of vitrified clay pipes were converted to mass units using conversion factor 3,0 tonnes per km.

Ceramic tiles production data were provided in square metres from 1990 to 2001 and in tile units from 2002. These data were converted to weight units assuming that average tile area is 350×200 mm and average weight is 2,8 kg (information by AB Palemono Keramika). Ceramics production in Lithuania in 1990-2011 is provided in Figure 4-12.

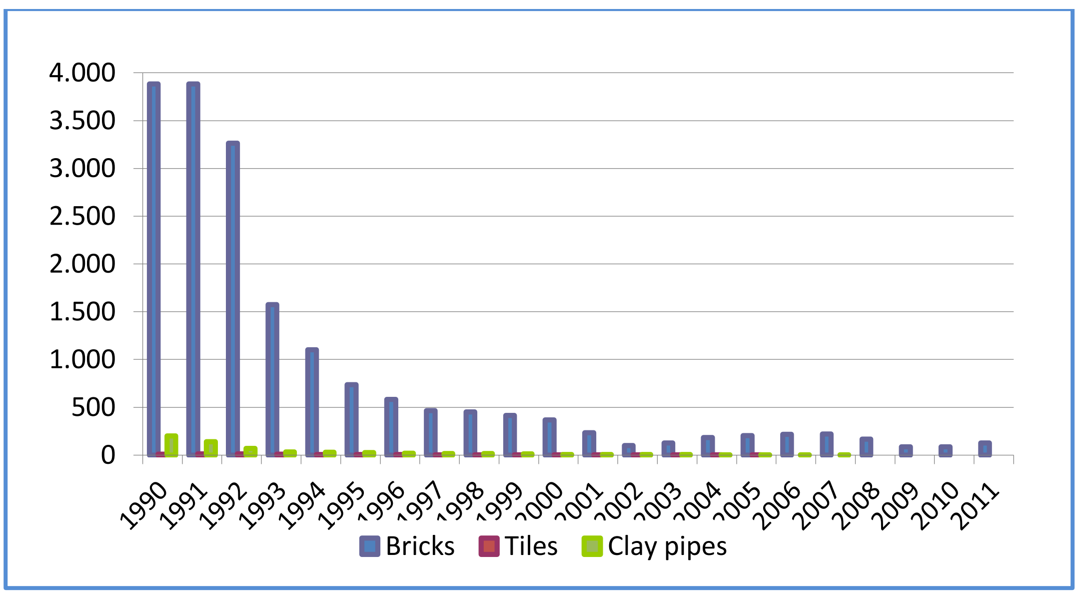

Figure 4-12. Production of ceramic products in 1990-2011, k tonnes

[19] http://db1.stat.gov.lt/statbank/default.asp?w=1440
[20] http://www.palemonokeramika.lt/

4.2.6.3.2 Methodological issues

CO_2 emissions from ceramics production were calculated from material balance based on CaO and MgO contents in the product provided by the AB Palemono Keramika. According to the company, CaO content in bricks is fluctuating from 3,5% to 4,7% and MgO content is varying from 1,65% to 2,65%. Average values of 4,1% CaO and 2,15% MgO were taken as emission factors for calculation of emissions.

CO_2 emissions were calculated using the following equation:

$$Emission = CP \times (C_{CaO} \times (M_{CO2}/M_{CaO}) + C_{MgO} \times (M_{CO2}/M_{MgO}).$$

where:

CP - ceramics production, Gg;

C_{CaO} and C_{MgO} - CaO and MgO fractions in ceramics products;

M_{CO2}, M_{CaO}, M_{MgO} - molecular weights of CO_2, CaO and MgO.

Estimated CO_2 emissions from ceramics production are provided in Table 4-14.

Table 4-14. Estimated CO_2 emissions (Gg/year) from briks and tiles production

Year	Emission
1990	228,1
1991	224,8
1992	186,3
1993	90,0
1994	63,3
1995	42,8
1996	33,9
1997	27,1
1998	26,2
1999	23,9
2000	20,9
2001	13,6
2002	6,0
2003	7,4
2004	10,3
2005	11,4
2006	12,1
2007	12,4
2008	9,2
2009	4,9
2010	4,8
2011	7,0

4.2.6.3.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- Activity data uncertainty is assumed to be 5%;
- Emission factor uncertainty is assumed to be 5%;
- Combined uncertainty is 7,1%.

Data on ceramic bricks, tiles and vitrified clay pipes production were taken from Statistics Lithuania publications[21]. Ceramic bricks production data in Statistics Lithuania publications for various periods are provided in different units. Data for 1990-2001 are provided in millions of bricks, while the data for the following years are in thousands cubic metres. Recalculation of data to mass units was made. Vitrified clay pipes production data in Statistics Lithuania publications are provided in thousands of kilometres for the period 1990-2001 and in tonnes for the remaining period. Production of vitrified clay pipes were converted to mass units. Ceramic tiles production data were provided in square metres from 1990 to 2001 and in tile units from 2002. These data were converted to weight units.

4.2.6.3.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

4.2.6.3.5 Source-specific recalculations

No source-specific recalculations were done.

4.2.6.3.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.3 Chemical Industry (CRF 2.B)

In Lithuanian GHG inventory this category includes non-fuel emissions of CO_2 from ammonia production, nitrous oxide from nitric acid production and CH_4 emissions from methanol production (Table 4-15).

Table 4-15. Reported emissions under the subcategory Chemical industry

CRF	Source	Emissions reported
2.B.1	Ammonia production	CO_2
2.B.2	Nitric acid production	N_2O
2.B.5.5	Methanol	CH_4

Ammonia and nitric acid production are key sources of this source category in Lithuanian inventory. Adipic acid, carbides, carbon black, dichloroethylene and styrene are not produced in Lithuania.

Emissions of chemical industry in 2011 were 2231,08 Gg CO_2 eq., and it was 85% of industry sector emissions.

[21] http://db1.stat.gov.lt/statbank/default.asp?w=1440

Nitric acid and ammonia is nowadays produced in Lithuania in a single company. Emissions of CO_2 from ammonia production were 2231,08 Gg in 2011. Emissions of N_2O from nitric acid production were 2,85 Gg in 2011. Ammonia and nitric acid production show recovery after the financial crisis and reached the levels of 2007-2008. Significant decline in N_2O emissions in 2009 - 2011 are due to installing of secondary catalyst in August 2008.

Emissions of CH_4 from methanol production comprise a small fraction in the emissions of greenhouse gases from chemical industry (did not exceed 0,2% during the whole time series 1990-2008). No methanol was produced in 1999, 2009 - 2011.

4.3.1 Ammonia Production (CRF 2.B.1)

4.3.1.1 Source Category Description

AB Achema is a single ammonia production company in Lithuania. In the production plant ammonia is produced at 22,0-24,0 MPa pressure from hydrogen and nitrogen, which are generated at 800-1000 °C temperatures by conversion of natural gas. The converted gas is cleaned from impurities (CO, CO_2, H_2O vapour, etc.).

Capacities of ammonia production:

- AM-70 unit – project (design or primary) capacity was 1360 t/day; after reconstruction (in 1995) it reached 1560 t/day or 569400 t/year.
- AM-80 unit – project capacity is 1560 t/day or 569400 t/year.
- Total ammonia capacity is 1138800 t/year.

Ammonia production and natural gas consumption data (Figure 4-13) were provided by AB Achema company. Other fuels are not used in the ammonia production process. At the production plant, the natural gas is measured at the entrance point to the ammonia production unit, the flows for heating and ammonia production process are not separately measured.

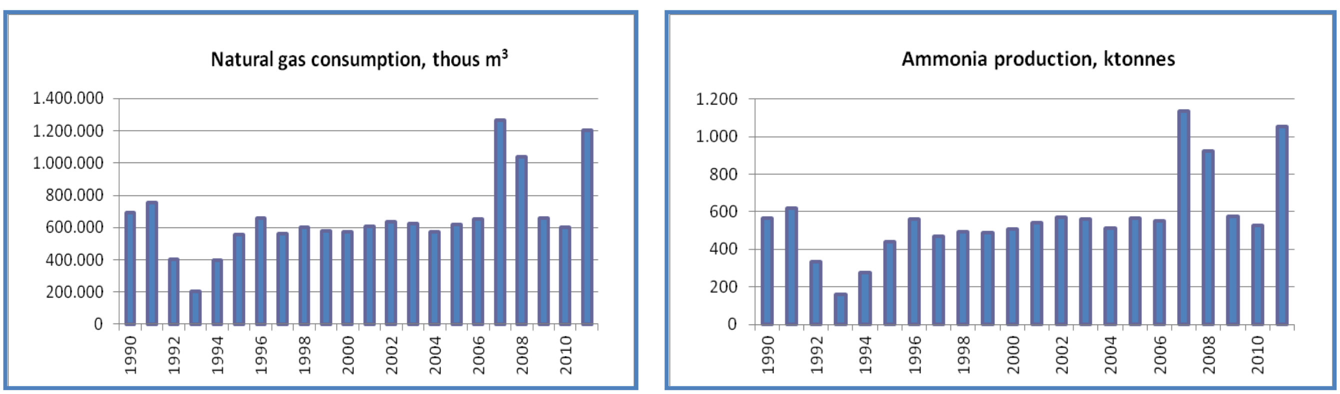

Figure 4-13. Natural gas consumption and ammonia production

Variations in ammonia production closely follow the variations in natural gas consumption. A sharp downwards trend in ammonia production in 2008-2010 was caused by the financial crisis. In 2011 ammonia production has increased by 100% as compared to 2010.

4.3.1.2 Methodological issues

In 2011 Lithuania has revised calculation method for CO_2 emissions from ammonia production. The producer has confirmed that carbon content factor used in the previous submissions were calculated back from the estimated CO_2 emissions. Therefore it was decided to use country specific energy sector emission factor.

The producer has provided complete data for the whole time series on ammonia production, natural gas consumption and lower calorific values (annual average) of natural gas. Recalculation was made for the whole time series. CO_2 emissions were calculated from the total fuel requirements data using Tier 3 method (2006 IPCC Guidelines, page 3.13). CO_2 emissions were calculated from the natural gas consumption using country specific emission factor.

$$CO_2 \text{ emitted} = TFR \times Cv \times 4.186 \times 10^{-9} \times EF$$

Where:

TFR_{NG} – Total fuel requirements for ammonia production (= total consumption of natural gas, thousand m^3). This includes the natural gas used for heating as well as ammonia production process;

Cv – lower calorific value of the natural gas (kcal/m^3);

4.186×10^{-9} – conversion factor TJ/kcal;

EF – Country specific CO_2 emission factor for natural gas (tCO_2/TJ). Constant emission factor 55.23 tCO_2/TJ is used over the whole time series. Justification of the country specific emission factor for natural gas is provided in NIR Energy chapter.

Data on average annual lower calorific value of natural gas is provided by the producer for the whole time series. Data is calculated on the basis of reports from the natural gas supplier AB „Lietuvos dujos". Calorific value of supplied natural gas is measured twice per month at Lithuania's natural gas supplier (AB "Lietuvos dujos") laboratory.

The same company produces urea and dry ice. In estimating CO_2 emissions from ammonia production, no account was taken for intermediate binding of CO_2 in downstream manufacturing processes and products (Revised 1996 IPCC Reference Manual p. 2.16).

Ammonia production (k tonnes/year), estimated CO_2 emissions (Gg/year) and implied emission factor (t CO_2 per tonne of ammonia produced) are provided in Table 4-16.

Table 4-16. Ammonia production (k tonnes/year), estimated CO_2 emissions (Gg/year) and implied emission factor (t CO_2 per tonne of ammonia produced)

Year	Ammonia production, k tonnes	Emission, Gg/year	Implied emission factor, t CO_2 per tonne of ammonia produced
1990	568,4	1291,5	2,27
1991	619,6	1407,2	2,27
1992	334,0	747,2	2,24

1993	157,9	377,9	2,39
1994	277,2	743,5	2,68
1995	442,3	1017,3	2,30
1996	560,6	1208,4	2,16
1997	467,3	1034,9	2,21
1998	495,6	1102,1	2,22
1999	487,3	1067,1	2,19
2000	509,9	1055,5	2,07
2001	540,1	1131,6	2,10
2002	568,6	1168,9	2,06
2003	561,2	1155,5	2,06
2004	515,2	1063,1	2,06
2005	565,5	1141,8	2,02
2006	551,1	1208,1	2,19
2007	1137,6	2339,8	2,06
2008	921,9	1925,1	2,09
2009	574,4	1223,1	2,13
2010	527,2	1115,3	2,12
2011	1056,0	2231,1	2,11

Variations in implied emission factor (t CO_2 per tonne of ammonia) are due to:

- Calorific value of the natural gas – variation is in the range of 1.2% from the 1990-2011 average;
- Stability of the production process and operation schedule of the production line. If the production process is not stable and/ or ammonia production has to be stopped and restarted again, share of natural gas used for thermal processes increases and thus higher values of EF (t CO_2 per tonne of ammonia) are obtained.

4.3.1.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- Activity data uncertainty is assumed to be 2%;
- Emission factor uncertainty is assumed to be 2.5%;
- Combined uncertainty is 3.2%.

The data is consistent over the time-series. Natural gas consumption data and annual average lower calorific values of the natural gas was provided by the production company. The same emission factor is used over the time-series.

4.3.1.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

4.3.1.5 Source-specific recalculations

The CO_2 emissions from ammonia production were recalculated for the whole time series.

The produced has confirmed that carbon content factor used in the previous submissions were calculated back from the estimated CO_2 emissions. Therefore it was decided to use country specific energy sector emission factor. Minor errors in activity data were eliminated.

More information on the country specific emission factor for natural gas is provided in NIR Energy chapter.

4.3.1.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.3.2 Nitric Acid Production (CRF 2.B.2)

4.3.2.1 Source Category Description

Nitric acid is produced by AB Achema which is the single nitric acid producer in Lithuania. According to information provided by AB Achema, the nitric acid is produced in UKL-7 units and GP unit by absorbing NO_2 with water. NO_2 is produced by air oxidation of NO with oxygen. Nitric oxide (NO) produced by air oxidation of ammonia with oxygen on Pt mesh catalyst. UKL-7 units are working by single pressure (high pressure) scheme. Gaseous emissions after absorption are cleaned from NOx in a reactor. Grande Paroisse (GP) unit uses a dual-pressure scheme (medium/high). Gaseous emissions from GP are cleaned from NOx in the reactor using a DeNOx technology.

Capacities:
At present AB Achema operates 9 UKL-7 units. The biggest capacity of one UKL-7 unit is 120 thous t/year (calculated to 100% HNO_3). Capacity of all UKL-7 units is 1080 thous t/year. Capacity of GP unit is 360 thous t/year. Total nitric acid production capacity is 1440 thous t/year.
Information on nitric acid production units operated during 1990-2011 period in AB Achema is provided in Table 4-17.

Table 4-17. Nitric acid production units in AB Achema in 1990-2011

Nitric acid production unit	1990-2002	2003	2004	2005-2008	2009-2011
UKL-1	operational	operational	operational	operational	operational
UKL-2	operational	operational	operational	operational	operational
UKL-3	operational	operational	operational	operational	operational
UKL-4	operational	operational	operational	operational	operational
UKL-5	operational	operational	operational	operational	operational
UKL-6	operational	operational	operational	operational	operational
UKL-7		operational	operational	operational	operational
UKL-8				operational	operational
UKL-9					operational
GP unit			operational	operational	operational

The Joint Implementation project "Nitrous Oxide Emission Reduction Project at GP Nitric Acid Plant in AB Achema Fertiliser Factory" was carried out by installing secondary catalyst in August 2008. The baseline campaign was launched from September 2007 to July 2008 during which emissions were monitored to determine the baseline emissions of the plant. After installing of the secondary catalyst, the first project campaign was launched and the Project emissions monitored until the end of the campaign – 26 September 2009.

BASF technology was applied by introducing a new catalyst bed which was installed in a new basket, directly under the Platinum gauze in the nitric acid reactors. The secondary catalyst (on Al_2O_3 basis with active metal oxides CuO and ZnO) was installed underneath the platinum gauze. In order to be able to install a secondary catalyst the reconstruction of a burner basket was performed.

Nitric acid production data (Figure 4-14) were provided by AB Achema.

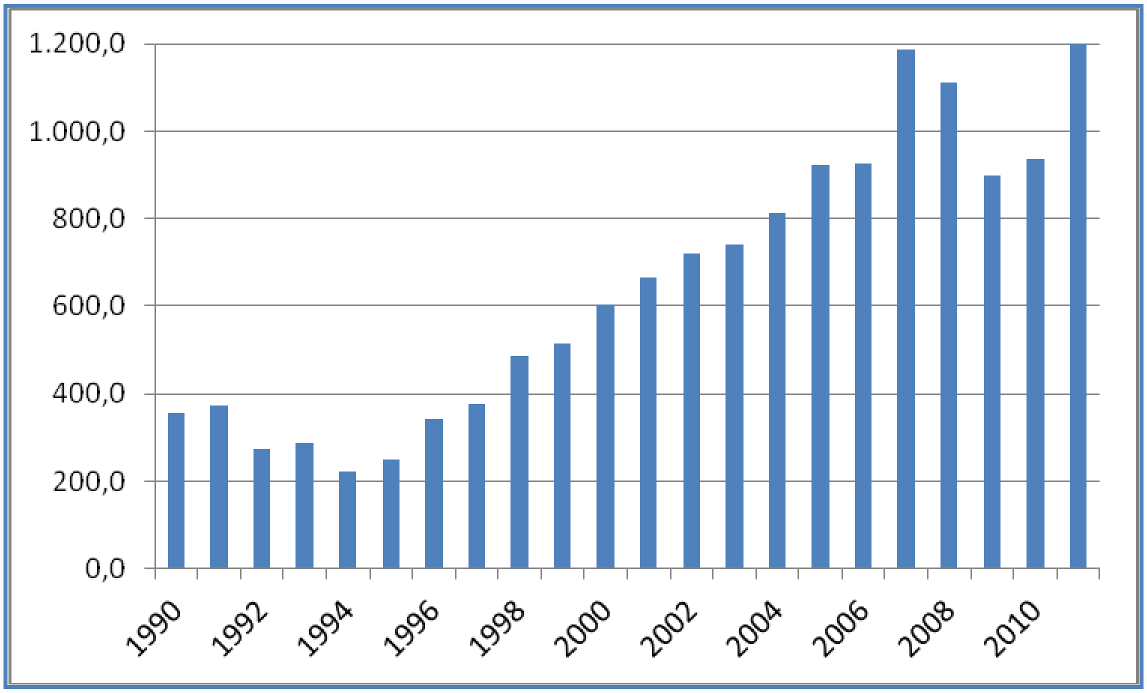

Figure 4-14. Nitric acid production, thousand tonnes (100% acid)

4.3.2.2 Methodological issues

The N_2O emissions from the nitric acid production were estimated based on the following data:

- Annual production of nitric acid:
  - Data on the level of production plant (1990-2008);
  - Data on the level of production units (2009-2011);
- Production unit specific N_2O emission factors (Table 4-18):
  - Prior to installation of catalyst (2007-2008 monitoring campaign data);
  - After installation of catalyst (2009, 2010 and 2011);

For the years 2009-2011 production unit specific N_2O emission factors were obtained from the producer (Table 4-18). The emisison factors were measured and registered in automated monitoring system (AMS) by AB Achema.

Table 4-18. Production unit specific N_2O emission factors calculated using measured and registered data in automated monitoring system, kg N_2O / t HNO_3 (100%)

Production unit code	2007-2008*	2009	2010	2011
UKL-1	9,63	1,72	1,86	1,87
UKL-2	9,51	1,43	1,42	1,65
UKL-3	5,45	2,22	2,92	2,16
UKL-4	7,73	1,88	2,4	1,68
UKL-5	6,61	2,07	1,87	1,69
UKL-6	10,34	3,73	3,51	2,65
UKL-7	9,09	2,70	1,54	1,16
UKL-8	6,96	2,35	1,58	1,50
UKL-9	not operational	4,81	4,84	6,65
GP	8,83	1,17	0,96	2,32

* Data source: Report of the AB Achema for the calculation of EU allowances for the third EU ETS period 2013-2020.

Annual emissions of N_2O from nitric acid production were estimated :

- 1990-2008: based on extrapolated unit specific activity data and the mean value of EFs of the actually operating units;
- 2009-2001: based on unit-specific activity data and unit-specific EFs.

For 1990-2008 emissions calculation production of nitric acid for each operational unit was extrapolated from the data on total annual production of nitric acid in a particular year based on information on unit-specific output (share of each production unit as % of the total production based on 2009-2010 data). Mean value of EFs of the actually operating production units is based on 2007-2008 measurements in automated monitoring system prior to installation of the catalyst (Table 4-18).

For 2009-2011 emissions calculation N_2O emissions were estimated using unit specific emission factors (Table 4-18) and unit specific production data provided by the producer. As already mentioned, in 2008 JI project for N_2O emission reduction from the nitric acid plant in AB Achema has started. During the implementation of the project, substantial emission reduction was achieved as monitored in a automated monitoring system (Table 4-18).

Estimated emissions of N_2O from nitric acid production are provided in Table 4-19.

Table 4-19. Estimated emissions of N_2O (Gg/year) from nitric acid production.

Year	Emission
1990	3,00
1991	3,14
1992	2,30
1993	2,41
1994	1,88
1995	2,10

1996	2,88
1997	3,18
1998	4,11
1999	4,33
2000	5,08
2001	5,61
2002	6,06
2003	6,31
2004	6,99
2005	7,79
2006	7,81
2007	10,04
2008	9,38
2009	2,12
2010	1,86
2011	2,85

4.3.2.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- Activity data is provided by a single producer. Uncertainty is assumed to be 2%;
- Emission factor uncertainty is assumed to be 10%;
- Combined uncertainty is 10.2%.

4.3.2.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

Plant specific emission factors were compared with IPCC GPG default factors. The plant specific EFs used for GHG inventory calculations are in the range of EFs provided in Table 3.8 (IPCC 2000 Guidance page 3.35), both for plants without abatement measures installed and for plants using catalytic reduction. Since 2007, plant specific EFs are based on measurements carried out in automated monitoring system by the plant, therefore it is considered that those plant-specific EFs represent the best possible knowledge and are accurate.

4.3.2.5 Source-specific recalculations

No source-specific recalculations were done.

4.3.2.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.3.3 Methanol Production (CRF 2.B.5)

4.3.3.1 Source Category Description

AB Achema company is a single methanol production company in Lithuania. According to information provided by the company, methanol is produced from the CO, CO_2 and H_2. The medium temperature technological scheme was used in which methanol synthesis reactions are carried out in 8,0 MPa and 180-280°C. Gases required for methanol synthesis are generated by converting natural gas. Project capacity of methanol unit is 74000 t/year.

Methanol production data (Figure 4-15) 1990-2008 were obtained from Statistics Lithuania publications[22]. According to AB Achema data methanol was not produced in 1999, 2009 – 2011.

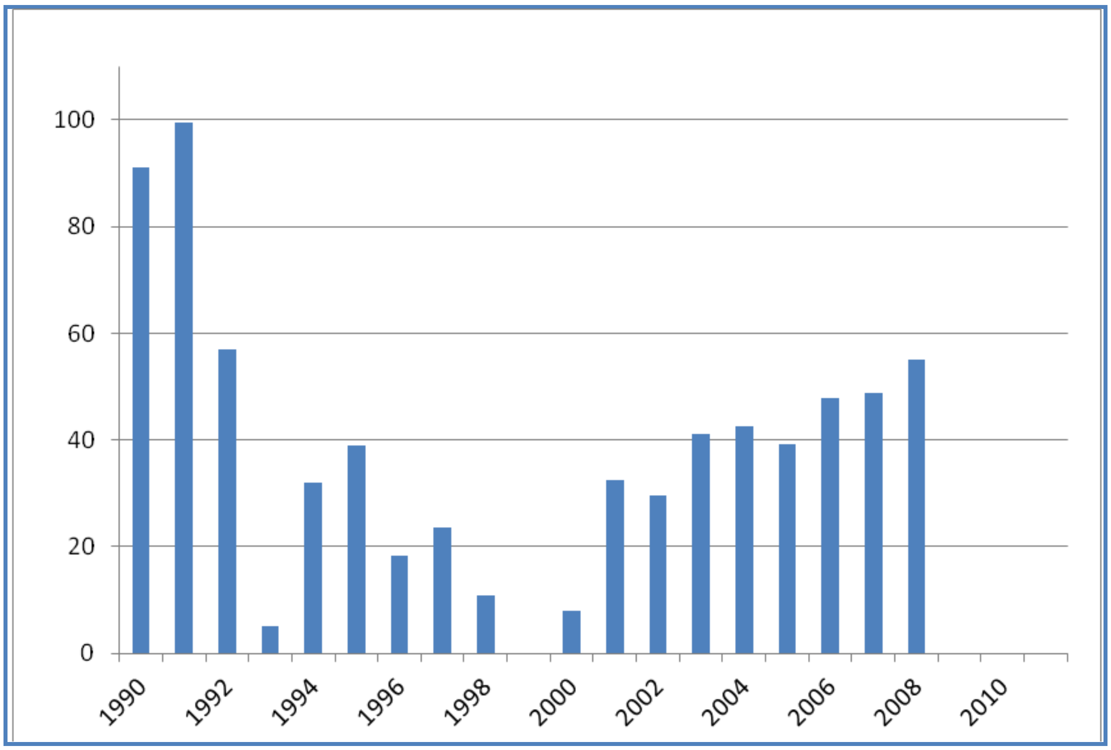

Figure 4-15. Methanol production, k tonnes

4.3.3.2 Methodological issues

CH_4 emissions were calculated from methanol production data using emission factor 2 kg CH_4 per tonne of produced methanol taken from the Revised 1996 IPCC Guidelines (Table 2-9, p. 2.22). Estimated emissions of CH_4 (Gg/year) from methanol production are provided in Table 4-20.

Table 4-20. Estimated emissions of CH_4 (Gg/year) from methanol production

Year	Emission
1990	0,182
1991	0,199
1992	0,114

[22] http://db1.stat.gov.lt/statbank/default.asp?w=1440

1993	0,010
1994	0,064
1995	0,078
1996	0,036
1997	0,047
1998	0,022
1999	NO
2000	0,016
2001	0,065
2002	0,059
2003	0,082
2004	0,085
2005	0,078
2006	0,096
2007	0,098
2008	0,110
2009	NO
2010	NO
2011	NO

4.3.3.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- Activity data was obtained from Statistics Lithuania publications. Uncertainty is assumed to be 5%;
- Emission factor uncertainty is assumed to be 30%;
- Combined uncertainty is 30,4%.

Data is consistent over the time-series. Methanol production activity data 1990-2008 was obtained from Statistics Lithuania publications. According to the production company no methanol was produced in 1999, 2009 – 2011.

4.3.3.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

4.3.3.5 Source-specific recalculations

No source-specific recalculations were done.

4.3.3.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.4 Metal production (CRF 2.C)

In Lithuanian GHG inventory this category includes non-fuel emissions of CO_2 from pig iron production (Table 4-21). There are two facilities producing cast iron in blast furnaces and one facility using electric arc furnace in Lithuania. Only scrap metal is used as raw material.

Table 4-21. Reported emissions under the subcategory Metal production

CRF	Source	Emissions reported
2.C.1.2	Pig iron production	CO_2

There are no key sources in this source category. Steel, sinter, coke, ferroalloys and aluminium are not produced in Lithuania. Emissions from metal production in 2011 were 3,72 Gg CO_2 eq., and it was only 0,1% of industry sector's emissions.

4.4.1 Iron and Steel Production (CRF 2.C.1)

4.4.1.1 Source Category Description

There are two facilities producing cast iron in blast furnaces and one facility using electric arc furnace in Lithuania. Only scrap metal is used as raw material.

Data from the total cast iron production are provided by Statistics Lithuania[23]. Data on cast iron production in blast furnaces and on coke consumption were obtained from the plants. Variations of cast iron production are shown in Figure 4-16.

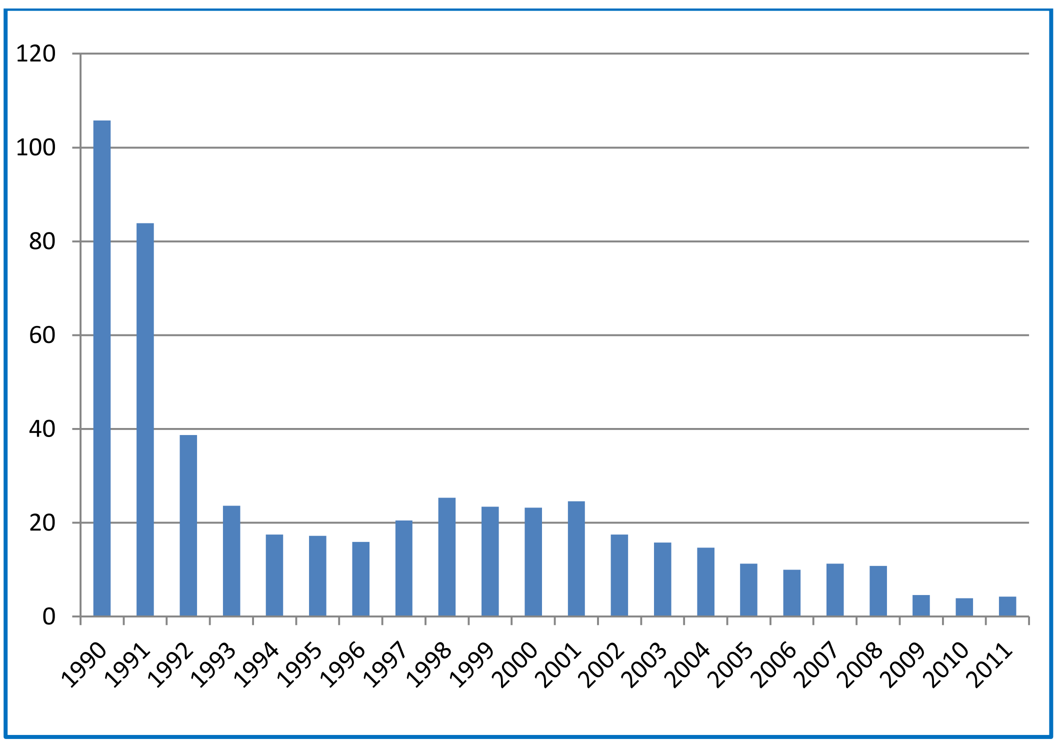

Figure 4-16. Cast iron production, k tonnes

[23] http://db1.stat.gov.lt/statbank/default.asp?w=1440

4.4.1.2 Methodological issues

CO_2 emissions from blast furnaces were calculated from coke consumption using default emission factor 3.1 tonnes CO_2 per tonne coke (Revised 1996 IPCC Guidelines. Table 2-12, p. 2.26).

Revised 1996 IPCC Guidelines do not provide emission factor for electric arc furnaces. Therefore emission factor 0,08 tonne CO_2 per tonne of steel produced is provided in 2006 IPCC Guidelines was used for evaluation of CO_2 emissions from electric arc furnace.

Estimated CO_2 emissions from cast iron production are shown in Table 4-22.

Table 4-22. Estimated CO_2 emissions (Gg/year) from Iron and Steel production

Year	Emission
1990	21,4
1991	17,2
1992	8,5
1993	6,2
1994	5,8
1995	5,0
1996	5,5
1997	6,0
1998	6,6
1999	7,0
2000	7,5
2001	7,8
2002	7,5
2003	7,0
2004	7,0
2005	7,2
2006	6,9
2007	6,5
2008	4,8
2009	4,0
2010	4,1
2011	3,7

4.4.1.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- Data on the total cast iron production were taken from Statistics Lithuania and data on cast iron production in blast furnaces were provided by the production companies. Uncertainty of the activity data is assumed to be 4%;
- In Lithuania cast iron is produced only from iron scrap while default emission factors are established for production from iron ores. Emission factor uncertainty is assumed to be 10%;

- Combined uncertainty is 10,8%.

Data is consistent over the time-series. Data on the total cast iron production are provided by Statistics Lithuania. Data on cast iron production in blast furnaces and on coke consumption were obtained from the production plants.

4.4.1.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

4.4.1.5 Source-specific recalculations

Errors in historical data on coke consumption were corrected. CO_2 emissions from Iron and Steel production were recalculated for the years 1995, 2002, 2003 and 2008.

4.4.1.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.5 Other production (CRF 2.D)

In Lithuanian inventory this category includes non-fuel emissions of SO_2 from paper and pulp production and NMVOC and CO_2 emissions from food and drink production (Table 4-23). Pulp was produced in Lithuania in 1990-1993 in a single paper mill AB Klaipėdos kartonas. From 1994 to 2010 paper and corrugated board used for manufacturing of sanitarian and domestic products are made in the process of recycling the secondary raw material – waste-paper. Pulp is not produced in Lithuania since 1993.

NMVOC emissions from food and drink production are calculated based on data from Statistics Lithuania.

Table 4-23. Reported emissions under the subcategory Other production

CRF	Source	Emissions reported
2.D.1	Pulp and Paper	SO_2
2.D.2	Food and Drink	NMVOC, CO_2

There are no key sources in this category. Emissions from other production were 8,25 Gg CO_2 eq. in 2011 and it was 0,3% of industry sector's emissions.

4.5.1 Pulp and paper (CRF 2.D.1)

4.5.1.1 Source Category Description

Paper is produced in two companies in Lithuania. Pulp was produced in AB Klaipėdos kartonas company from 1990 to 1993. From 1994 to 2011 paper and corrugated board used for manufacturing of sanitarian and domestic products are made in the process of recycling the secondary raw material

– waste-paper. Data on the pulp production was provided by AB Klaipėdos kartonas. Variations of pulp production are shown in Figure 4-17.

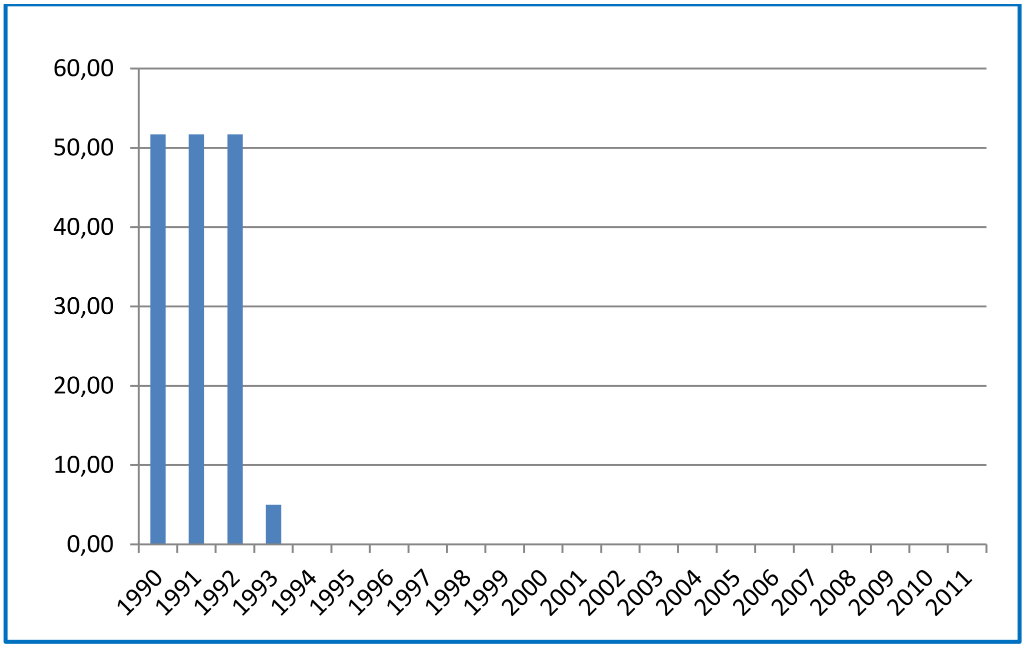

Figure 4-17. Pulp production, k tonnes

4.5.1.2 Methodological issues

Emissions of SO_2 from pulp and paper manufacturing were calculated using IPCC simple methodology (Revised 1996 IPCC Guidelines, p. 2.39-2.40). AB Klaipėdos kartonas used acid sulphite pulping process for production of pulp. SO_2 emissions were calculated from pulp production data using default emission factor 30 kg SO_2 per tonne dried pulp (Revised 1996 IPCC Guidelines, Table 2-23, p. 2.40). Estimated SO_2 emissions from pulp production are shown in Table 4-24.

Table 4-24 Estimated SO_2 emissions (Gg/year) from pulp and paper production

Year	Emission
1990	1,55
1991	1,55
1992	1,55
1993	0,15
1994-2011	NO

4.5.1.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- Uncertainty of activity data is assumed to be 10%;
- Emission factor uncertainty is assumed to be 5%;
- Combined uncertainty is 11,2%.

Historical data on production of pulp was obtained from production companies and covers period 1990-1993. Production of pulp was stopped in 1993.

4.5.1.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

4.5.1.5 Source-specific recalculations

Data on emissions from pulp and paper production are reported for the first time in Lithuanian inventory.

4.5.1.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.5.2 Food and drink (CRF 2.D.2)

4.5.2.1 Source Category Description

Data on production of food and drink products were taken from Statistics Lithuania publications[24]. Data is available for 2000-2011. Data on production of the following beverages was used for greenhouse gas emission inventory: spirits and liqueurs, grape wine, fruit and berry wine, sparkling grape wine and beer (Table 4-25).

Table 4-25. Total annual production of beverages, thousand decaliters in 2000-2011

Year	Spirits and liqueurs	Grape wine	Fruit and berry wine	Sparkling grape wine	Beer
2000	854	169	1245	234	21049
2001	899	127	889	302	21935
2002	908	203	872	269	26885
2003	932	140	890	215	26417
2004	1068	249	983	267	26898
2005	1230	463	1055	322	28946
2006	1519	388	1161	409	29340
2007	1853	342	1374	544	28564
2008	1546	297	1371	538	29685
2009	1038	246	1233	294	27623
2010	893	290	1370	434	29182
2011	932	175	1421	437	30511

Note: Spirits and liqueurs are expressed as 100% alcohol

Average for the period 2000-2011 was used to estimate production of beverages for the period 1990-1999.

[24] http://db1.stat.gov.lt/statbank/default.asp?w=1440

Data on production of the following products was used for greenhouse gas emission inventory: meat and meat sub products, food fish and marine products, sugar, confectionery products, bread and pastry products and prepared mixed animal feeds (Table 4-26).

Table 4-26. Total annual production of food products, k tonnes in 2000-2011

Year	Meat and meat sub products	Food fish and marine products	Sugar	Confectionery products	Bread and pastry products	Prepared mixed animal feeds
2000	79	52	127	44	180	265
2001	71	66	109	41	189	254
2002	83	59	138	43	187	277
2003	106	58	132	41	178	282
2004	118	64	133	45	186	360
2005	159	73	125	47	193	394
2006	165	64	97	50	183	454
2007	186	64	125	51	173	483
2008	173	65	70	49	169	350
2009	155	64	107	45	158	380
2010	182	76	104	47	158	433
2011	180	67	135	52	150	426

Average for the period 2000-2011 was used to estimate food production for the period 1990-1999.

4.5.2.2 Methodological issues

NMVOC emissions from food and drink production are calculated based on total annual production data (Revised 1996 IPCC Guidelines, p. 2.41-2.42). NMVOC emissions were calculated using default emission factors (Revised 1996 IPCC Guidelines, Table 2-24, p. 2.41, Table 2-25, p.2.42). Emission factors are provided in Table 4-27.

Table 4-27. Emission factors for beverages and food production

Product	Category in Lithuanian Statistics	Emission factor (NMVOC)
Beverages, kg/HL beverage		
Spirits (unspecified)	Spirits and liqueurs	15,0
Wine	Grape wine	0,08
	Fruit and berry wine	
	Sparkling grape wine	
Beer	Beer	0,035

Food production, kg/tonne product		
Meat, fish and poultry	Meat and meat sub products	0,3
	Food fish and marine products	
Sugar	Sugar	10,0
Cakes, biscuits and breakfast cereals	Confectionery products	1,0
Bread	Bread and pastry products	8,0
Animal Feed	Prepared mixed animal feeds	1,0

Estimated NMVOC emissions from food and drink production were converted to CO_2 equivalent using factor of 1,91 tonne CO_2 per t NMVOC (factor for ethanol). Estimated NMVOC and CO_2 eq. emissions from food and drink production are shown in Table 4-28.

Table 4-28. Estimated NMVOC and CO2 eq. emissions (Gg/year) from food and drink production

Year	NMVOC	CO_2 eq.
1990	4,9	9,3
1991	4,9	9,3
1992	4,9	9,3
1993	4,9	9,3
1994	4,9	9,3
1995	4,9	9,3
1996	4,9	9,3
1997	4,9	9,3
1998	4,9	9,3
1999	4,9	9,3
2000	4,4	8,4
2001	4,4	8,4
2002	4,7	9,0
2003	4,6	8,8
2004	5,0	9,5
2005	5,3	10,1
2006	5,4	10,3
2007	6,1	11,7
2008	5,0	9,5
2009	4,5	8,6
2010	4,3	8,3
2011	4,6	8,8

4.5.2.3 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- Activity data was obtained from Statistics Lithuania publications. Uncertainty is assumed to be 5%;
- Emission factor uncertainty is assumed to be 5%;
- Combined uncertainty is 7,1%.

Data is consistent over the time-series. Data on total annual production of food and drink products were taken from Statistics Lithuania publications.

4.5.2.4 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

4.5.2.5 Source-specific recalculations

No source-specific recalculations were done.

4.5.2.6 Source-specific planned improvements

No source-specific improvements have been planned.

4.6 Production of Halocarbons and SF6 (CRF 2.E)

Fluorinated gases, monitored under the UNFCCC, are not produced in Lithuania and national consumption is covered only by import.

4.7 Consumption of Halocarbons and SF6 (CRF 2.F)

Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) are used as alternatives to chlorofluorocarbons (CFCs), ozone depleting substances being phased out under the Montreal Protocol. Emissions of HFCs and SF_6 occur as leakage from the charge of equipment, its use and from the destruction of such equipment at the end of life.

General knowledge on the use of HFCs and SF_6 in the country is incomplete. A new study Analysis of the Use of Fluorinated Greenhouse Gases in Lithuania in 1990-2011 was carried out in 2012. The contract between the Ministry of Environment and UAB Ekotermija was signed in July 2012, the final report was delivered in September 2012. The project was financed from the national sources. The study covered CRF sections 2.F.1-2.F.9. The results of the study were used for the preparation of the present report.

The share of GHG emissions from the consumption of halocarbons and SF_6 is steadily increasing. In 2011 the emissions were estimated at 224,4 Gg CO_2 equivalent (or 6,5% from the aggregated emissions from Industrial processes).

Based on the current knowledge, the major source of GHG emissions in the sub-sector "Consumption of Halocarbons and SF_6" is mobile air conditioning (CRF 2.IIA.F.1.6), which accounts for approximately 37,7% of the emissions (as CO_2 equivalent). Transport Refrigeration (CRF 2.IIA.F.1.3) and Commercial Refrigeration (CRF 2.IIA.F.1.2) account for 25,7% and 15,2% of the 2011 emissions respectively (as CO_2 equivalent).

Estimated emissions from consumption of halocarbons and SF_6 in 1993-2011 are shown in Figure 4-18.

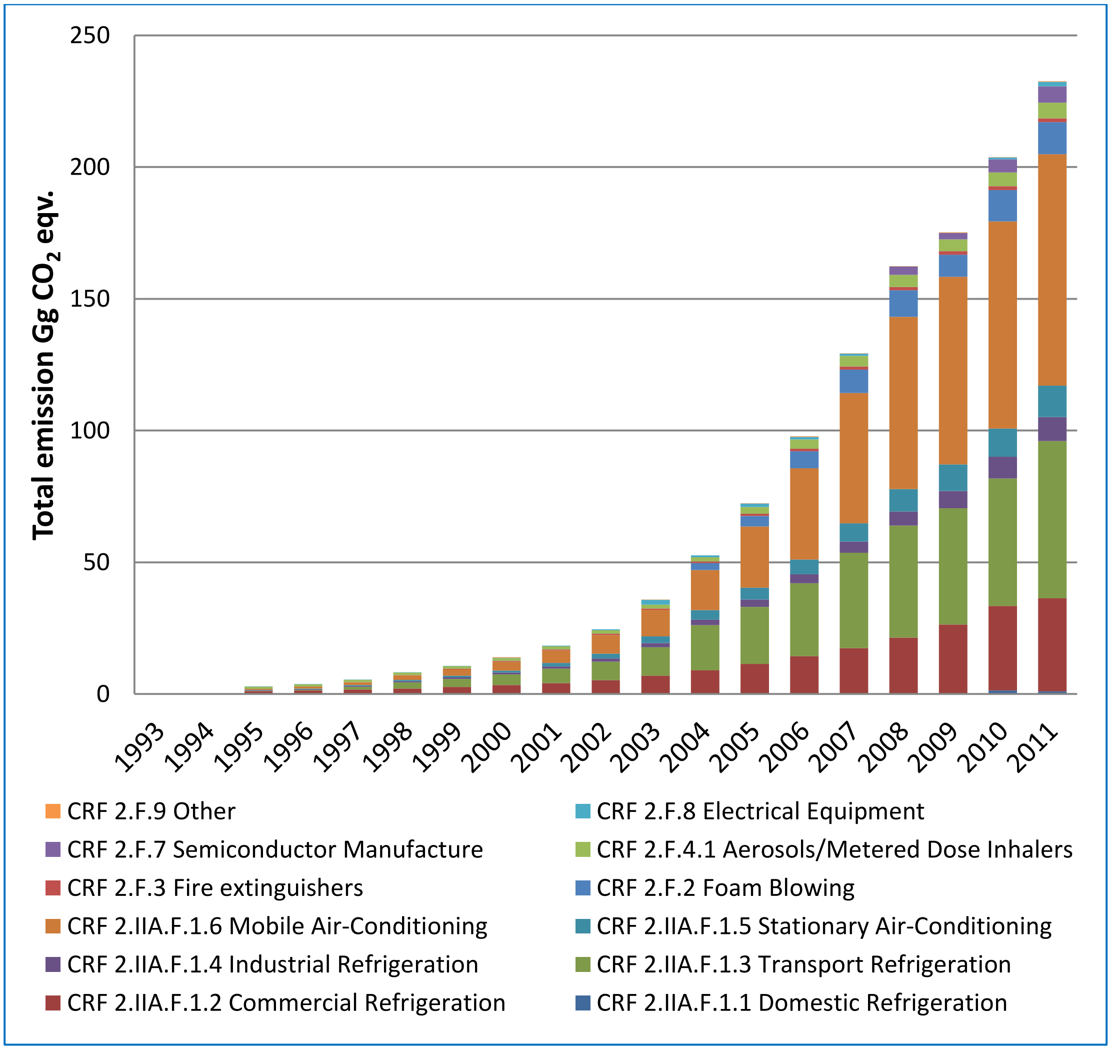

Figure 4-18. Estimated emissions from consumption of Halocarbons and SF_6 in 1993-2011.

4.7.1 Refrigeration and air conditioning equipment (CRF 2.F.1)

This section covers emissions of halocarbons from domestic, commercial, transport and industrial refrigeration, stationary and mobile air-conditioning.

4.7.1.1 Domestic Refrigeration (CRF 2.IIA.F.1.1)

There is only one company manufacturing domestic refrigerators in Lithuania, joint-stock company AB Snaigė. According to the company data, all domestic refrigerators manufactured by the company in 2011 were filled with the refrigerant R600a. The company started using isobutane (R600a, formula $CH(CH_3)_3$) in 2000. Over the period 2000-2010, part of refrigerators manufactured by AB Snaigė were charged with the refrigerant R-134a, which resulted in fluorinated gas emissions during their assembly/manufacturing process when refrigerators were being filled with the refrigerant.

The company provided annual data on sales/production of domestic refrigerators for 2000-2011, specifying number refrigerators filled with R-134a. The use of the refrigerant R-134a for the charging of new equipment during the said period was continuously going down and was completely discontinued from 2011.

Following the data of AB Snaigė:

- the average charge of the equipment with refrigerant is 120 g;
- the emission factor during the initial charging of new equipment k = 0.5 %.

Emissions of HFC due to the charging process of new equipment were calculated using the following equation (2006 IPCC Guidelines, p. 7.50):

$$E_{charge,\,t} = M_t \ x \ k$$

Where:

$E_{charge,\,t}$ – emission during system manufacture/assembly in year *t*, tonnes

M_t – amount of HFC charged into new equipment in year *t*, tonnes;

k – emission factor of assembly losses of the HFC charged into new equipment, %.

Estimates demonstrated in Figure 4-19.

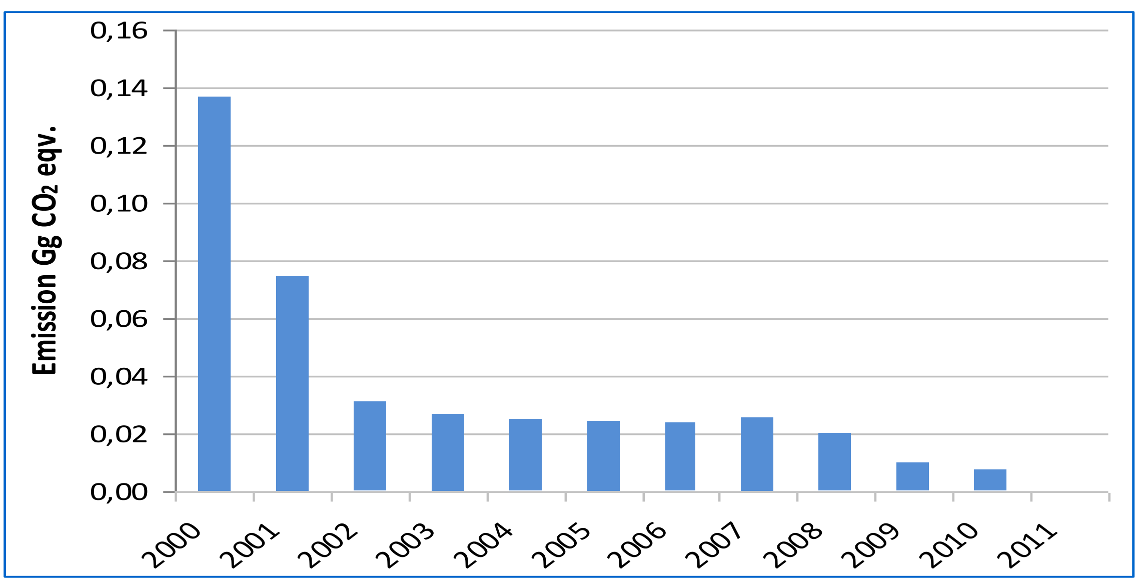

Figure 4-19. Fluorinated gas emissions during the initial charging of refrigerant into domestic refrigerators manufactured by AB Snaigė for 2000-2011

The largest amounts of fluorinated gases (0.14 Gg CO2-equivalent) were emitted in 2000 as a result of rather extensive use of the refrigerant R-134a for the initial charging of domestic refrigerators at the company (about 80% of the total amount used). The use of this refrigerant in the subsequent years gradually went down.

Domestic (household) refrigeration: refrigerators and freezers

The predominant refrigerant in domestic refrigeration equipment is R-134a, a small number of the appliances are also filled with the refrigerant R-152a. Over the past decade, the use of these refrigerants has been limited, so more and more of new equipment is charged with isobutane R600a which does not contain fluorinated gases.

According to the study Analysis of the Use of Fluorinated Greenhouse Gases in Lithuania conducted in 2008, the HFCs were not collected in Lithuania until 2007. The first company to start this activity in 2007 was UAB EMP Recycling. Following the company data, refrigerators collected by UAB EMP Recycling account for up to 50% of the total amount of refrigerators discarded in Lithuania. The remaining refrigerators are collected by various companies, however, part of the collected refrigeration equipment is transferred to UAB EMP Recycling.

AB Snaige (Lithuanian producer of refrigerators) itself collects only a small number of refrigerators. The company has an old refrigerator recycling system. In the middle of 2006, the company started managing waste of large household appliances, such as refrigerators and freezers. According to the company data, there is practically no refrigerant left in recycled refrigerators and the amount of R-134a collected during the last year totals about 156 grams.

The following data from Statistics Lithuania was used for the estimation of emissions from the stock of HFCs in existing domestic refrigerators:

- the number of inhabitants in Lithuania;
- the average size of households in Lithuania;
- the percentage of households using domestic refrigerators.

Due to absence of sufficient data for estimating the amount of HFCs charged in domestic refrigerators and the percentage of domestic refrigerators containing HFCs, the following assumptions based on expert judgment were made:

- the average amount of refrigerant charged in a refrigerator is 120 g (data source: AB Snaigė);
- the average amount of refrigerant charged in a freezer is 150 g (according to the data of UAB EMP Recycling, the charge is 30% higher than in refrigerators);
- 13% of refrigerators (of the total number) used to be filled with HFC-134a until 1995. The same assumption is applied to freezers (based on laboratory analysis of gases collected from recycled domestic refrigerators, data source: UAB EMP Recycling);
- 5% of refrigerators (of the total number) used to be filled with HFC-152a until 1995. The same assumption is applied to freezers (based on laboratory analysis of gases collected from recycled domestic refrigerators, data source: UAB EMP Recycling);
- average annual refrigerant loss/leakage is 0.4% of the quantity in stock (emission factor during the operation of the equipment) (revised according to 2006 IPCC Guidelines, p. 7.52);

- 30% of refrigerators operating in 1995-2011 were filled with HFC-134a. The same assumption is applied to freezers;
- 7% of refrigerators operating in 1995-2011 were filled with HFC-152a. The same assumption is applied to freezers.

Annual leakage from the stock in the domestic refrigerators was calculated using the following equation (2006 IPCC Guidelines, p 7.50):

$$E_{lifetime,\,t} = B_t \; x \; x$$

Where:

$E_{lifetime,\,t}$ – amount of HFCs banked in exicting systems in year *t*, tonnes;
B_t – amount of HFCs banked in existing systems in year *t*, tonnes;
x – emission factor of HFCs of each sub-application bank during operation, accounting for average annual leakage and average annual emission during servicing, %.

Emissions at system disposal were calculated from 2010 using the following factors and assumptions:

- the average lifetime of the refrigerator is 20 years (data source: UAB EMP Recycling);
- the average lifetime of the freezer is 15 years (data source: UAB EMP Recycling);
- the amount of recycled gases recovered from refrigerators in 2010 was 19% of all gases subject to disposal and in 2011 – 47% of all disposable gases (based on the percentage of domestic refrigerators recycled in Lithuania) (data source: UAB EMP Recycling);
- the amount of recycled gases recovered from freezers in 2010 was 58% of all gases subject to disposal and in 2011 – 53% of all disposable gases (based on the percentage of domestic freezers recycled in Lithuania) (data source: UAB EMP Recycling);
- the residual gas amount at system disposal (refrigerators) is 92% of the initial charge filled into the system during the production process;
- the remaining gas amount at system disposal (freezers) is 94% of the initial charge filled into the system during the production process.

Emissions at disposal of domestic refrigeration equipment were calculated using the following formula (2006 IPCC Guidelines, p. 7.51):

$$E_{end\text{-}of\text{-}life,\,t} = M_{t\text{-}d} \; x \; p \; x \; (1\text{-}\eta_{rec,d})$$

Where:

$E_{end\text{-}of\text{-}life,\,t}$ – amount of HFCs emitted at system disposal in year *t*, t
$M_{t\text{-}d}$ – amount of HFCs initially charged into new systems installed in year *(t-d)*, t;
p – residual charge of HFCs in equipment being disposed of expressed in percentage of full charge, %;
$\eta_{rec,d}$ – recovery efficiency at disposal, which is the ratio of recovered HFCs referred to the HFCs contained in the system, %.

Total emissions:

$$E_{total,\,t} = E_{charge,\,t} + E_{lifetime,\,t} + E_{end\text{-}of\text{-}life,\,t}$$

Following the afore-mentioned Study Analysis of the Use of Fluorinated Greenhouse Gases in Lithuania (2008) and expert judgement, over the period 1986-2002 the refrigerant R12 in domestic refrigeration compressors was gradually replaced by R-134a. The use of R-134a at the beginning of the said period was very insignificant, meanwhile the period 1994-1995 saw a wider use of this refrigerant in domestic refrigeration equipment, as witnessed by the experience of other European countries in the production of these domestic appliances. According to the situation described, fluorinated gas emissions from domestic refrigeration equipment have been estimated since 1995.

Estimates of fluorinated gas emissions from domestic refrigerators and freezers in Lithuania for 1995-2011 are demonstrated in Figures 4-20 and 4-21 below.

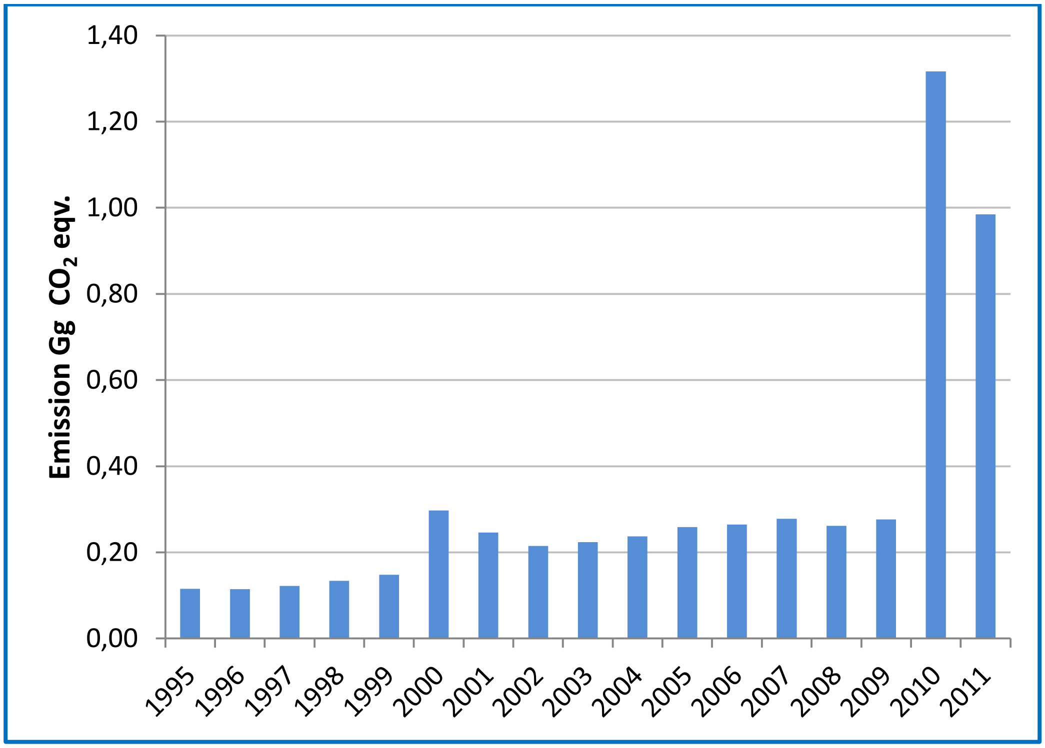

Figure 4-20. Fluorinated gas emissions from domestic refrigerators in Lithuania for 1995-2011

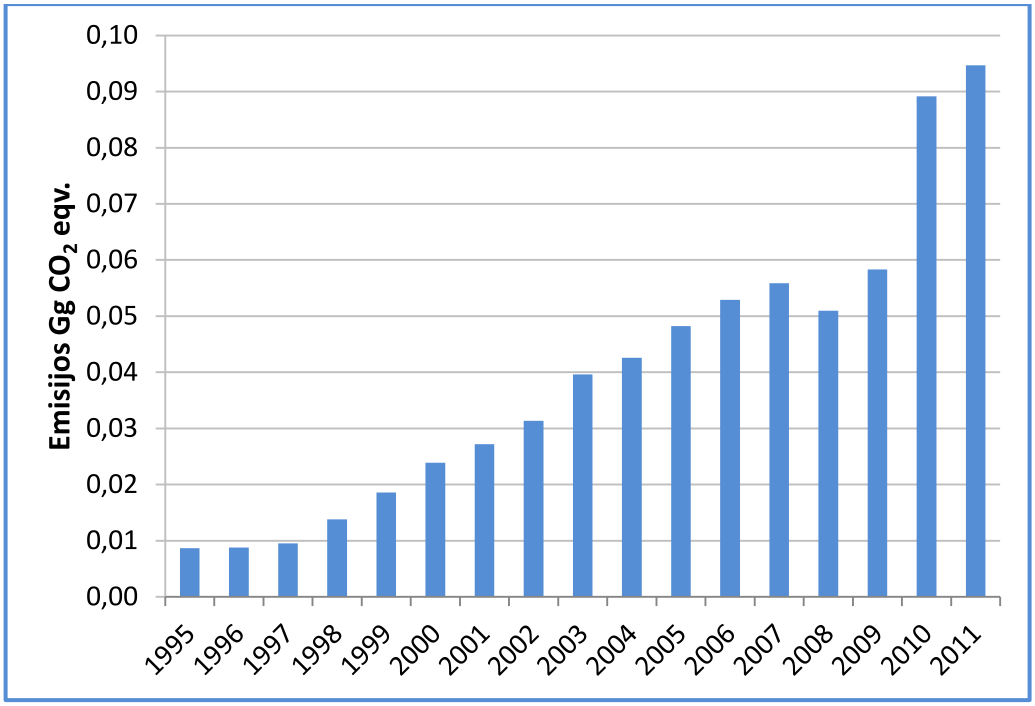

Figure 4-21. Fluorinated gas emissions from domestic freezers in Lithuania for 1995-2011

Estimated total emissions of fluorinated gases from domestic refrigeration are provided in Table 4-29.

Table 4-29. Total fluorinated gas emissions from domestic refrigeration for 1995-2011

Year	Emissions form manufactoring Gg CO_2 eqv.	Emissions from operation (refrigerators) Gg CO_2 eqv.	Emissions from operation (freezers) Gg CO_2 eqv.	Total, Gg CO_2 eqv.
1995		0,11	0,01	0,12
1996	NO	0,11	0,01	0,11
1997	NO	0,11	0,01	0,12
1998	NO	0,12	0,01	0,13
1999	NO	0,13	0,02	0,15
2000	0,14	0,14	0,02	0,30
2001	0,07	0,14	0,03	0,25
2002	0,03	0,15	0,03	0,21
2003	0,03	0,16	0,04	0,22
2004	0,03	0,17	0,04	0,24
2005	0,02	0,19	0,05	0,26
2006	0,02	0,19	0,05	0,26
2007	0,03	0,20	0,06	0,28
2008	0,02	0,19	0,05	0,26
2009	0,01	0,21	0,06	0,28
2010	0,01	1,22	0,09	1,32
2011	NO	0,89	0,09	0,98

Fluorinated gas emissions increased in 2010 and 2011 as a result of inclusion of emissions at the time of disposal of equipment in those years.

Uncertainties and time-series consistency

Emission uncertainty was estimated using Approach 1 of the 2006 IPCC Guidelines (p. 3.27).

Uncertainty estimates of activity data and emission factors are presented in Table 4-30.

Table 4-30. Uncertainty (UN) estimates of fluorinated gas emissions in the sub-category of domestic refrigeration for 2011

Emission source	Input data UN, %	EF during operation UN, %	Input data UN, %	Recovery EF UN, %	Total emission UN, %
CRF 2.IIA.F.1.1 Domestic refrigeration					28,84
Domestic refrigerators	10	20	10	20	31,62
Domestic freezers	10	20	10	20	31,62

4.7.1.2 Commercial Refrigeration (CRF 2.IIA.F.1.2)

A survey of fluorinated gas use in commercial and industrial refrigeration_in Lithuania was conducted in 2008 and the results of the survey were used as a basis for calculation of emissions. The data on the use of F-gases was collected by interviewing representatives of the most important trade and industry sectors. The representatives were also asked to evaluate the market situation and market share of the company. The estimated use of fluorinated gases is shown in **Klaida! Negaliojanti šios nuorodos žymelė**4-31.

Table 4-31. Estimated use of fluorinated gases in Lithuania

	F-gases in surveyed enterprises, t			Market share %	Total F-gases in use, t		
	R404a	R134a	R407c		R404a	R134a	R407c
Skating rinks	0,15	-	-	90%	0,17	-	-
Supermarkets	72,86	1,48	-	65%	112,10	2,27	-
Other retail enterprises*	-	-	-	-	5,61	0,11	-
Meat processing	2,15	-	-	30%	7,17	-	-
Milk processing	0,59	-	-	20%	2,95	-	-
Fish processing	1,01	-	-	20%	5,03	-	-
Fruit and vegetable processing	1,28	-	-	30%	4,27	-	-
Beverage production	0,28	-	-	20%	1,41	-	-
Processing of berries and mushrooms	1,07	-	-	45%	2,38	-	-
Prefabricated food products	0,66	-	-	30%	2,20	-	-
Warehouses	1,15	-	-	30%	3,83	-	-
Poultry processing	1,20	-	-	25%	4,80	-	-
PET production	0,13	0,12	0,39	30%	0,43	0,40	1,28
Other industries**	-	-	-	-	1,72	0,02	0,06
Total				-	154,06	2,81	1,35

**Assumed as 5% of supermarkets; **Assumed 5% of the total*

Historically, ammonia was the most widely used refrigerant in meat, milk and other food product production and storage systems in the eighties. However, these huge systems were not able to survive in the early nineties after the introduction of market economy and were closed or split into smaller production units. Old refrigeration systems were substituted by new smaller systems mainly using chlorinated refrigerants, such as R-12 and R-22, which were also used in refrigeration systems in supermarkets.

Fluorinated refrigerants were started to be used in Lithuania in newly installed systems approximately from 2003. Based on expert judgement, it was assumed that the amount of F-gases in refrigeration systems was increasing on average approximately 30% annually, and in 2003-2004, immediately before the accession to the EU, it reached 45% annually.
The following groups of fluorinated gas use in commercial refrigeration were estimated:
- skating rinks;
- supermarkets;
- other retail enterprises;
- storage facilities.

A new study on the use of HFCs in Lithuanian carried out in 2012 assessed the database of the Environmental Protection Agency (EPA). This database is made up of company reports submitted in accordance with Order No. D1-12 of the Minister of Environment of the Republic of Lithuania of 7 January 2010 on the approval of the procedure for the provision, collection and handling of data on fluorinated greenhouse gases and ozone-depleting substances and accounting of equipment and systems containing such gases or substances.

The study identified a key drawback of the existing data collection system: the first inventory of the total fluorinated gas amount in equipment took place in 2009; however, the equipment was not properly classified at that time. The equipment classification was modified in 2012, so currently there is no information available either on the total amount of gases in different equipment categories or on changes in these amounts. Consequently, today the EPA data is not suitable for estimating emissions according to the IPCC Guidelines. It was recommended to continue following the revised calculation model which so far has been applied for the preparation of national reports until the format of reports submitted to the EPA changes.

Blends selected from the 2009 EPA database, which formally includes an inventory of all F-gas amounts contained in equipment, were also identified as blends used in commercial and industrial refrigeration equipment in a study conducted in 2008.

These blends were broken into constituent substances and changes in the amounts of fluorinated gases during a year as a result of new equipment were estimated and compared with the amounts of substances used for charging new equipment contained in the 2011 EPA register of the use of fluorinated gases.

Table 4-32. Changes in the amounts of fluorinated gases in commercial refrigeration in 2011 as a result of newly installed equipment (source: EPA database)

F-gases	Contained in old equipment, 2009, kg	Contained in new equipment, 2011, kg	Annual change, %
HFC-32	5 016,53	163,05	3,25
HFC-125	41 089,27	3 434,39	8,36
HFC-134a	18 736,76	3 427,34	18,29
HFC-143a	44 856,84	3 843,19	8,57

Based on these findings lower values for the annual change of HFC in commercial refrigeration were used (Table 4-33)

Table 4-33. Annual changes in fluorinated gas emissions in 2009-2011 as a result of newly installed commercial refrigeration equipment (based on the 2008 study)

F-gases	Annual change		
	2009	2010	2011
HFC-32	42%	42%	5%
HFC-125	25%	25%	10%
HFC-134a	25%	24%	20%
HFC-143a	24%	24%	10%

Estimates of fluorinated gas emission from commercial refrigeration (supermarkets, shops, skating rinks) are demonstrated in Figure 4-22 below.

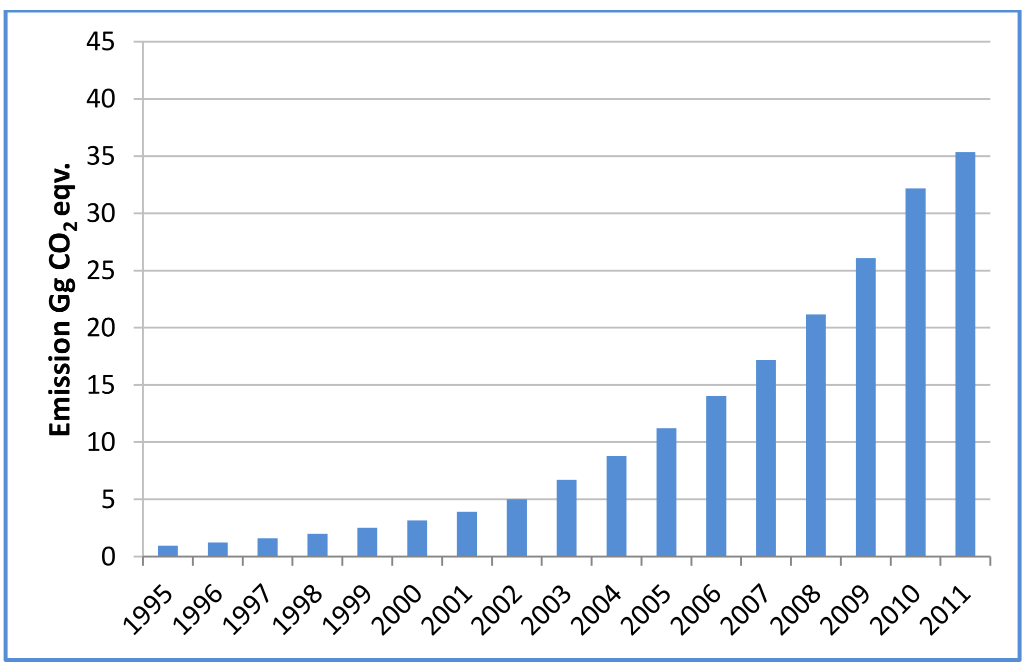

Figure 4-22. Fluorinated gas emissions from commercial refrigeration (supermarkets, shops, skating rinks) for 1995-2011, estimated using a revised 2011 calculation methodology

The 2012 study on the use of HFCs in Lithuania identified that drink coolers are charged with the refrigerant HFC-134a. Emissions in this sector were estimated on the basis of specific company data (UAB Kalnapilio-Tauro grupe, AB Volfas Engelman, TUB Rinkuskiai, UAB Svyturio-Utenos alus, Coca Cola HBC Lietuva) and using the following factors and assumptions:

- the average amount of refrigerant charged in equipment is 250 g, except TUB Rinkuskiai (150 g);
- the emission factor during the operation of the equipment is 8% (data source: drink producers);
- the average lifetime of drink coolers is 10 years (data source: data source: drink producers);
- emissions at system disposal is 10% (data source: EMP);
- since coolers delivered are already charged with refrigerant by producers, the emission factor during the initial charging was not assessed;
- there is no data available for the assessment of the emission factor during equipment maintenance, therefore this factor is assumed to be included in the emission factor during operation.

Emissions of HFCs from drink coolers were calculated using the following equation (2006 IPCC Guidelines, p. 7.49, Tier 2a):

$$E_{total,\ t} = E_{lifetime,\ t} + E_{enf\text{-}of\text{-}life,\ t}$$

Where:

$E_{total,\ t}$ – total HFC emission, t;

$E_{lifetime,\ t}$ – amount of HFCs emitted during system operation in year *t, tonnes;*

$E_{end\text{-}of\text{-}life,\ t}$ – amount of HFCs emitted at system disposal in year *t*, t.

Emissions during lifetime:

$$E_{lifetime,\ t} = B_t \ x \ x$$

Where:

B_t – amount of HFCs banked in existing systems in year *t, tonnes;*

x – emission factor of HFCs for each sub-application bank during operation, accounting for average annual leakage and average annual emission during servicing, %.

Emissions at end-of-life:

$$E_{end\text{-}of\text{-}life,\ t} = M_{t-d} \ x \ p \ x \ (1-\eta_{rec,\ d})$$

Where:

M_{t-d} – amount of HFCs initially charged into new systems installed in year *(t-d)*, t;

p – residual charge of HFCs in equipment being disposed of expressed in percentage of full charge, %;

$\eta_{rec,\ d}$ – recovery efficiency at disposal, which is the ratio of recovered HFCs referred to HFC contained in the system, %.

Estimates of fluorinated gas emissions from drink coolers air-conditioning systems are demonstrated in Figure 4-23 below.

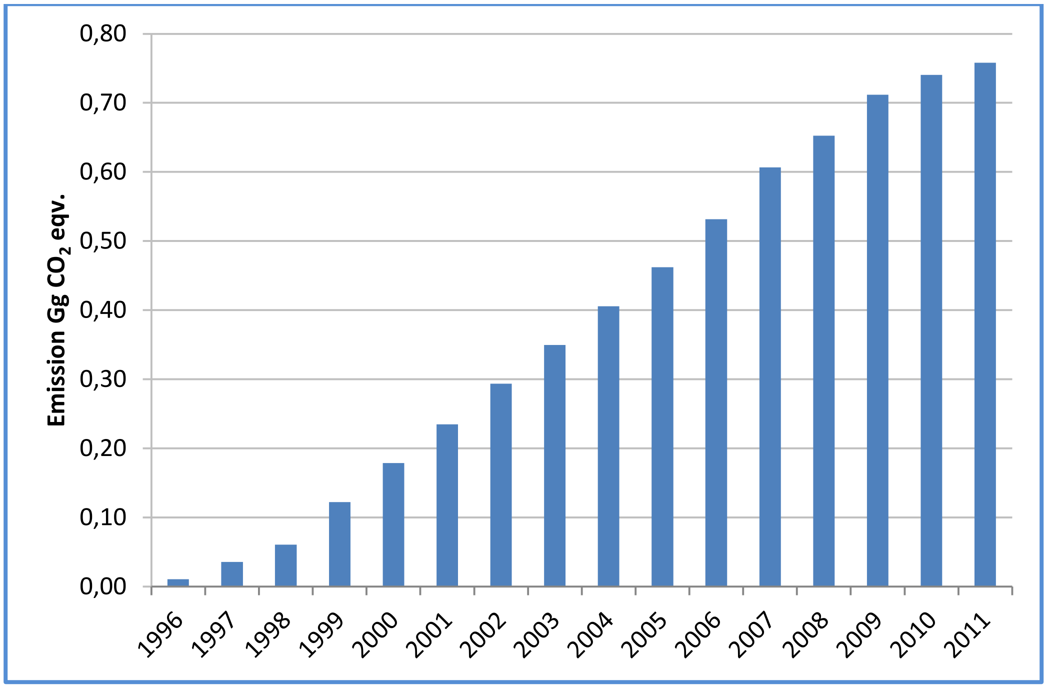

Figure 4-23. Fluorinated gas emissions from drink coolers for 1996-2011 m.

Commercial refrigeration equipment in accommodation and catering businesses (hotels, cafés, bars, canteens) was assessed using the national statistical data.

The data on the number of accommodation and catering businesses provided by Statistics Lithuania covers the period 2006-2011.

The following factors and assumptions were used to estimate the emissions:

- refrigerants charged in the equipment are HFC-134a and HFC-404A;
- the average amount of refrigerant charged in the equipment is 750 g;
- the average lifetime of drink coolers is 15 years;
- the emission factor during the operation of the equipment is 15% (2006 IPCC Guidelines);
- the data on the use of HFC-134a and HFC-404A in Lithuania is available from 1995;
- the number of accommodation and catering businesses in 1995 was 15% less than in 2006; based on this assumption, the number of the companies was interpolated for the period 1996-2005;
- emissions at system disposal – 10% (data source: UAB EMP);
- there is no data on possible initial charge of such equipment in situ instead of the factory charge, therefore the emission factor during the initial charging was not assessed;
- there is no data available for the assessment of the emission factor during equipment servicing, therefore this factor was assumed to be included in the emission factor during operation.

Emissions of HFCs from commercial refrigeration equipment in accommodation and catering businesses were calculated using the equations provided in the 2006 IPCC Guidelines, 7.49 p., Tier 2a.

Estimates of fluorinated gas emissions from commercial refrigeration equipment in accommodation and catering businesses are demonstrated in Figure 4-24 below.

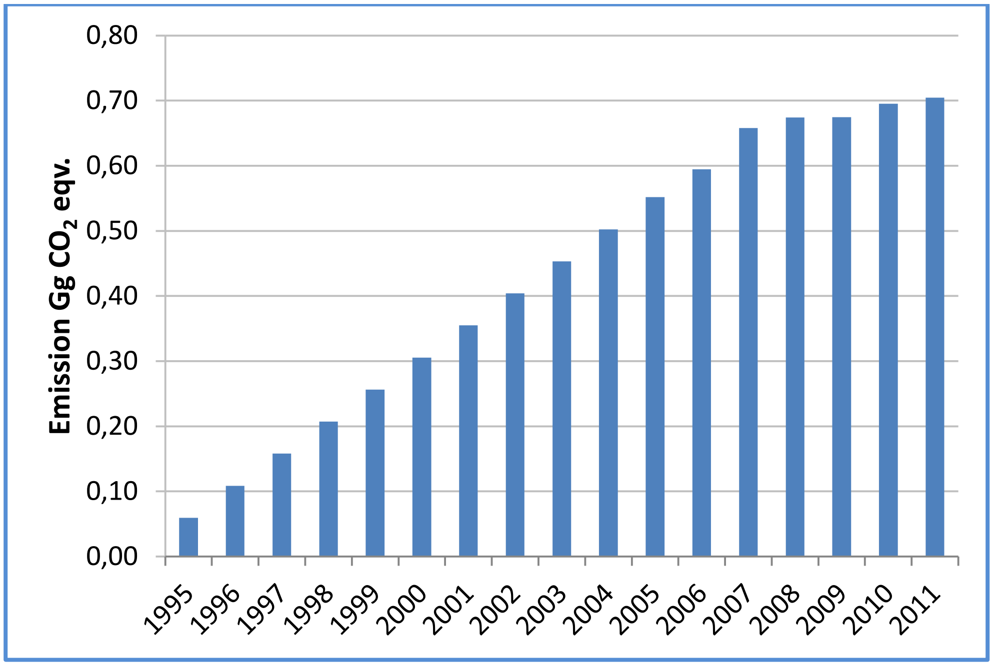

Figure 4-24. Fluorinated gas emissions from commercial refrigeration in accommodation and catering businesses for 1995-2011

The total emissions of fluorinated gases from commercial refrigeration are provided in Table 4-34.

Table 4-34. Total emissions of fluorinated gases from commercial refrigeration for 1995-2011

Year	Emissions from commercial refrigeration (supermarkets, shops, skating rinks), Gg CO_2 eqv.	Emissions from drink coolers, Gg CO_2 eqv.	Emissions from commercial refrigeration in accommodation and catering businesses, Gg CO_2 eqv.	Total emissions from commercial refrigeration, Gg CO_2 eqv.
1995	0,90		0,06	0,96
1996	1,12	0,01	0,11	1,24
1997	1,40	0,04	0,16	1,59
1998	1,74	0,06	0,21	2,00
1999	2,16	0,12	0,26	2,54
2000	2,68	0,18	0,31	3,17
2001	3,34	0,23	0,35	3,93
2002	4,33	0,29	0,40	5,02
2003	5,92	0,35	0,45	6,73
2004	7,89	0,41	0,50	8,80
2005	10,21	0,46	0,55	11,23
2006	12,91	0,53	0,59	14,04
2007	15,90	0,61	0,66	17,16

2008	19,83	0,65	0,67	21,16
2009	24,68	0,71	0,67	26,07
2010	30,73	0,74	0,70	32,17
2011	33,88	0,76	0,70	35,34

Uncertainties and time-series consistency

Emission uncertainty was estimated using Approach 1 of the 2006 IPCC Guidelines (p. 3.27).

Uncertainty estimates of activity data and emission factors are presented in Table 4-35.

Table 4-35. Uncertainty (UN) estimates of fluorinated gas emissions in the sub-category of commercial refrigeration equipment for 2011

Emission source	Input data UN, %	EF during operation UN, %	Input data UN, %	Recovery EF UN, %	Total emission UN, %
CRF 2.IIA.F.1.2 Commercial refrigeration					45,48
Refrigeration in supermarkets and shops	30	15	30	15	47,43
Drink coolers	5	10	10	10	18,03
Refrigeration in accommodation and catering businesses	20	10	20	10	31,62

4.7.1.3 Transport Refrigeration (CRF 2.IIA.F.1.3)

The following companies were surveyed for the 2012 study on the use of HFCs in Lithuania:

1. state enterprise Regitra – in order to obtain missing data on vehicles with refrigeration units registered in Lithuania by class and year of manufacture;
2. companies servicing vehicles with refrigeration units in order to obtain more specific data on the variety of refrigerants used in refrigeration equipment, average charge of refrigerated vehicles by vehicle class, and factors of emission during equipment operation;
3. joint stock company AB Lietuvos geležinkeliai (Lithuanian Railway) – in order to collect data on refrigerated freight wagons and to assess fluorinated gas emissions from refrigeration on the basis of this information;
4. companies which operate shipping containers and reefers – in order to obtain data for the assessment of fluorinated gas emissions.

The EPA database could not be used for the assessment of fluorinated gas emissions from refrigerated vehicles for the following reasons:

- there is no such category of gas use in the EPA 2009-2010 database (it covers both stationary and mobile equipment classified by refrigerant weight); also, not all companies servicing refrigeration units in vehicles submitted reports in 2012 to the EPA (there are only a few declarations of the gas use in the equipment of this category and in some cases most probably a wrong category was indicated);

- the data collection period (2009-2011) is too short to be able to create an accurate database of the EPA, and assessment of the missing period by way of extrapolation does not show the actual/factual annual consumption and emissions of fluorinated gases (the accuracy would be higher if suppliers and servicing companies provided relevant information);
- information provided by individual companies servicing refrigeration equipment in vehicles does not allow formulating country-specific assumptions and emission factors.

The emission calculation methodology which was applied is provided below.

Refrigerated road vehicles: refrigerated trucks, refrigerated vans, refrigerated semi-trailers

HFC gases in refrigeration units in vehicles have been used since 1993. The refrigerant R-404a is a blend, consisting of HFC-125 (44%), HFC-143a (52%) and HFC-134a (4%). Fluorinated gas emissions from this equipment are assessed following the 2006 IPCC Guidelines. Assessments are based on the number of refrigerated vehicles registered on the territory of the Republic of Lithuania. The data on vehicles with refrigeration units registered in Lithuania in 1992-2011 by vehicle class and year of manufacture was obtained from the state enterprise Regitra.

The following classes of freight vehicles and semi-trailers were considered:
- refrigerated trucks;
- refrigerated vans;
- refrigerated semi-trailers.

The said refrigerated vehicles were manufactured in 1993-2011. In addition, Regitra provided the average lifetime of the vehicles by class.

Four companies servicing refrigerated vehicles were contacted in order to specify the refrigerants used, the average refrigerant charge in refrigerated vehicles, and factors of emission at the time of operation; however, a partial reply was received only from one company, private limited liability company UAB Sadomaksa. According to the data of the said company, the refrigerants used in refrigeration equipment are R-134a and R-404a:
- R-134a and R-404a are used in freight vehicles up to 3.5 t (trucks, vans, semi-trailers);
- mainly R-404a is used in freight vehicles above 3.5 t (trucks, vans, semi-trailers).

Following the German experience, it was assumed that if two refrigerants are used in one vehicle category, the use of each refrigerant is considered to be 50%.

There is no data available on the original factory charge, therefore the emission factor during the initial charging and the emissions were not assessed.

The assessment of emissions during the operation of the equipment was based on the following factors and assumptions:

1. the average amount of refrigerant charged in the equipment in the below listed vehicle classes is as follows (according to the data on freight vehicles by their weight provided by UAB Sadomaksa):
   - 2 kg in refrigerated trucks and refrigerated vans up to 3.5 t;
   - 7 kg in refrigerated trucks and refrigerated vans over 3.5 t;

- 2 kg in refrigerated semi-trailers up to 3.5 t;
- 7 kg in refrigerated semi-trailers over 3.5 t

2. the emission factor during the operation of the equipment is 30% (2006 IPCC Guidelines, p. 7.52);
3. there is no data available for the assessment of the emission factor during equipment servicing, therefore this factor was assumed to be included in the emission factor during operation.

Emissions during lifetime were calculated using the following equation (2006 IPCC Guidelines, p. 7.50):

$$E_{lifetime,\ t} = B_t \ x \ x$$

Where:
B_t – amount of HFCs banked in existing systems in year *t, tonnes;*
x – emission factor of HFCs for each sub-application bank during operation, %.

The assessment of emissions of fluorinated gases at system disposal was based on the following assumptions:

- the residual charge in the system being disposed is 70%;
- there is no data available on recycling processes of refrigerated vehicles, therefore recovery efficiency was not assessed.

Emissions at end-of-life were calculated using the following equation (2006 Guidelines, p. 7.51):

$$E_{end\text{-}of\text{-}life,\ t} = M_{t\text{-}d} \ x \ p \ x \ (1\text{-}\eta_{rec,\ d})$$

Where:
M_{t-d} – amount of HFCs initially charged into new systems installed in year *(t-d)*, t;
p – residual charge of HFC in equipment being disposed of expressed in percentage of full charge, %;
$\eta_{rec,\ d}$ – recovery efficiency at disposal, which is the ratio of recovered HFCs referred to HFCs contained in the system, %.

HFC gases have been used in refrigerated vehicles since 1993, which is demonstrated by the German experience in the production of refrigerated vehicles. Most of refrigerated vehicles which are operated in Lithuania were manufactured in Western Europe (including Germany), therefore fluorinated gas emissions during equipment operation have also been assessed since 1993.

Estimations of fluorinated gas emissions from refrigerated road vehicles are demonstrated in Figure 4-25 below.

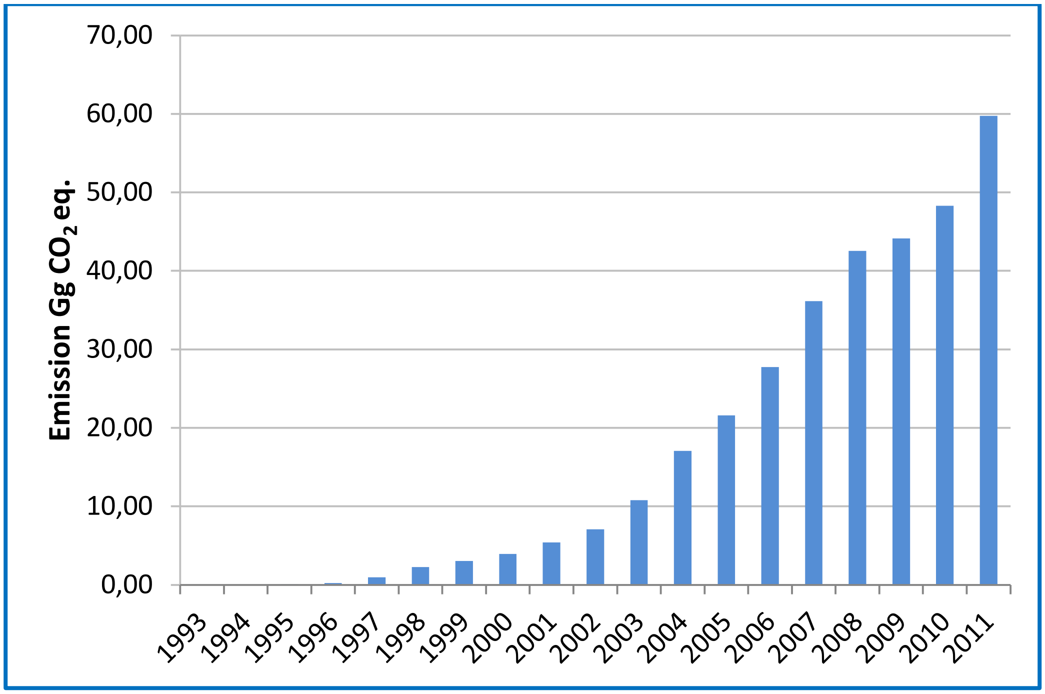

Figure 4-25. Fluorinated gas emissions from refrigerated road vehicles for 1993-2011

Trains – freight wagons

The refrigerant R-134s has been used in refrigerated freight wagons since 2006. The number of freight wagons was continuously going down during the period 2006-2011. Radviliškis freight wagon depot of the joint-stock company AB Lietuvos geležinkeliai was contacted to obtain necessary data.

AB Lietuvos geležinkeliai provided the number of refrigerated freight wagons operated in 2006-2011 pointing out that every wagon has two refrigeration equipments. The refrigerant used in most wagons is R-134a. In addition, a small percentage of R-22 is also used, its use is assumed to be around 20%.

There is no data available on the original factory charge therefore the emission factor during the initial charging and the emissions were not assessed.

Freight wagons of Radviliškis freight wagon depot carry goods to Eastern countries riding in Lithuania only a short segment of the whole trip. Upon consultation of the head of the company, it was assumed that only 10% of fluorinated gas emissions during the operation of the refrigeration equipment shall attributed to Lithuania.

The assessment of the emissions during equipment operation was based on the following factors and assumptions:

1. Pursuant to the data of Radviliškis freight wagon depot of AB Lietuvos geležinkeliai:
   - the average amount of refrigerant charged in the equipment is 15 kg;
   - the emission factor during the operation of the equipment (which is fairly new) is 10%.
2. Other assumptions:
   - 80% of all freight wagons are charged with the refrigerant R-134a;
   - there is no data available for the assessment of the emission factor during equipment servicing, therefore this factor was assumed to be included in the total emission factor

Emissions during the lifetime were calculated using the following equation (2006 IPCC Guidelines, p. 7.50):

$$E_{lifetime,\,t} = B_t \;x\; x$$

Where:
B_t – amount of HFCs banked in existing systems in year *t, tonnes;*
x – emission factor of HFCs for each sub-application bank during operation, %.

The refrigeration equipment in freight wagons belongs to Radviliškis freight wagon depot of AB Lietuvos geležinkeliai. It is fairly new – operated since 2006, its lifetime (28 years) has not expired yet and so emissions at system disposal were not assessed.

Estimates of fluorinated gas emissions from freight wagons are demonstrated in Figure 4-26 below.

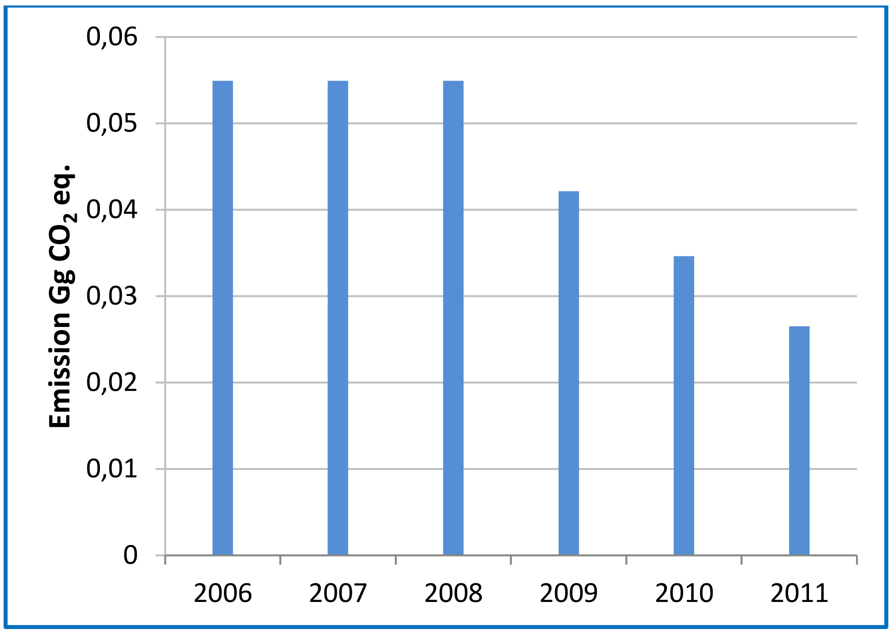

Figure 4-26. Fluorinated gas emissions from freight wagons for 2006-2011

Total fluorinated gas emissions from transport refrigeration were calculated using the following formula:

$$E_{total,\,t} = E_{lifetime,\,t} + E_{end\text{-}of\text{-}life,\,t}$$

Estimates of the total fluorinated gas emissions from transport refrigeration are provided in Table 4-36.

Table 4-36. Total fluorinated gas emissions from transport refrigeration for 1993-2011

Year	Emissions from refrigerated road vehicles, Gg CO_2 eqv.	Emissions from refrigerated rail vehicles, Gg CO_2 eqv.	Total HFC emissions in sub-category, Gg CO_2 eqv.
1993	0,01	NO	0,01
1994	0,04	NO	0,04
1995	0,11	NO	0,11
1996	0,24	NO	0,24
1997	0,96	NO	0,96
1998	2,27	NO	2,27
1999	3,05	NO	3,05
2000	3,95	NO	3,95
2001	5,41	NO	5,41
2002	7,06	NO	7,06
2003	10,77	NO	10,77
2004	17,08	NO	17,08
2005	21,58	NO	21,58
2006	27,68	0,05	27,73
2007	36,09	0,05	36,14
2008	42,49	0,05	42,55
2009	44,09	0,04	44,13
2010	48,26	0,03	48,29
2011	59,70	0,03	59,73

Shipping containers

A few companies were interviewed in order to identify Lithuanian companies which operate shipping containers. During the interview, private limited liability company UAB Klaipėdos šaldytuvų terminalas (Klaipėda Refrigerator Terminal) pointed out that most of their cold storage facilities are stationary, meanwhile joint stock company Klaipėdos smeltė does not have any refrigerated containers at all. Private limited liability company UAB Conteinerships has shipping containers which are shipped all over the world and serviced abroad as well.

Fluorinated gas emissions from shipping containers were not assessed for the following reasons:

- the number of shipping containers in Lithuania is not available and difficult to establish;
- most refrigerated containers ship cargo all over the world and practically do not call Lithuanian ports and are serviced in foreign countries.

Reefers

According to the data provided by the Lithuanian Maritime Safety Administration, seven reefers (six transport vessels and one fishing vessel) were registered at the Register of Seagoing Ships of the Republic of Lithuania as on 31 July 2012. Refrigeration equipment for the needs of the crew and passengers is installed on 36 cargo and fishing vessels. The average lifetime of marine vessels is 30-50 years.

State enterprise Klaipėda State Seaport Authority, on the basis of the data of the Port Control Department, provided information on reefers calling Klaipėda State Seaport from 2002 to 2011 (Table 4-37).

Table 4-37. Reefer vessels calling Klaipėda State Seaport in 2002-2011

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Annual number of reefer vessels with the Lithuanian flag calling Klaipėda Seaport	9	7	10	11	2	8	5	1	0	3
Total annual number of reefer vessels	260	316	304	315	237	254	227	192	202	192
Difference in per cent	3.46	2.22	3.29	3.49	0.84	3.15	2.20	0.52	0.00	1.56

Fluorinated gas emissions from reefer vessels were not assessed for the following reasons:

- according to specialists, the annual number of reefer vessels with the Lithuanian flag calling Klaipėda Seaport is very small;
- the part of the voyage spent by reefer vessels at the shores of the Republic of Lithuania is not known;
- there is no data available from companies servicing refrigeration equipment, therefore it is difficult to establish average refrigerant charges and the emission factor during the operation of the equipment;
- reefer vessels migrate/ship freight all over the world.

Uncertainties and time-series consistency

Emission uncertainty was estimated using Approach 1 of the 2006 IPCC Guidelines (p. 3.27).

Uncertainty estimates of activity data and emission factors are presented in Table 4-38.

Table 4-38. Uncertainty (UN) estimates of fluorinated gas emissions in the sub-category of commercial refrigeration in 2011

Emission source	Input data UN, %	EF during operation UN, %	Input data UN, %	Recovery EF UN, %	Total emission UN, %
CRF 2.IIA.F.1.3 Refrigeration in vehicles					31,61
Refrigerated road vehicles	10	20	10	20	31,62
Refrigerated rail vehicles	5	5	-	-	7,07

4.7.1.4 Industrial Refrigeration (CRF 2.IIA.F.1.4)

As already indicated in previous sections, the database of the Environmental Protection Agency is currently not suitable for the calculation of emissions according to the IPCC Guidelines. Consequently, therefore it was decided to continue following a revised calculation model which has been applied until now for the preparation of national reports until the format of reports submitted to the Environmental Protection Agency is changed.

The methodology for the revision of the calculation model used in the national report is described in the section Commercial Refrigeration. Emissions from industrial refrigeration in 2011 were calculated using a revised assumption on the change in the amount of substances. Emissions for the period 1995-2010 were not re-estimated based on the revised assumption because the data has already been submitted to the European Commission, and the assumption used for the justification of the recalculation is not strong enough.

The following fluorinated gas uses in industrial refrigeration were assessed:
- Meat processing;
- Milk processing;
- Fish processing;
- Fruit and vegetable processing;
- Beverage production;
- Processing of berries and mushrooms;
- Prefabricated food products;
- Poultry processing;
- PET production;
- Other industries.

Estimations of fluorinated gas emissions from industrial refrigeration are demonstrated in Figure 4-27 below.

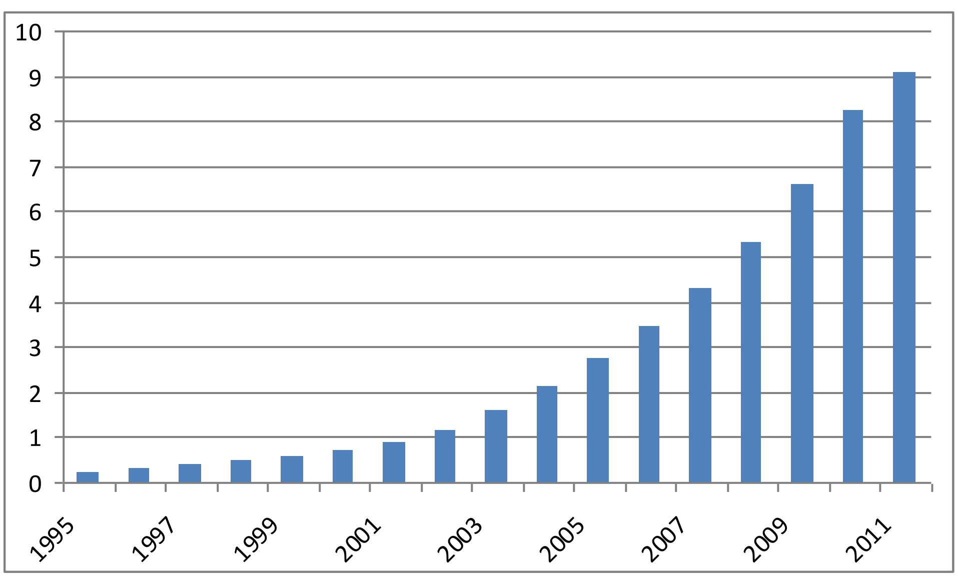

Figure 4-27. Fluorinated gas emissions from industrial refrigeration for 2006-2011, Gg CO_2 eq.

Uncertainties and time-series consistency

Emission uncertainty was estimated using Approach 1 of the 2006 IPCC Guidelines(p. 3.27).

Uncertainty estimates of activity data and emission factors are presented in Table 4-39.

Table 4-39. Uncertainty (UN) estimates of fluorinated gas emissions in the sub-category of industrial refrigeration for 2011

Emission source	Input data UN, %	EF during operation UN, %	Input data UN, %	Recovery EF UN, %	Total emission UN, %
CRF 2.IIA.F.1.4 Industrial refrigeration	30	15	30	15	47,43

4.7.1.5 Stationary Air-Conditioning (CRF 2.IIA.F.1.5)

Taking into account the results of the EPA database analysis (2012 study on the use of HFCs in Lithuania) and shortage of activity data, emissions from stationary air-conditioning systems were estimated observing the following recommendations:

- the amounts of HFC-125, HFC-134a, HFC-143a, HFC-32 declared in the Register of the Use of Fluorinated Gases of the EPA database of 2011 are deemed to be annual recharge amounts in air-conditioning systems;
- the amount of gases contained in air-conditioning systems in 2011 = annual recharge *10 (assumption that the annual amount of gases in the systems is ten times larger than the amount of recharge);
- the aggregate useful floor area of buildings built in 2000-2011 was estimated pursuant to the data of Statistics Lithuania on useful floor area (thousand m²) of residential buildings completed during that period. Annual changes in the useful floor area of residential buildings were estimated with the year 2011 being the benchmark;
- pursuant to the information that refrigerants have been used in stationary air-conditioning systems since 1995 (information provided in national reports of other countries), it was assumed that the initial amount of refrigerants in the systems was 1% as compared to the year 2011. The amounts of refrigerants for 1996-1999 were estimated by way of direct interpolation;
- the emission factor during the operation of the equipment is 10% (upper range limit of the factor given in the 2006 IPCC Guidelines);
- the lifetime of the equipment given in the 2006 IPCC Guidelines is 10-20 years; however, emissions will not be estimated until types of the systems used in Lithuania and their characteristics are revised;
- emissions during the initial charging were not estimated for the above-said reasons.

Emissions of HFCs during the lifetime of the equipment were calculated using the following equation (2006 IPCC Guidelines, p. 7.50, Tier 2a):

$$E_{lifetime,\, t} = B_t \ x \ x$$

Where:

B_t – amount of HFCs banked in the existing systems in year *t, tonnes;*

x – emission factor of HFCs for each sub-application bank during operation, accounting for average annual leakage and average annual emission during servicing, %.

Estimates of fluorinated gas emissions from stationary air-conditioning systems are demonstrated in Figure 4-28 below.

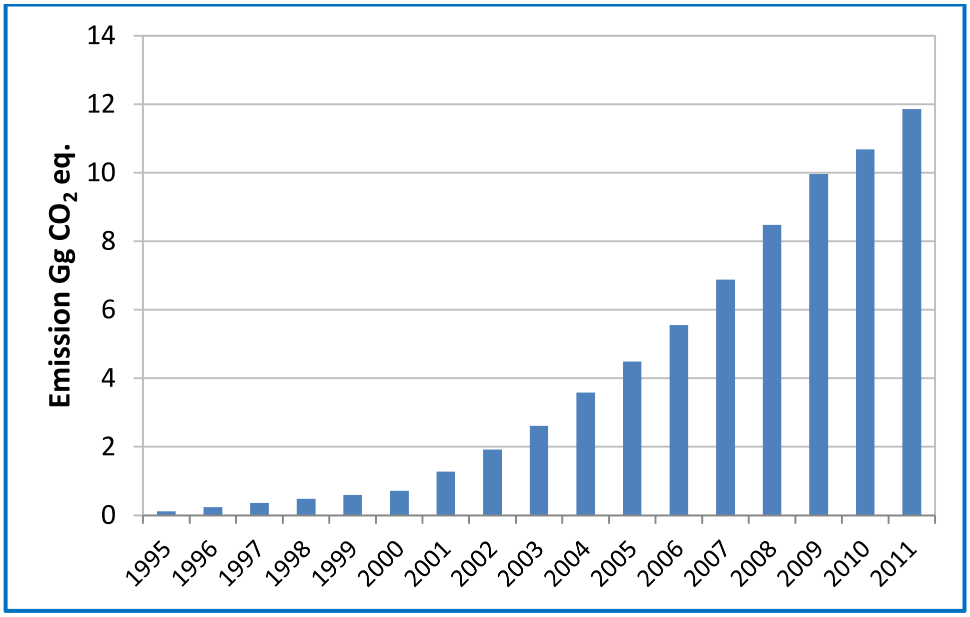

Figure 4-28. Fluorinated gas emissions from stationary air conditioning for 1995-2011

Data of other countries demonstrate that stationary air conditioning has been used since approximately 1995, therefore, in the absence of other information source, it is reasonable to believe that Lithuania also started using such systems charged with fluorinated gases not earlier than in 1995.

Heat pumps

So far, emissions from installed heat pumps have not been assessed in Lithuania. While performing the 2012 study on the use of HFCs in Lithuania, the Lithuanian Geothermal Association and companies which install and service heat pumps were contacted with a request to provide necessary data.

The Lithuanian Geothermal Association provided the following information:

- in Lithuania heat pumps have been installed since 2005, the largest number was installed in 2005 m., (about 700 units), approximately 400 units were installed in 2010-2011 and about 300 – in 2012;
- the average amount of refrigerant charged in the equipment is about 3 kg, though 6 kg is also possible;
- the main refrigerants are HFC-4087C and HFC-410A;
- the lifetime of the equipment is around 15 years;
- there are no leakages of emission during the operation of the equipment.

Companies installing heat pumps consider information on the number of installed heat pumps a commercial secret, so the only source of information is summary data provided in the journal

"Systemes Solaires le journal des énergies renouvelables N° 205 – 2011/ Barometre pompes a chaleur– Eurobserv'er – septembre 2011" (2011). This data is accurate: the number of pumps sold in 2009 is 413, the total number of pumps installed in 2009 is 1865, the number of pumps sold in 2010 is 356, and the number of those installed in 2010 is 2221.

The annual number of heat pumps in Lithuania for 2005-2011 was estimated on the basis of the information provided in "Eurobserv'er 2011" and by the Lithuanian Geothermal Association.

Following the data provided by private liability companies UAB Vilpra and UAB Geoterminio šildymo sistemos and by the Lithuanian Geothermal Association, the following assumptions were formulated:

- the proportion of new geothermal/aerothermal pumps installed until 2010 was 75% : 25%, and from 2010 – 50% : 50% (aerothermal heating tends to occupy an increasing market share);
- the average amount of refrigerant charged in the equipment is 3 kg;
- R-407C accounts for about 80% and R-410A – for approximately 20% of the total amount of refrigerants in geothermal pumps, meanwhile 100% of aerothermal pumps are filled with R-410A;
- in Lithuania heat pumps have been installed since 2005, their lifetime is 15 years, therefore emissions at system disposal were not estimated.

The calculations of emissions during the charging and operation of the equipment were made using the factors in the lower range limit given in the 2006 IPCC Guidelines:

- the emission factor during the initial charging is 0.2 %;
- the emission factor during the operation of the equipment is 1%.

Emissions of HFCs during the initial charging of new equipment were calculated using the following equation (2006 IPCC Guidelines, p. 7.50, Tier 2a):

$$E_{charge,\,t} = M_t \ x \ \ k$$

Where:

$E_{Charge,\,t}$ –emissions during system manufacture/assembly in year *t, tonnes;*

M_t – amount of HFCs charged into new equipment in year *t, tonnes;*

k – emission factor of assembly losses of HFCs charged into new equipment, %.

Emissions during lifetime:

$$E_{lifetime,\,t} = B_t \ \ x \ \ x$$

Where:

B_t – amount of HFCs banked in existing systems in year *t, tonnes;*

x – emission factor of HFCs for each sub-application bank during operation, accounting for average annual leakage and average annual emission during servicing, %.

Total emissions:

$$E_{total,\,t} = E_{charge,\,t} \ x \ \ E_{lifetime,\,t}$$

Emissions in this sector were calculated for 2005-2011 on the basis of specific information on the beginning of the installation of these systems in Lithuania (2005).

Estimates of fluorinated gas emissions from heat pumps are demonstrated in Figure 4-29 below.

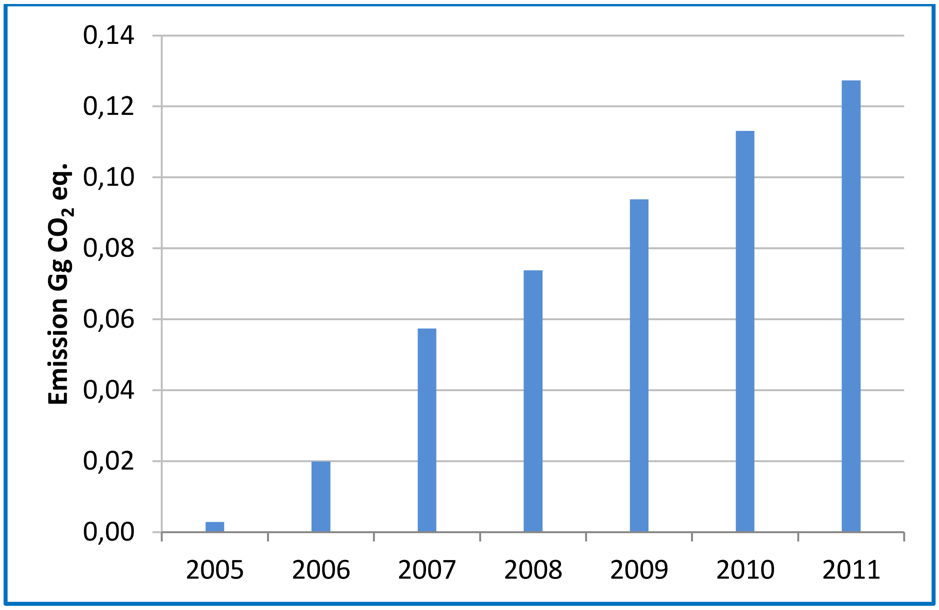

Figure 4-29. Fluorinated gas emissions from heat pumps for 2006-2011

Estimates of fluorinated gas emissions from heat pumps are provided in Table 4-40.

Table 4-40. Total HFC emissions from stationary air conditioning and heat pumps for the period 1995-2011

Year	Emissions from stationary air conditioning, Gg CO_2 eqv.	Emissions from heat pumps, Gg CO_2 eqv.	Total HFC emissions, Gg CO_2 eqv.
1995	0,12	NO	0,12
1996	0,24	NO	0,24
1997	0,36	NO	0,36
1998	0,48	NO	0,48
1999	0,60	NO	0,60
2000	0,72	NO	0,72
2001	1,27	NO	1,27
2002	1,92	NO	1,92
2003	2,61	NO	2,61
2004	3,58	NO	3,58
2005	4,49	0,00	4,49
2006	5,55	0,02	5,57
2007	6,88	0,06	6,93
2008	8,48	0,07	8,55
2009	9,96	0,09	10,05
2010	10,68	0,11	10,79
2011	11,86	0,13	11,98

Uncertainties and time-series consistency

Emission uncertainty was estimated using Approach 1 of the 2006 IPCC Guidelines (p. 3.27).

Uncertainty estimates of activity data and emission factors are presented in Table 4-41.

Table 4-41. Uncertainty (UN) estimates of fluorinated gas emissions in the sub-category of stationary air conditioning for 2011

Emission source	Input data UN, %	EF during operation UN, %	Input data UN, %	Recovery EF UN, %	Total emission UN, %
CRF 2.IIA.F.1.5 Stationary air conditioning					35,66
Air-conditioning and ventilation equipment	30	20	-	-	36,06
Heat pumps	20	20	-	-	28,28

4.7.1.6 Mobile Air-Conditioning (CRF 2.IIA.F.1.6)

Road vehicles with air conditioning: passenger vehicles, buses, freight vehicles

According to the information provided in the 2012 study on the use of HFCs in Lithuania, the refrigerants R-134a and R-404a have been used in mobile air-conditioning systems since 1993. The refrigerant R-404a is a blend of fluorinated gases consisting of HFC-125 (44%), HFC-143a (52%), and HFC-134a (4%).

Fluorinated gas emissions from this equipment were estimated following the 2006 IPCC Guidelines and on the basis of the statistical data on vehicles registered in the Republic of Lithuania. The data on vehicles registered in 1991-2011 by vehicle category and year of manufacture was obtained from state enterprise Regitra:

- M1 – passenger cars;
- M2 – buses ≤ 5 t;
- M3 – buses > 5 t;
- N1 – freight vehicles up to 3.5 t;
- N2 – freight vehicles from 3.5 to 12 t;
- N3 – freight vehicles above 12 t.

The vehicles considered in this report were manufactured in 1993-2011. The company Regitra also provided the average lifetime by vehicle category. The percentage of vehicles equipped with air conditioning in the vehicle fleet of Lithuania by vehicle category and year of manufacture was estimated on the basis of vehicle suppliers (Table 4-42).

Table 4-42. Estimated percentage of vehicles equipped with air conditioning by year of manufacture and vehicle category

Year of manufacture	M1	M2	M3	N1	N2	N3
1990	20%	0%	0%	0%	0%	25%
1991	24%	0%	0%	0%	0%	28%
1992	28%	0%	0%	0%	0%	31%
1993	32%	0%	0%	0%	0%	34%
1994	36%	0%	0%	0%	0%	37%
1995	40%	0%	0%	0%	0%	40%
1996	44%	2%	2%	2%	2%	43%
1997	48%	4%	4%	4%	4%	46%
1998	52%	6%	6%	6%	6%	49%
1999	56%	8%	8%	8%	8%	52%
2000	60%	10%	10%	10%	10%	55%
2001	64%	18%	18%	18%	18%	63%
2002	68%	26%	26%	26%	26%	71%
2003	72%	34%	34%	34%	34%	79%
2004	76%	42%	42%	42%	42%	87%
2005	80%	50%	50%	50%	50%	95%
2006	84%	58%	58%	58%	58%	96%
2007	88%	66%	66%	66%	66%	97%
2008	92%	74%	74%	74%	74%	98%
2009	96%	82%	82%	82%	82%	99%
2010	100%	90%	90%	90%	90%	100%
2011	100%	94%	94%	94%	94%	100%

There is no data available on the original factory charge therefore the emission factor during the initial charging and the emissions were not estimated.

The assessment of the emissions during the operation of the equipment was based on the following factors and assumptions:

1. Data of a vehicle maintenance company UAB Sadomaksa:
   - the average annual amount of refrigerant in the equipment:

     M2 – buses ≤ 5 t – 8 kg;

     M3 – buses > 5 t – 13 kg;
2. 2006 IPCC Guidelines (p. 7.52):
   - the average annual amount of refrigerant in the equipment:

     M1 – passenger car– 0.7 kg

     N1 – freight vehicles up to 3.5 t – 0.7 kg;

     N2 – freight vehicles from 3.5 to 12 t – 1.2 kg;

     N3 – freight vehicles above 12 t – 1.2 kg;
   - the emission factor during the operation of the equipment (for all vehicle categories) is 15%.

3. Other assumptions:
   - there is no data available for the assessment of the emission factor during equipment maintenance, therefore this factor was assumed to be included in the emission factor during operation.

Emissions of HFCs during the lifetime of the equipment were calculated using the following equation (2006 IPCC Guidelines, p. 7.50, Tier 2a):

$$E_{lifetime,\,t} = B_t \; x \; x$$

Where:
B_t – amount of HFCs banked in existing systems in year *t, tonnes;*
x – emission factor of HFCs for each sub-application bank during operation, accounting for average annual leakage and average annual emission during servicing, %.

The assessment of emissions at system disposal was based on the following factors and assumptions:

1. Data of state enterprise Regitra:
   - The lifetime of vehicles:

   M1 – passenger car – 17 years,
   M2 – buses ≤ 5 t – 16 years,
   M3 – buses > 5 t – 21 years,
   N1 – freight vehicles up to 3.5 t – 22 years,
   N2 – freight vehicles from 3.5 to 12 t – 23 years,
   N3 – freight vehicles above 12 t – 20 years.
2. Other assumptions:
   - the residual gas amount in the system being disposed is 85%;
   - there is no data available on recycling of vehicle air-conditioning systems, therefore the factor of recovery efficiency was not estimated.

Emissions at system end-of-life were calculated using the following equation (2006 Guidelines, p. 7.51):

$$E_{end\text{-}of\text{-}life,\,t} = M_{t\text{-}d} \; x \; p$$

Where:
M_{t-d} – amount of HFCs initially charged into new systems installed in year *(t-d)*, t;
p – residual charge of HFCs in equipment being disposed of expressed in percentage of full charge, %.

It is likely that fluorinated gases contained in vehicle air-conditioning systems are not collected or recovered in Lithuania and are simply emitted into the atmosphere.

Estimations of fluorinated gas emissions from vehicles with air conditioning are demonstrated in Figure 4-30 below.

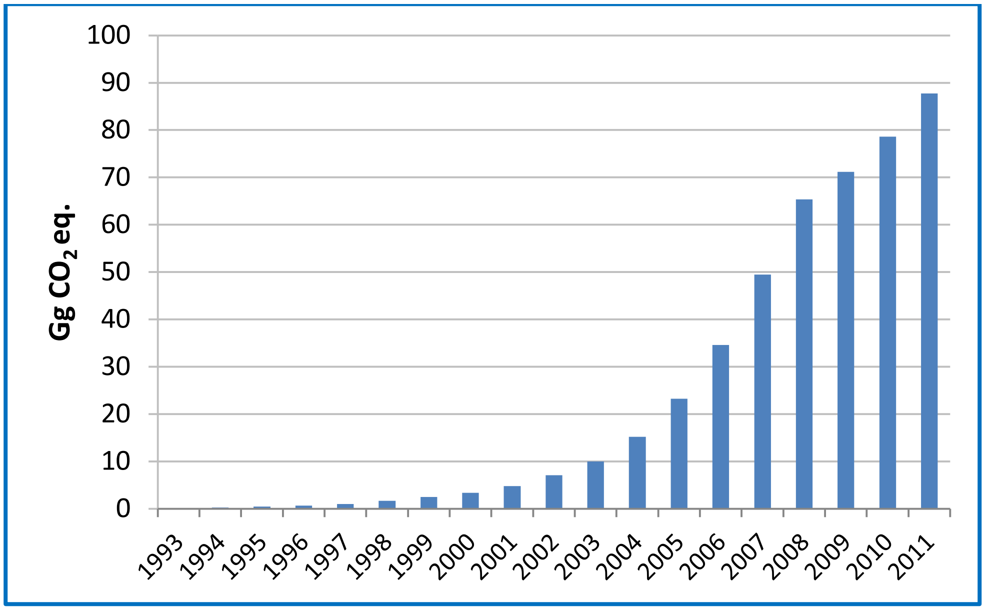

Figure 4-30. Fluorinated gas emissions from vehicles with air conditioning for 1993-2011

Trains – passenger carriages

The refrigerant R-134a in passenger carriages equipped with air conditioning has been used since 2006. According to the data provided by joint-stock company AB Lietuvos geležinkeliai, at present this company has 29 passenger carriages equipped with air conditioning, with each carriage having a UKV-type air conditioner. The company performs regular maintenance of air conditioners but does not recycle end-of-life equipment. The lifetime of air conditioners is 28 years.

There is no data available on the original factory charge, therefore the emission factor during the initial charging and the emissions were not assessed.

The assessment of the emissions during the operation of the equipment was based on the following factors and assumptions:

1. Data of the Passenger Transportation Directorate of the company AB Lietuvos geležinkeliai:
   - the average annual amount of refrigerant in UKV-type air conditioner is 10 kg;
   - the emission factor during the operation of the equipment is 15% .
2. Other assumptions:
   - there is no data available for the assessment of the emission factor during equipment maintenance, therefore this factor was assumed to be included in the emission factor during operation.

Emissions of HFCs during the lifetime of the equipment were calculated using the following equation (2006 IPCC Guidelines, p. 7.50):

$$E_{lifetime,\,t} = B_t \;\; x \;\; x$$

Where:

B_t – amount of HFCs banked in existing systems in year *t, tonnes;*

x – emission factor of HFCs for each sub-application bank during operation, accounting for average annual leakage and average annual emission during servicing, %.

The air-conditioning equipment installed in passenger carriages which belongs to the company AB Lietuvos geležinkeliai is rather new – it has been used since 2006, its lifetime has not expired yet and so emissions at system disposal were not estimated.

Estimates of fluorinated gas emissions from passenger carriages are demonstrated in Figure 4-31 below.

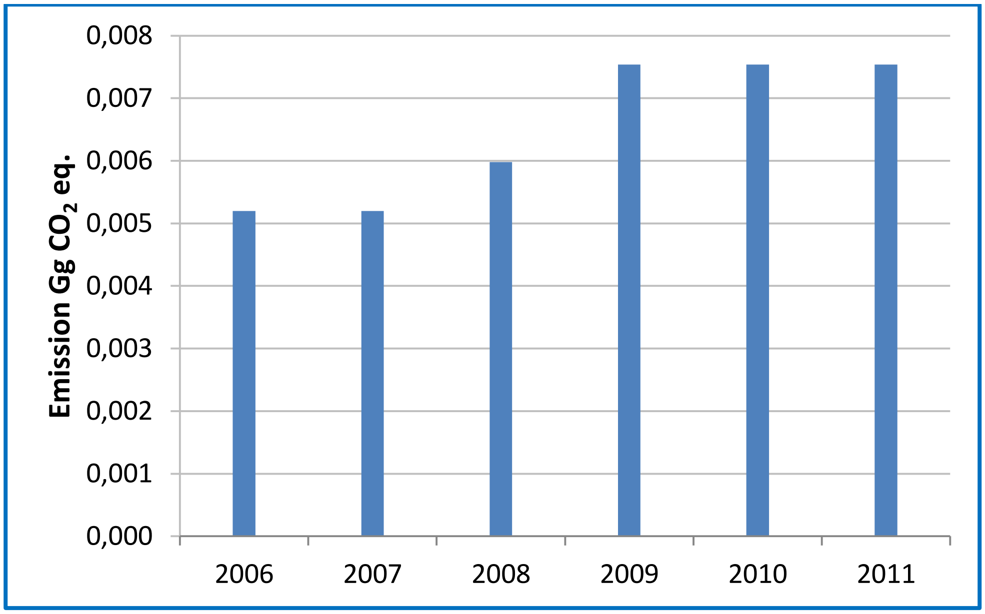

Figure 4-31. Fluorinated gas emissions from passenger carriages for 2006-2011

Total emissions:

$$E_{total,\,t} = E_{lifetime,\,t} + E_{end\text{-}of\text{-}life,\,t}$$

Estimates of fluorinated gas emissions from mobile air-conditioning systems are presented in Table 4-43.

Table 4-43. Total HFC emissions from mobile air conditioning for the period 1993-2011

Year	Emissions from vehicles with air conditioning, Gg CO_2 eqv.	Emissions from rail vehicles with air conditioning, Gg CO_2 eqv.	Total emissions, Gg CO_2 eqv.
1993	0,09	NO	0,09
1994	0,23	NO	0,23
1995	0,43	NO	0,43
1996	0,64	NO	0,64
1997	1,02	NO	1,02
1998	1,67	NO	1,67
1999	2,45	NO	2,45
2000	3,34	NO	3,34
2001	4,78	NO	4,78

2002	7,05	NO	7,05
2003	9,99	NO	9,99
2004	15,21	NO	15,21
2005	23,25	NO	23,25
2006	34,58	0,005	34,59
2007	49,48	0,005	49,49
2008	65,34	0,006	65,35
2009	71,16	0,008	71,16
2010	78,58	0,008	78,59
2011	87,75	0,008	87,76

Uncertainties and time-series consistency

Emission uncertainty was estimated using Approach 1 of the 2006 IPCC Guidelines (p. 3.27).

Uncertainty estimates of activity data and emission factors are presented in Table 4-44.

Table 4-44. Uncertainty (UN) estimates of fluorinated gas emissions in the sub-category of mobile air conditioning for 2011

Emission source	Input data UN, %	EF during operation UN, %	Input data UN, %	Recovery EF UN, %	Total emission UN, %
CRF 2.IIA.F.1.6 Mobile air conditioning					31,62
Air-conditioning equipment in road vehicles	10	20	10	20	31,62
Air-conditioning equipment in rail vehicles	5	5	-	-	7,07

4.7.2 Foam Blowing(CRF 2.F.2)

The 2012 study on the use of HFCs in Lithuania verified the information provided in the last year's National Report that HFCs are not used for foam manufacture in Lithuania. A number of producers of foams for construction or packaging are using BASF technology in which foams are blown by the steam. Lithuanian producer of domestic refrigerators AB Snaigė uses cyclopentane for production of insulation foams.

In this sector HFCs are emitted only from the use of imported foam products containing fluorinated gases. Eleven biggest companies importing foam products were interviewed in 2012. Two companies using closed cell polyurethane (PU) foams (insulation spray) have confirmed the use of products containing F-gases and provided data on the total amount of material used and composition of the F-gases (HFC-365 mfc, HFC-134a, HFC-245fa, HFC-227ea). According to the data provided by UAB Termomontazas, actual amounts of F-gases used for the foam blowing constitute 7.5% of the foam material by weight.

The following assumptions and calculations were made on the basis of summary information provided by companies and in national reports and literature of other countries:

1. The amounts (import and export) used in Lithuania were estimated following the statistical data on PU foam import and export for 2004-2011 provided by Statistics Lithuania;
2. 50% of this amount accounts for systems with HFCs (data source: UAB Termosnaigė);
3. Blends used in systems with fluorinated gases:
   Variant I: 93% HFC-365 mfc, 7% HFC-227ea;
   Variant II: 95% HFC-365 mfc, 5% HFC-245 fa;
   Variant III: 100% HFC-134a;
   Frequency of the use of these blends: Variant I – 60%, Variant II – 20%, Variant III – 20% (based on the 2012 National Inventory Reports of Lithuania, Estonia and Germany and other literature);
4. Estimations included the initial amount of HFCs for PU foam production in the system;
5. Following the 2006 IPCC Guidelines (p. 7.35):
   - the first year loss emission factor is 10%;
   - the annual loss emission factor is 4.5%;
   - the lifetime of the system is 20 years, therefore emissions at system disposal were not estimated.

Emissions of HFCs from closed cell foam were calculated using the following equation (2006 IPCC Guidelines, p. 7.33, Tier 2a):

$$Emissions_t = M_t \times EF_{FYL} + Bank_t \times EF_{AL}$$

Where:

M_t – total HFCs used in manufacturing new closed-cell foam in year *t*, tones

EF_{FYL} – first year loss emission factor, fraction

$Bank_t$ – HFC charge blown into closed-cell foam manufacturing between year t and year *t-n*, tones

EF_{AL} – annual loss emission factor, fraction

According to the information received from companies, HCF 141b was used until 2004 (which is verified by data from other countries and literary sources). When the use of this gas was prohibited, other blowing agents were started to be used (HFC-365mfc, HFC-227ea, HFC-245 fa, HFC-134a), therefore emissions in Lithuania were estimated for the period 2004-2011.

Estimations of fluorinated gas emissions from closed cell foam are demonstrated in Figure 4-32 below.

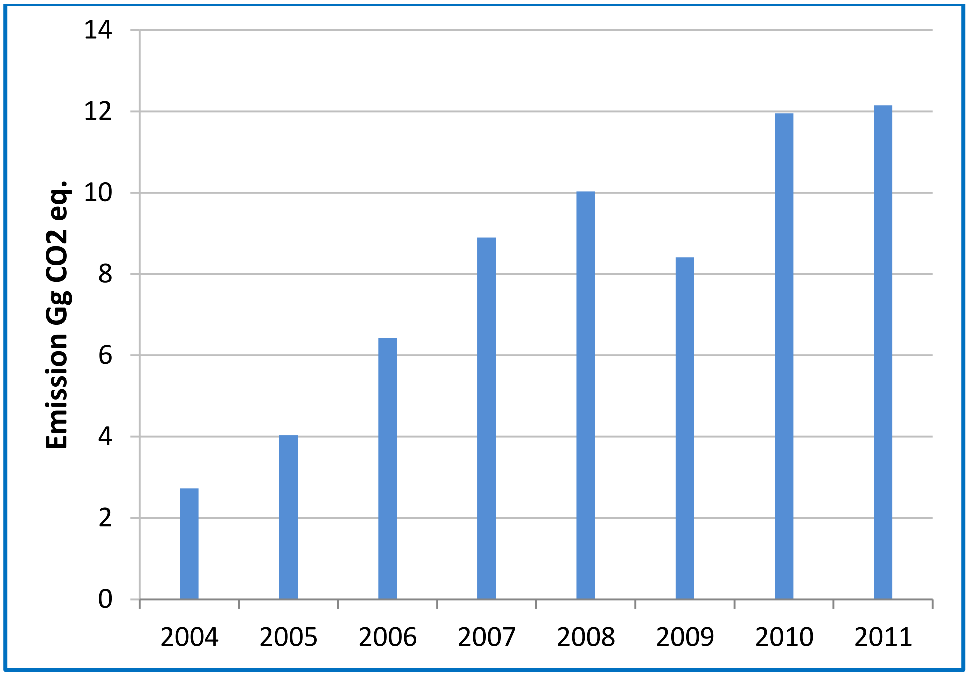

Figure 4-32. Emissions from closed cell foam for 2004-2011

Foam

Private limited liability company UAB Vita Baltic International, which has been operating in Lithuania since 1997 and which belongs (is part of) the VITA GROUP, one of the largest polyurethane producers in the world, informed that it has never used fluorinated gases in its production and has been using chlorides instead.

Estimates of fluorinated gas emissions from foam blowing are presented in Table 4-45.

Table 4-45. Total HFC emissions from foam blowing for the period 2004-2011

Year	Emissions from foam blowing, Gg CO_2 eqv.
2004	2,73
2005	4,03
2006	6,43
2007	8,90
2008	10,03
2009	8,41
2010	11,95
2011	12,15

Uncertainties and time-series consistency

Emission uncertainty was estimated using Approach 1 of the 2006 IPCC Guidelines (p. 3.27).

Uncertainty estimates of activity data and emission factors are presented in Table 4-46.

Table 4-46. Uncertainty (UN) estimates of fluorinated gas emissions in the sub-category of foam blowing for 2011

Emission source	Input data UN, %	EF during operation UN, %	Input data UN, %	Recovery EF UN, %	Total emission UN, %
CRF 2.F.2 Foam blowing	30	30	-	-	42,43

4.7.3 Fire Extinguishers (CRF 2.F.3)

The following information on fluorinated gas use in fire protection systems was obtained during the 2012 study on the use of HFCs in Lithuania:

1. Survey of the companies certified to install and supervise stationary automatic fire extinguishing systems:
   - the main source of fluorinated gases is stationary automatic fire extinguishing systems;
   - the main gas is FM 200 (HFC-227ea), which has been used since 1996;
   - small amounts of HFC-23 have also been used;
   - the average amount of gas contained in one system totals 100 kg, however, the range is 50-500 kg (or even 1000 kg), therefore it is not appropriate to estimate gas amounts on the basis of the number of installed systems;
   - as from the year 2008, basically only FM 200 is used, meanwhile FS49C2 (R866) is no longer used in newly installed systems;
   - fluorinated gases are not used in non stationary fire extinguishers;
   - There were only few registered cases when stationary fire extinguishing systems were triggered and emitted gasses into the atmosphere. Therefore emissions were estimated using the emission factor recommended in the 2006 IPCC Guidelines (1.5%).
   - Didposal of the stationary automatic fire extinguishing systems has not yet started.

2. TheMinistry of National Defence provided data on the amounts of HFC-236fa contained in fire protection systems installed in vehicles. So far these systems have not been triggered. Emissions were estimated using the emission factor recommended in the 2006 IPCC Guidelines (1.5%).

3. The database of the Environmental Protection Agency (EPA) on use of F-gas. This database is made up of company reports. The database was used to estimate amounts and emissions of FS49C2

The annual amounts for 2000-2011 were estimated on the basis of the following data and assumptions:

1. Information provided by companies certified to install and supervise stationary automatic fire extinguishing systems was used as a basis for calculation of HFC-227ea emissions. To calculate the annual amounts of HFC-227ea it was assumed that installation of the systems is driven by trends in construction industry (data of Statistics Lithuania on the useful floor area of completed buildings for 2000-2011);
2. Information provided by the Ministry of National Defence was used as a basis for calculation of HFC-236fa emissions.

3. EPA database was used as a basis for calculation of FS49C2 emissions. Amount of the gas in operating systems during 2000-2011 was calculated based on the following assumptions:
   - FS49C2has been used in Lithuania since 2000;
   - the amount of the gas in 2000 comprised 20% of the amount in 2011;
   - the gas has not been used in new systems installed after 2007;

The lifetime of the stationary fire extinguicher equipment is 20 years (the lifetime of military equipment is longer, 25-30 years) therefore emissions at system disposal were not estimated.

Emissions of HFCs from fire protection systems were calculated using the following equation (2006 IPCC Guidelines, p. 7.61):

$$Emissions_t = Bank_t \times EF$$

Where:
$Bank_t$ - bank of agent in fire protection equipment in year *t*, tones;
EF - fraction of agent in equipment emitted each year.

Estimates of fluorinated gas emissions from fire protection systems are demonstrated in Figure 4-33 below.

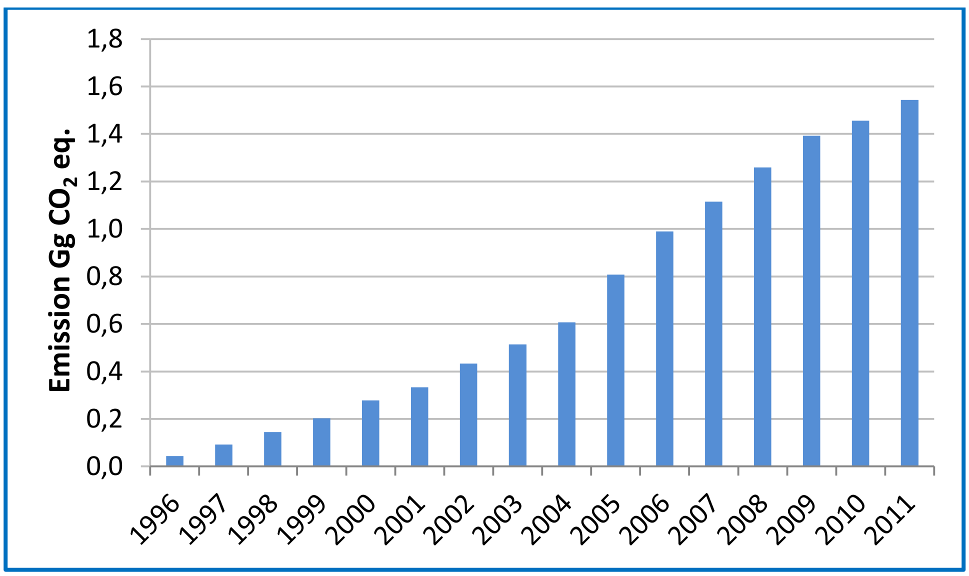

Figure 4-33. Fluorinated gas emissions from fire protection systems for 1996-2011

Emissions were estimated for the period 1996-2011 on the basis of information provided by companies on the beginning of the gas use.

Estimates of fluorinated gas emissions from fire protection systems are presented in Table 4-47.

Table 4-47. Total HFC emissions from fire protection systems for the period 1996-2011

Year	Emissions from fire protection systems, Gg CO_2 eqv.
1996	0,04

1997	0,09
1998	0,15
1999	0,20
2000	0,28
2001	0,33
2002	0,43
2003	0,51
2004	0,61
2005	0,81
2006	0,99
2007	1,11
2008	1,26
2009	1,39
2010	1,46
2011	1,54

Uncertainties and time-series consistency

Emission uncertainty was estimated using Approach 1 of the 2006 IPCC Guidelines (p. 3.27).

Uncertainty estimates of activity data and emission factors are presented in Table 4-48.

Table 4-48. Uncertainty (UN) estimates of fluorinated gas emissions in the sub-category of fire extinguishers for 2011

Emission source	Input data UN, %	EF during operation UN, %	Total emission UN, %
CRF 2.F.3 Fire extinguishers	20	20	28,28

4.7.4 Aerosols/Metered Dose Inhalers (CRF 2.F.4)

Data on total annual sales of metered dose inhalers containing HFCs and a specific amount of HFC-134a initially charged in product was obtained from the State Medicines Control Agency under the Ministry of Health of the Republic of Lithuania.

The data was available for the period 2004-2010. Emissions for the period 1995-2003 were extrapolated, taking into account that metered dose inhalers containing F-gases started to be registered in Lithuania's Register of Medicinal Products from 1994 year and making an assumption that emissions in 1995 constituted 50% of emissions in 2004.

Emissions of HFCs from metered dose inhalers were calculated using the following equation (2006 IPCC Guidelines, p. 7.28):

$$E_t = S_t \times EF + S_{t-1} \times (1 - EF)$$

Where:

S_t – quantity of HFCs contained in aerosol products sold in year *t*, tonnes

S_{t-1} – quantity of HFCs contained in aerosol products sold in year *t-1*, tonnes

EF – emission factor (fraction of chemical emitted during the first year).

Estimates of fluorinated gas emissions from metered dose inhalers are demonstrated in Figure 4-34 below.

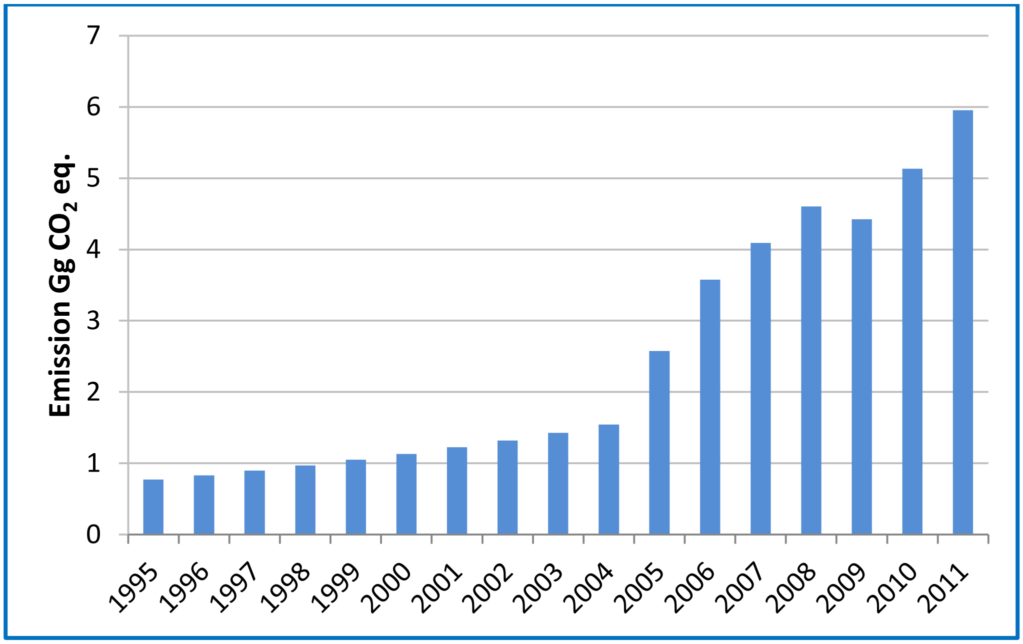

Figure 4-34. Fluorinated gas emissions from metered dose inhalers for 1995-2011

Estimates of HFC emissions from metered dose inhalers are presented in Table 4-49.

Table 4-49. Total HFC emissions from metered dose inhalers for the period 1995-2011

Year	Emissions from metered dose inhalers, Gg CO_2 eqv.
1995	0,77
1996	0,83
1997	0,90
1998	0,97
1999	1,05
2000	1,13
2001	1,22
2002	1,32
2003	1,43
2004	1,54
2005	2,58
2006	3,58
2007	4,09
2008	4,60
2009	4,42

2010	5,13
2011	5,96

Uncertainties and time-series consistency

Emission uncertainty was estimated using Approach 1 of the 2006 IPCC Guidelines (p. 3.27).

Uncertainty estimates of activity data and emission factors are presented in Table 4-50.

Table 4-50. Uncertainty (UN) estimates of fluorinated gas emissions in the sub-category of metered dose inhalers for 2011

Emission source	Input data UN, %	EF during operation UN, %	Total emission UN, %
CRF 2.F.4 Aerosols/Metered dose inhalers	5	5	7,07

4.7.5 Solvents (CRF 2.F.5)

The two studies of the use of fluorinated gases (2008 and 2012) have not identified any potential area for application for the solvents containing fluorinated gases. Taking into account the experience from other countries ir is very unlikely that solvents containing fluorinated gases are used in significant quantities in Lithuania. Therefore notation key „NO" is used.

4.7.6 Other Applications Using ODS Substitutes (CRF 2.F.6)

In the previous report, SF_6 emissions from semiconductor production were assigned to the category "CRF 2.F.6. Other Applications Using ODS Substitutes". In the present report, however, these emissions were categorised under "CRF 2.F.7. Semiconductor Manufacture".

4.7.7 Semiconductor Manufacture (CRF 2.F.7)

There is one company in Lithuania, UAB Vilniaus Ventos puslaidininkiai, which produces semiconductors, and this company was contacted for necessary data. The company said that the SF_6 gas has been used only since 2008 and it's atmosphere emissions are estimated at 50%. SF_6 emissions were estimated for the period 2008-2011.

Emissions of SF_6 from semiconductor manufacturing were calculated using the following modified equation (2006 IPCC Guidelines):

$$E_{SF6,\,t} = F_{SF6,\,t} \times C_i$$

Where:

$F_{SF6,\,t}$ - quantity of HFCs used by the company in year *t*, tonnes

C_i - emission factor during production.

Estimates of SF_6 emissions from semiconductor manufacture are demonstrated in Figure 4-35 below.

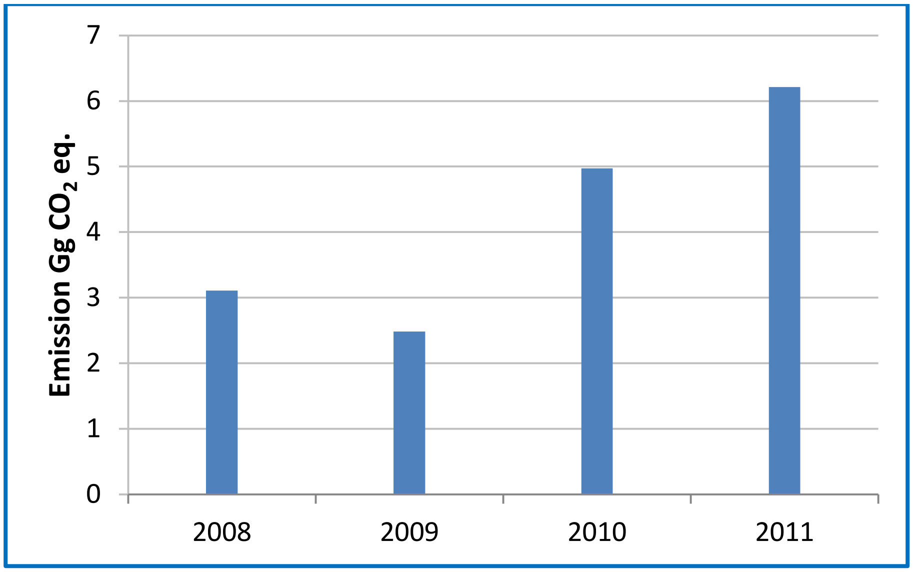

Figure 4-35. SF_6 emissions from semiconductor manufacture for 2008-2011

Estimates of fluorinated gas emissions from semiconductor manufacture are presented in Table 4-51.

Table 4-51. Total SF6 emissions from semiconductor manufacture for the period 2008-2011

Year	Emissions from semiconductor manufacture, Gg CO_2 eqv.
2008	3,11
2009	2,49
2010	4,97
2011	6,21

Uncertainties and time-series consistency

Emission uncertainty was estimated using Approach 1 of the 2006 IPCC Guidelines (p. 3.27).

Uncertainty estimates of activity data and emission factors are presented in Table 4-52.

Table 4-52. Uncertainty (UN) estimates of SF_6 emissions in the sub-category of semiconductor manufacture for 2011

Emission source	Input data UN, %	EF during operation UN, %	Total emission UN, %
CRF 2.F.7 Semiconductor manufacture	5	5	7,07

4.7.8 Electrical Equipment (CRF 2.F.8)

Sulphur hexafluoride (SF_6) is used for electrical insulation and current interruption in equipment used in the transmission and distribution of electricity. Most of the SF_6 used in electrical equipment is used in gas insulated switchgear and substations and in gas circuit breakers.

The Lithuanian energy management system was reorganized in 2011. The 2012 study on the use of HFCs in Lithuania identified all electrical equipment which was transferred from the balance of some companies to others, drawing up a single register. The data was provided by the following companies:

- joint stock company AB Litgrid, operator of the electricity transmission system;
- joint stock company AB Lesto, operator of the electricity distribution network;
- joint stock company Lietuvos energija, operator of electrical equipment.

At present, high voltage equipment, which suffers operational losses and requires annual recharge is managed by the company AB Litgrid. Medium voltage equipment is leakproof and will be returned to the manufacturer after the expiry of its lifetime.

AB Litgrid provided exact data on annual operating losses meanwhile other companies pointed out that there have been no emissions from their equipment. All companies maintained that the lifetime of their equipment has not expired yet therefore there have been no emissions at system disposal (but even in such case the equipment would be forwarded to the manufacturer).

Private limited liability company UAB Orlen Lietuva and joint stock company AB Lifosa also declared the use of the SF_6 gas in their equipment:

- the SF_6 gas has been contained in high voltage power equipment of AB Lifosa since 2000, no operating losses have been registered so far;
- the SF_6 gas has been contained in many facilities operated by AB Orlen Lietuva for about 15 years, the equipment is hermetic, no maintenance has been required so far (in such case the equipment would be forwarded to the manufacturer).

Following the 2000 IPCC Guidelines, emissions were estimated using Tier 3a method (on the basis of the data directly obtained from each company) for the period 1995-2011 (first operating losses were registered in 1995).

Estimates of SF6 emissions in the sub-category of electrical equipment are demonstrated in Figure 4-36 below.

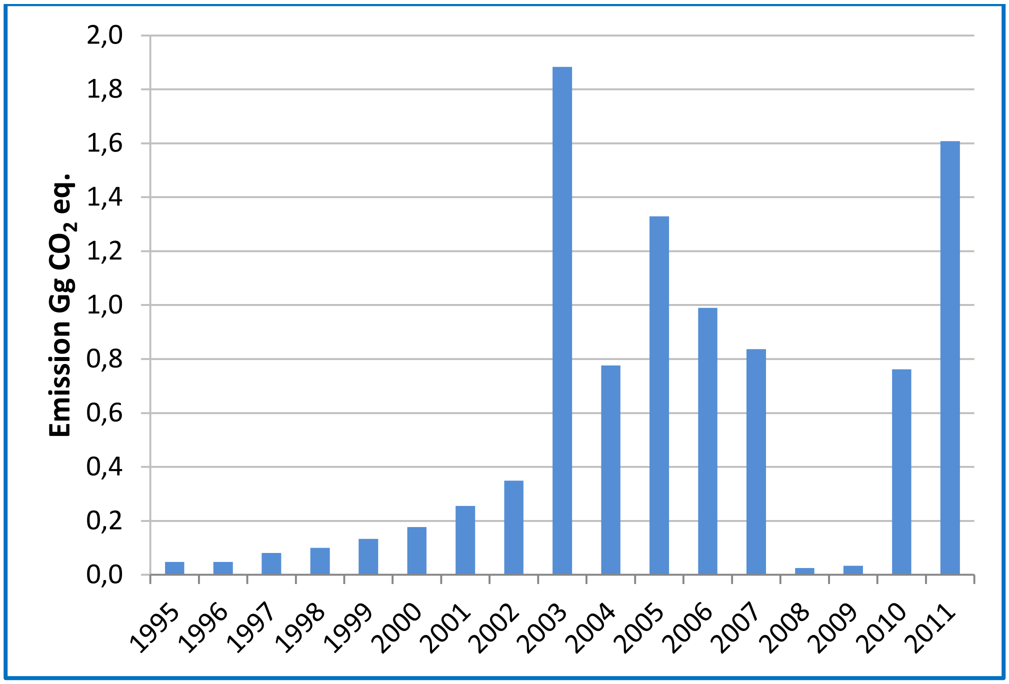

Figure 4-36. SF_6 emissions from electrical equipment for 1995-2011

AB Litgrid was asked to comment on the emission variations. It was explained that the emissions cover both allowable operating losses and leakages due to various technical faults. However, no explanation was provided as to why losses in some years were significantly higher than in other years, the company has not recorded any consistent patterns.

Estimates of fluorinated gas emissions from electrical equipment are presented in Table 4-53.

Table 4-53. Total SF6 emissions from electrical equipment for the period 1995-2011

Year	Emissions from electrical equipment, Gg CO_2 eqv.
1995	0,05
1996	0,05
1997	0,08
1998	0,10
1999	0,13
2000	0,18
2001	0,26
2002	0,35
2003	1,88
2004	0,78
2005	1,33
2006	0,99
2007	0,84
2008	0,03

2009	0,03
2010	0,76
2011	1,61

Uncertainties and time-series consistency

Emission uncertainty was estimated using Approach 1 of the 2006 IPCC Guidelines (p. 3.27).

Uncertainty estimates of activity data and emission factors are presented in Table 4-54.

Table 4-54. Uncertainty (UN) estimates of SF6 emissions in the sub-category of electrical equipment systems for 2011

Emission source	Input data UN, %	EF during operation UN, %	Total emission UN, %
CRF 2.F.8 Electrical equipment	5	5	7,07

4.7.9 Other (CRF 2.F.9)

The entities surveyed during the 2012 study on the use of HFCs in Lithuania also included:

- largest manufacturers of double-glazed windows;
- hospitals providing oncological treatment.

Manufacturers of sound-proof double-glazed windows confirmed that the SF_6 gas is not used in Lithuania. The gas used instead is inert argon (in rare cases – crypton).

The surveyed hospitals which apply radiation therapy for cancer treatment confirmed the use of accelerators containing the SF_6 gas:

- Kauno klinikos, Hospital of Lithuanian University of Health Sciences (5 units),
- Institute of Oncology Vilnius University (4 units),
- Šiauliai County Hospital (1 unit),
- Klaipėda University Hospital (1 unit).

SF_6 gas emissions were estimated based on the data provided directly by the hospitals for 1999-2011 (the first devices were put into operation in 1999).

Emissions increased in 2000, 2003, 2006, 2009, and 2011 due to the use of the equipment Mevatron MD2 in the hospital Kauno klinikos, when the total amount of the SF_6 gas was emitted during the replacement of the magnetron. There is no information on the specific years when the magnetron was replaced, however, it is known that it was replaced four times from the start of its operation, so it was assumed that the replacements took place at regular intervals. This equipment was dismantled in 2011.

Estimates of SF_6 emissions from accelerators (in radiation therapy facilities) are demonstrated in Figure 4-37 below.

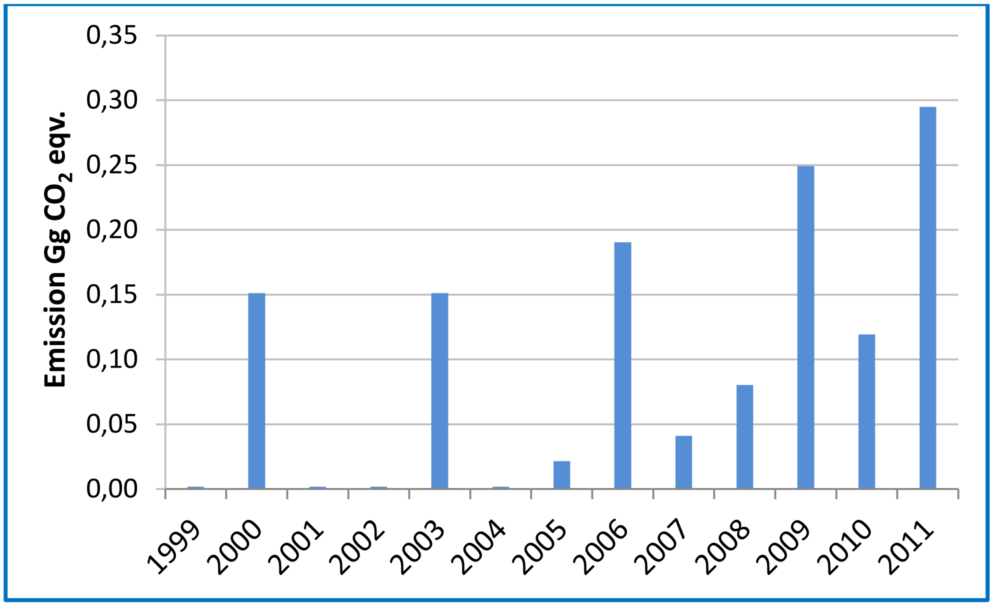

Figure 4-37. SF_6 emissions from accelerators (in radiation therapy facilities) for 1999-2011

Estimates of SF6 emissions from accelerators (in radiation therapy facilities) are presented in Table 4-55.

Table 4-55. Total SF6 emissions from accelerators in radiation therapy facilities for the period 1996-2011

Year	Emissions from accelerators (in radiation therapy facilities), Gg CO_2 eqv.
1999	0,02
2000	0,151
2001	0,002
2002	0,002
2003	0,151
2004	0,002
2005	0,021
2006	0,190
2007	0,041
2008	0,080
2009	0,249
2010	0,119
2011	0,295

Uncertainties and time-series consistency

Emission uncertainty was estimated using Approach 1 of the 2006 IPCC Guidelines (p. 3.27).

Uncertainty estimates of activity data and emission factors are presented in Table 4-56.

Table 4-56. Uncertainty (UN) estimates of fluorinated gas emissions from accelerators (in radiation therapy facilities) for 2011

Emission source	Input data UN, %	EF during operation UN, %	Total emission UN, %
CRF 2.F.9 Other	5	5	7,07

4.7.10 Source-specific recalculations

Domestic refrigeration (CRF 2.IIA.F.1.1)

HFC emissions from domestic refrigeration were recalculated for the period 1995-2010 based on the findings of the 2012 Study on use of HFC in Lithuania:

- Data on HFC-134a emissions from manufacturing of new products (2000-2011) is reported for the first time;
- New activity data was collected and emissions of HFC-134a and HFC-152 from freezers were estimated (1995-2010);
- HFC-152 emissions from domestic refrigeration reported for the first time;
- Average amount of F-gases per refrigeration unit was updated;
- Emission factor for annual leakage rate from domestic refrigeration was updated;
- Number of domestic refrigeration units filled with HFC-134a and HFC-152 prior to 1995 was updated based on data from recycling company.

Commercial refrigeration (CRF 2.IIA.F.1.2)

HFC emissions from commercial refrigeration were recalculated for the period 1995-2010 based on the findings of the 2012 Study on use of HFC in Lithuania:

- HFC-134a emissions from drink coolers in supermarkets (1996-2011) are reported for the first time;
- HFC-134a, HFC-125 and HFC-143a emissions from refrigeration equipment in hotels, cafés, bars (1995-2011) are reported for the first time.

Transport refrigeration (CRF 2.IIA.F.1.3)

HFC emissions from transport refrigeration were recalculated for the period 1993-2010 based on the findings of the 2012 Study on use of HFC in Lithuania:

- HFC-134a emissions from refrigerated freight wagons (2006-2011) are reported for the first time;
- Average life time of the transport refrigeration units was updated based on country specific vehicle registration data;
- Emission factor for annual leakage rate from transport refrigeration was updated;
- Average amount of F-gases per refrigeration unit was updated based on country specific data.

Industrial refrigeration (CRF 2.IIA.F.1.4)

No source-specific recalculations were done.

Stationary air-conditioning (CRF 2.IIA.F.1.5)

HFC emissions from stationary air conditioning (1995-2011) are reported for the first time. Estimated emissions from geothermic installations are also reported under this category.

Mobile air-conditioning (CRF 2.IIA.F.1.6)

HFC emissions from mobile air-conditioning were recalculated for the period 1993-2010 based on the findings of the 2012 Study on use of HFC in Lithuania:

- HFC-134a emissions from air conditioning in passenger carriages (2006-2011) are reported for the first time;
- HFC-125 and HFC-143a emissions from mobile air conditioning reported for the first time;
- Data on number of vehicles was updated (1991-2001);
- Average amount of F-gases per MAC unit (buses) was updated based on country specific data;
- Average life time of the vehicles was updated based on country specific vehicle registration data.

Foam blowing (CRF 2.F.2)

Emissions of HFC-365mfc, HFC-134a, HFC-245fa, HFC-227ea from foam blowing for the period 2004-2010 were recalculated based on the new activity data obtained by the 2012 Study on use of HFC in Lithuania.

Fire extinguishers (CRF 2.F.3)

HFC emissions from fire extinguishers were recalculated for the period 1996-2010 based on the findings of the 2012 Study on use of HFC in Lithuania:

- Emissions from fire fighting vehicles (2002-2011) are reported for the first time;
- HFC-236fa emissions (2002-2011) are reported for the first time;
- Emission factor was updated (introduced EF based on 2006 IPCC Guidance).
- New data on use of F-gases in automatic fire protection systems.

Aerosols/ Metered Dose Inhalers (CRF 2.F.4)

No source-specific recalculations were done.

Semiconductor manufacture (CRF 2.F.7)

Introduced calculation of SF_6 emission from semiconductor manufacture for the period 2008-2011 based on newly obtained data from UAB Vilniaus Ventos puslaidininkiai.

Electrical equipment (CRF 2.F.8)

Emissions of SF_6 from electrical equipment for the period 1995-2005 were recalculated based on data provided by AB Litgrid. Typing error in 2010 data was corrected.

Other (CRF 2.F.9)

Introduced calculation of SF_6 emission from accelerators in radiation therapy facilities for the period 1999-2011 based on newly obtained data from hospitals which apply radiation therapy for cancer treatment.

4.7.11 Source-specific planned improvements

Significant improvements of the data collection practices in the Environmental Protection Agency are planned in order to collect complete and reliable data on import, use and recovery of HFCs, PFCs and SF_6 in Lithuania.

5 SOLVENT AND OTHER PRODUCTS USE (CRF 3)

Solvent and other products use contribute a small amount to the total GHG emissions in Lithuania. Share to the total emission was only 0,4% in 2011 (excl. LULUCF). Indirect CO_2 emission from NMVOC for the following CRF categories was estimated:

- Paint application (CRF 3.A)
- Degreasing and dry cleaning (CRF 3.B)
- Other (CRF 3.D) (includes emissions from the use of N_2O for anaesthesia, emissions from use of glues and adhesives, graphic arts, domestic solvent use).

The inventory of NMVOC emissions from the solvent and other product use sector is performed at Lithuanian Environmental Protection Agency. The NMVOC inventory is carried out to meet the obligations of the UNECE Convention on Long-range Transboundary Air Pollution.

In this annual submission sector Solvent and other product use were identified as a key category. This information is provided in Table 5-1 below.

Table 5-1. Key category from Solvent and other product use in 2011 by Level and Trend excluding LULUCF

IPCC source categoty	Gas	Identification criteria	Approach used
3. Solvent and Other Product Use	CO_2	Level	Tier 2
		Trend	Tier 2
3. Solvent and Other Product Use	N_2O	Level	-
		Trend	Tier 2

5.1 Paint Application, Degreasing and Dry Cleaning, Other (CRF 3.A, 3.B & 3.D)

5.1.1 Source Category Description and Methodological issues

NMVOC emissions were calculated according to EMEP/CORINAIR methodology simpler approach based on per capita data for several source categories. Default per capita emission factors proposed in EMEP/CORINAIR guidebook were used, multiplying them by the number of inhabitants (Table 5-2).

Table 5-2. NMVOC emission factors

Sub-sectors	NMVOC emission factors, kg/cap/year
Paint application	4,50
Industrial degreasing	0,85
Dry cleaning	0,31
Graphic arts	0,65
Glues and adhesives	0,60
Domestic solvent use	1,80

Emissions were calculated using annual average population data provided by the Statistics Lithuania.
It was assumed that the average carbon content is 85 percent by mass for all categories under sector of solvents and other products use. CO_2 emissions from solvent and other product use were calculated using the equation below.

$$Emission\ CO_2 = Emission\ NMVOC \times 0{,}85 \times 44/12$$

N_2O emissions from N_2O used in anaesthesia were estimated taking into account amount of N_2O sold in Lithuania. Following the *2006 IPCC Guidelines*, it was assumed that 100% of N_2O sold for anaesthesia was emitted to the air, therefore activity data is equal to estimated emissions. The data on the N_2O sales was available since 2005. Activity data was provided by the State Medicines Control Agency. Emissions for 1990-2004 were estimated with the increasing trend accordingly. Other sources of N_2O emissions were not estimated due to lack of activity data. CO_2, N_2O and NMVOC emissions (Gg) from solvents and other products use is presented in Table 5-3.

Table 5-3. CO_2, N_2O and NMVOC emissions (Gg) from solvents and other products use for the period 1990-2011

Year	CO_2 emission	NMVOC emission	N_2O emission
1990	100,42	32,22	0,31
1991	100,59	32,27	0,31
1992	100,48	32,24	0,30
1993	100,00	32,09	0,30
1994	99,31	31,87	0,29
1995	98,55	31,62	0,28
1996	97,80	31,38	0,28
1997	97,09	31,15	0,27
1998	96,38	30,93	0,27
1999	95,70	30,71	0,26
2000	95,03	30,49	0,25
2001	94,22	30,23	0,25
2002	93,43	29,98	0,24
2003	92,65	29,73	0,24
2004	91,57	29,38	0,23
2005	90,01	28,88	0,22
2006	88,52	28,40	0,13
2007	87,47	28,07	0,10
2008	86,61	27,79	0,01
2009	85,72	27,50	0,03
2010	84,04	26,96	0,01
2011	82,29	26,40	0,01

5.1.2 Uncertainties and time-series consistency

All uncertainty estimates of activity data and emission factors have so far been based on expert judgment:

- Uncertainty of activity data is assumed to be 30%;
- Emission factor uncertainty is assumed to be 20%;
- Combined uncertainty is 36%.

5.1.3 Source-specific QA/QC and verification

All quality procedures according to the Lithuanian QA/QC plan have been implemented during the work with this submission.

5.1.4 Source specific recalculation

The following recalculations were done:

- NMVOC and CO_2 emissions from Paint application, Industrial degreasing, Dry cleaning, Graphic arts, Glues and adhesives and Domestic solvent use were recalculated for the period 2001-2010 due to updated population data by Statistics Lithuania;
- Typing error was corrected for CO_2 emission from paint application (1990).

Table 5-4. CO_2 and NMVOC emissions (Gg) recalculations

Year	Previous submission	This submission	Difference	Previous submission	This submission	Difference
	CO_2	CO_2		NMVOC	NMVOC	
1990	100,4	100,5	0,1	32,2	32,2	0
1991	100,6	100,6	0	32,3	32,3	0
1992	100,5	100,5	0	32,2	32,2	0
1993	100,0	100,0	0	32,1	32,1	0
1994	99,3	99,3	0	31,9	31,9	0
1995	98,6	98,6	0	31,6	31,6	0
1996	97,8	97,8	0	31,4	31,4	0
1997	97,1	97,1	0	31,2	31,2	0
1998	96,4	96,4	0	30,9	30,9	0
1999	95,7	95,7	0	30,7	30,7	0
2000	95,0	95,0	0	30,5	30,5	0
2001	94,2	94,5	0,3	30,2	30,3	0,1
2002	93,4	94,2	0,8	30,0	30,2	0,3
2003	92,7	93,8	1,1	29,7	30,1	0,4
2004	91,6	93,3	1,7	29,4	29,9	0,6
2005	90,0	92,7	2,7	28,9	29,8	0,9
2006	88,5	92,2	3,7	28,4	29,6	1,2
2007	87,5	91,7	4,2	28,1	29,4	1,3
2008	86,6	91,2	4,6	27,8	29,3	1,5
2009	85,7	90,7	5,0	27,5	29,1	1,6
2010	84,0	89,3	5,2	27,0	28,6	1,7

5.1.5 Planned improvements

No planned improvements are under the consideration.

6 AGRICULTURE (CRF 4)

6.1 Overview of the sector

Greenhouse gas (GHG) emissions from agriculture sector in Lithuania include: CH_4 emissions from enteric fermentation of domestic livestock; CH_4 and N_2O emissions from manure management; direct and indirect N_2O emissions from 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, cultivation of organic soils and sewage sludge application. Indirect N_2O emission sources include emissions from atmospheric deposition and from nitrogen leaching. Rice is not cultivated and savannas do not exist in Lithuania, therefore reported as "NO" in CRF tables. Field burning of agricultural residues is prohibited by the legislation[25] and reported as "NO". For agriculture sector nine relevant categories were evaluated as the key categories (Table 6-1).

Table 6-1. Key category from Agriculture in 2011 by Level and Trend excluding LULUCF

IPCC source categoty	Gas	Identification criteria	Approach used
4.A Enteric Fermentation, cattle	CH_4	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
4.B Manure Management, cattle	CH_4	Level	Tier 1 / Tier 2
		Trend	Tier 2
4.B Manure Management, swine	CH_4	Level	Tier 1 / Tier 2
		Trend	Tier 2
4.B Manure Management	N_2O	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
4.D.1.1 Direct Soil Emissions Synthetic N fertilizers	N_2O	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
4.D.1.2 Direct Soil Emissions Manure fertilizers	N_2O	Level	Tier 1 / Tier 2
		Trend	Tier 2
4.D.1.3. Direct Soil Emissions N-fixing crops	N_2O	Level	Tier 2
		Trend	Tier 2
4.D.1.4 Direct Soil Emissions Crop residues	N_2O	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
4.D.1.5. Direct Soil Emissions Cultivation of histosols	N_2O	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
4.D.2 Pasture, Range and Paddock Manure	N_2O	Level	Tier 1 / Tier 2
		Trend	Tier 2
4.D.3 Indirect Emissions	N_2O	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2

Emissions were evaluated using methodology of *Revised 1996 IPCC Guidelines*, *IPCC Good Practice Guidance 2000* and *IPCC Guidelines for National Greenhouse Gas Inventories 2006*.

[25] Order of the Minister of Environment No 269 Concerning the environmental protection requirements for burning dry grass, reeds, straw and garden waste, as amended. In force from 9th of September, 1999

4979,97 Gg CO_2 eq. of GHG emissions in Lithuania originated from agriculture sector in 2011. The major part of GHG emissions is related to the agricultural soils (Figure 6-1).

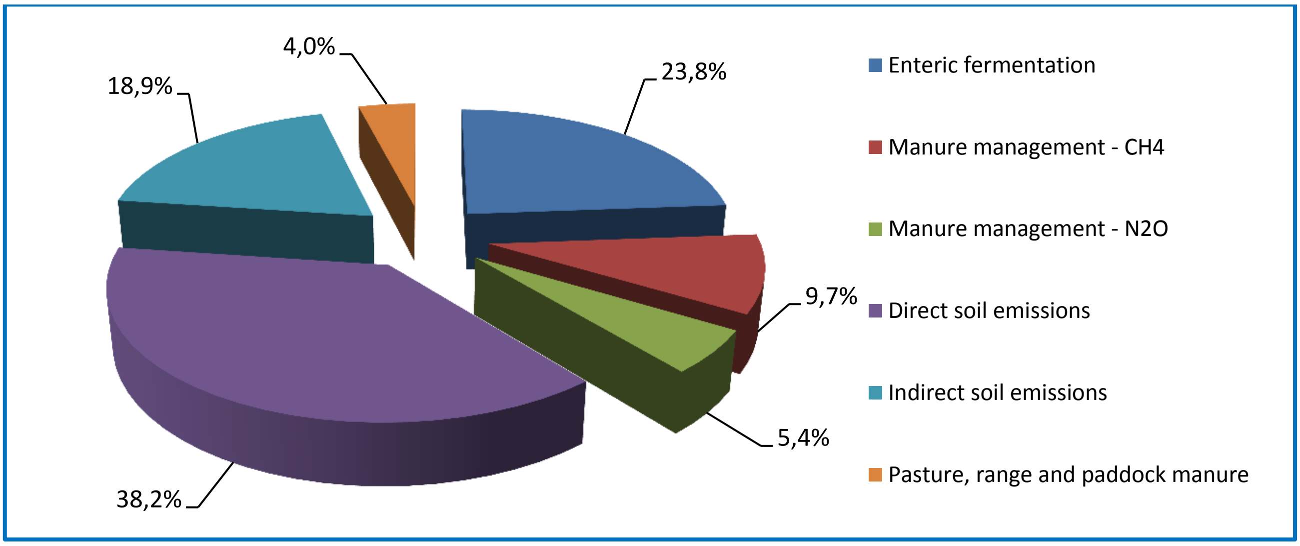

Figure 6-1. The share of aggregated emissions by categories from key sources within the sector in 2011 (%)

In 2011 N_2O emissions contributed 66,4% of the total GHG emission from the agriculture sector. The major part of CH_4 emissions from agriculture sector originates from digestive processes. From 1990 to 2011 emissions from agriculture have decreased by 51,6% (Figure 6-2, Table 6-2).

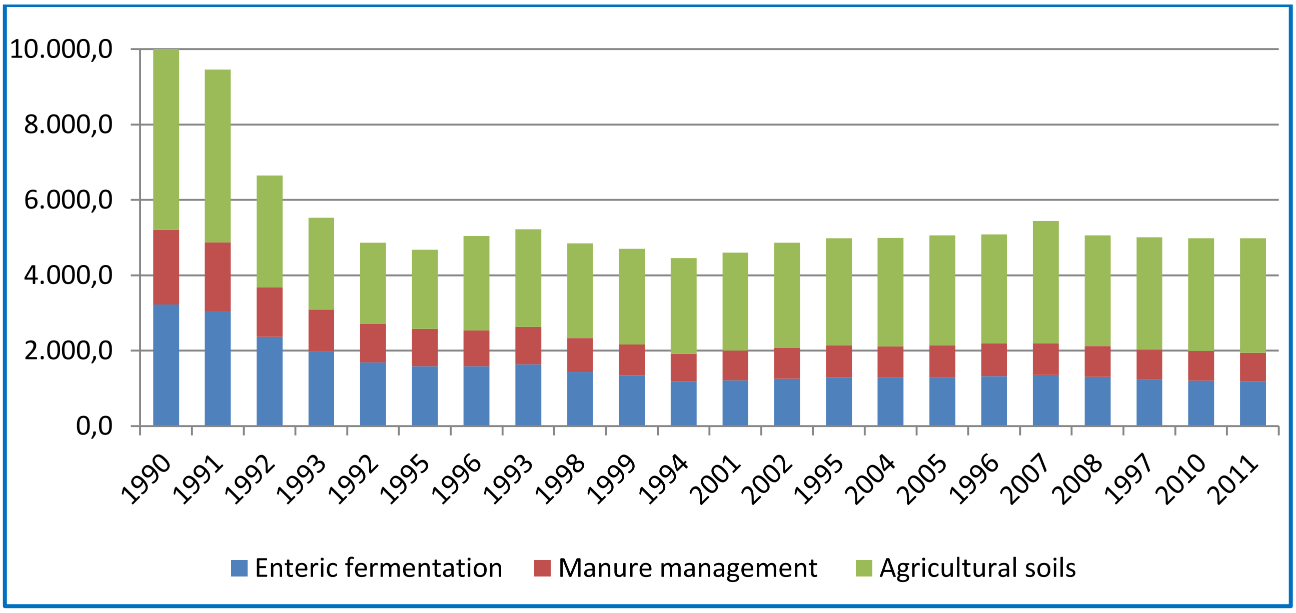

Figure 6-2. The trend in aggregated emissions by categories within the sector during the period 1990-2011(Gg CO_2 eq.)

Emissions from agriculture sector decreased substantially in the beginning of 90's. The agriculture sector contributed 24% of the national GDP in 1992 and employed 19% of the labor force. Lithuania's agriculture, efficient according to the past soviet standards, produced a huge surplus that could not be consumed domestically. Traditionally, Lithuania grew grain (wheat, rye, barley, and feed grains), potatoes, flax, and sugar beets, developed dairy farming, meat production, and food processing. Crops accounted for one-third and livestock for two-thirds of the total value of agricultural output. Lithuanian agricultural production was high enough to allow the export of about 50% of total output.

Significant reforms were introduced in the early 90s, particularly after the restoration of independence, to reestablish private ownership and management in the agriculture sector. The laws were provided for dismemberment of the collective farms, but they did not definitively ensure their replacement by at least equally productive private farms or corporations. Agricultural production decreased by more than 50% from 1989 to 1994. The farms were broken into smallholdings, averaging 8,8 ha in size, often not large enough to be economically viable.

Table 6-2. GHG emissions from agriculture sector by sources during the period 1990-2011 (Gg CO_2 eq.)

Year	Enteric fermentation	Manure management		Agricultural soils		
				Direct	Pasture, range and paddock	Indirect
	CH_4	CH_4	N_2O	N_2O	N_2O	N_2O
1990	3.226,5	1.093,8	885,9	2.702,7	493,8	1.889,4
1991	3.040,5	1.017,2	819,7	2.458,4	465,6	1.663,3
1992	2.370,0	708,9	607,7	1.607,8	365,8	991,6
1993	1.971,7	619,5	496,3	1.387,5	311,0	744,8
1994	1.689,8	603,5	421,9	1.263,0	269,5	618,4
1995	1.588,2	598,1	390,7	1.260,5	253,5	589,7
1996	1.587,8	566,9	383,9	1.509,1	256,0	742,4
1997	1.635,9	606,2	392,8	1.555,6	264,6	765,8
1998	1.434,6	559,8	340,9	1.551,0	235,6	726,7
1999	1.349,3	498,9	317,4	1.577,2	219,4	742,7
2000	1.188,1	452,6	280,5	1.607,3	203,4	725,4
2001	1.215,0	502,2	283,7	1.639,3	205,5	753,5
2002	1.252,8	532,7	292,2	1.753,9	211,4	820,0
2003	1.294,8	542,8	303,8	1.787,2	220,2	838,6
2004	1.276,9	538,0	300,2	1.815,0	219,5	844,3
2005	1.281,5	553,3	304,9	1.843,1	219,7	860,1
2006	1.323,5	562,3	312,5	1.782,1	225,9	880,0
2007	1.353,9	530,6	313,6	2.002,5	225,8	1.013,6
2008	1.304,6	521,4	297,3	1.826,3	217,0	890,5
2009	1.238,2	506,0	280,3	1.871,0	205,8	907,7
2010	1.200,6	519,8	275,4	1.858,4	199,7	930,8
2011	1.185,6	485,3	268,3	1.901,3	199,2	940,3

After 1990 agricultural companies and enterprises were prevailing types of farming in Lithuania. During the land reform implementation process, the number of agricultural companies and their produced agricultural production amount was constantly decreasing, but the most effective farms were formed during this period. On the contrary, during this period the number of livestock kept in private farms was constantly increasing. In 1996-1997 dairy cattle productivity in the private farms was about 3296-3301 kg per cow and reached 3444 kg in 1998, but in 1999 felt down to 3223 kg and was lower than in agricultural companies and enterprises (3266 kg). The producer purchase prices of the milk decreased by 8% in 1999 comparing to 1998 and could have an impact on milk productivity indicators. Overall, during 1990-2011 dairy cattle productivity increased by 39,4%. Data on average milk yield per year per cow are presented in Table 6-3. Data provided by Statistics Lithuania.

Table 6-3. Milk yield average per cow, kg

Year	Milk yield
1990	3734
1991	3481
1992	3080
1993	2910
1994	2925
1995	3010
1996	3093
1997	3205
1998	3384
1999	3228
2000	3673
2001	3903
2002	4003
2003	4015
2004	4176
2005	4312
2006	4484
2007	4708
2008	4778
2009	4811
2010	4901
2011	5206

Climatic conditions

Lithuanian climate belongs to Atlantic forest area in the continental southwest region. Except the Baltic coastal region which is closer to climate of Western Europe and can be attributed to individual Southern Baltic climate region. More detailed information on climatic conditions and temperature is presented in the Introduction (see Section 1.1.1).

Precipitation[26]

Average annual rainfall in 1991-2006 comparing with 1961-1990 in western and central part of Lithuania decreased by 12-56 mm, and in the South and the North-East part of Lithuania increased by 20-66 mm. In 2008 annual rainfall (697 mm) was close to the climatic standards of 1961-1990, which was 675 mm. 60-65% of the annual rainfall comes from April to October. Each summer very strong falls occur with 30 mm of rainfall per day. An average number of days with snow cover comparing the periods 1961-1990 and 1991-2006 decreased by 4-10 days. However, the maximum

[26] Lithuania's Fifth National Communication under the United Nations Framework Convention on Climate Change. Vilnius, January 2010

snow thickness increased by 0,8-2,0 cm. This relates to increasing precipitation in the cold period and more frequent snowfalls in the recent years.

6.2 Enteric fermentation (CRF 4.A)

6.2.1 Source category description

CH_4 emission from enteric fermentation of domestic livestock includes emissions from cattle (dairy cattle, non-dairy cattle), sheep, goats, horses, swine, rabbits, nutria and fur-bearing animals (minks, foxes and polar foxes). Methods for treating poultry in this context are not yet developed. According to *Revised 1996 IPCC*[27], the relevant quantities are considered as negligible and are not calculated, however population of poultry is presented in Table 6-4 as it is used for calculations in subsector Manure management. Activity data have been obtained from Statistics Lithuania (agriculture section)[28] and from the register of Agricultural Information and Rural Business Centre (AIRBC)[29]. Animal population numbers used in the inventory are presented in Table 6-4. The number of dairy cattle in 2011 decreased by 59,3% comparing with 1990. In the same time non-dairy cattle population decreased by 76%, population of horses decreased by 54,4%, swine population – by 67,6%. The number of sheep population increased by 6,5%, goats - by 188,5%. Generally decline of the livestock population was caused by the changes in the economy due to collapse of the Soviet Union.

Table 6-4. Data on livestock population used in GHG inventory (thous. heads)

Year	Dairy cattle	Non-dairy cattle	Sheep	Goats	Horses	Swine	Rabbits	Nutria	Fur-bearing animals	Poultry
1990	842,0	1479,5	56,5	5,2	79,9	2435,9	73,4	17,3	158,2	16820
1991	831,9	1364,7	58,1	6,3	82,6	2179,8	73,7	17,1	155,9	16990
1992	737,8	963,2	51,7	8,8	79,7	1359,8	83,5	13,3	146,1	8260
1993	678,1	706,2	45,0	10,4	81,3	1196,2	92,8	10,3	99,5	8730
1994	614,9	537,5	40,0	12,4	78,2	1259,8	88,1	10,0	94,7	8850
1995	586,0	479,1	32,3	14,6	77,6	1270,0	84,3	8,9	90,0	8440
1996	589,9	464,2	28,2	16,9	81,4	1127,6	93,9	7,1	93,4	7780
1997	615,3	452,7	24,0	18,5	78,5	1205,2	119,5	4,8	90,5	7420
1998	541,0	386,7	15,8	23,7	74,3	1167,7	102,5	3,5	45,6	6750
1999	494,3	403,5	13,8	24,7	74,9	936,1	85,4	2,2	41,8	6370
2000	438,4	309,9	11,5	23,0	68,4	867,6	82,3	2,2	44,8	5580
2001	441,8	309,9	12,3	23,7	64,5	1010,8	74,1	2,0	51,6	6580
2002	443,3	335,8	13,6	22,0	60,7	1061,0	74,6	1,6	60,5	6850
2003	448,1	364,0	16,9	27,2	63,6	1057,4	98,3	1,5	92,3	8070
2004	433,9	358,1	22,2	26,9	63,6	1073,3	96,6	1,4	131,5	8420
2005	416,5	383,8	29,2	22,0	62,6	1114,6	99,9	1,7	172,2	9400
2006	399,0	439,8	36,6	20,8	60,9	1127,1	103,5	2,9	172,7	9440
2007	398,0	436,1	52,0	19,7	55,9	923,2	102,1	1,7	161,0	9880
2008	393,6	379,4	53,7	16,6	54,4	897,1	103,5	1,3	175,2	9110
2009	371,9	359,2	54,2	14,7	49,0	928,2	107,5	1,3	120,1	9310
2010	354,7	353,0	55,8	16,0	44,7	929,4	103,5	1,4	175,7	9470
2011	342,8	355,2	60,2	15,0	36,4	790,3	98,1	0,3	193,1	8921

[27] *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*
[28] Statistics Lithuania. Available from: *http://www.stat.gov.lt/en/*
[29] State enterprise Agricultural Information and Rural Business Centre. Available from: *http://www.vic.lt/*

The population of sheep in the past few years increased due to promotion of farming in poorer lands. CH_4 emissions are primarily related to cattle, which, in 2011 contributed 95,9% of the total emission from enteric fermentation. In 2011 dairy cattle produced 64,2% and non-dairy cattle – 31,7% of CH_4 emissions from enteric fermentation. The share of other livestock was small. Emission from swine made 1,5%, horses – 1,2%, sheep and goats – 1,3% of the total emission from enteric fermentation.

CH_4 emission from enteric fermentation comprised about 71% of the total CH_4 emission from livestock and 23,3% of the total emissions from agriculture sector. In 2011, comparing with 2010, CH_4 emission from enteric fermentation decreased by 1,2%. During the period 1990-2011 CH_4 emission from enteric fermentation decreased by 63,3% (Table 6-5).

Table 6-5. CH_4 emissions from enteric fermentation by livestock categories during the period 1990-2011 (Gg)

Year	Cattle		Sheep	Goats	Horses	Swine	Rabbits, nutria and fur-bearing animals
	Dairy	Non-dairy					
1990	76,35	72,50	0,66	0,03	1,44	2,60	0,07
1991	73,32	66,88	0,68	0,03	1,49	2,33	0,07
1992	62,06	47,20	0,60	0,04	1,43	1,45	0,07
1993	55,88	34,61	0,54	0,05	1,46	1,28	0,07
1994	50,76	26,34	0,49	0,06	1,41	1,35	0,06
1995	48,88	23,48	0,39	0,07	1,40	1,36	0,06
1996	49,69	22,75	0,34	0,08	1,47	1,20	0,07
1997	52,52	22,19	0,30	0,09	1,41	1,30	0,08
1998	47,19	18,19	0,19	0,12	1,34	1,22	0,07
1999	42,37	19,18	0,16	0,12	1,35	1,02	0,06
2000	39,55	14,58	0,14	0,12	1,23	0,91	0,05
2001	40,77	14,54	0,14	0,12	1,16	1,07	0,05
2002	41,30	15,80	0,16	0,11	1,09	1,14	0,05
2003	41,92	17,07	0,19	0,14	1,14	1,12	0,07
2004	41,36	16,69	0,26	0,13	1,14	1,14	0,07
2005	40,21	18,00	0,34	0,11	1,13	1,16	0,08
2006	39,23	20,96	0,41	0,10	1,10	1,14	0,08
2007	40,12	21,66	0,55	0,10	1,01	0,96	0,08
2008	40,39	19,07	0,58	0,08	0,98	0,95	0,08
2009	38,27	18,15	0,59	0,07	0,88	0,92	0,08
2010	36,73	17,89	0,61	0,08	0,80	0,98	0,08
2011	36,25	17,89	0,66	0,07	0,65	0,84	0,08

The overall reduction of CH_4 emission was caused by decrease in total number of livestock (excluding sheep, goats, rabbits and minks). In case of dairy cattle the attrition of animals was partly counterbalanced by an increase in productivity of animals resulting in higher emission per animal.

6.2.2 Methodological issues

Choice of methods

Cattle are the most important producer of CH_4 among all domestic animals due to their digestive system, relatively high weight and number comparing with other livestock population. Cattle are a key source due to the contribution to the total greenhouse gas emissions. Therefore the Tier 2 method was used for estimation of CH_4 emissions from enteric fermentation of dairy and non-dairy cattle. Tier 2 method was also used for CH_4 emission estimation from enteric fermentation of sheep and swine (Table 6-6). For estimating CH_4 emission from enteric fermentation of goats, horses, rabbits, nutria and fur-bearing animals (minks, foxes and polar foxes) the Tier 1 method was used.

Table 6-6. Methods and emission factors used for estimations of emission from enteric fermentation

Animal category	Sub-categories			Method applied	Emission factor
Dairy cattle*				Tier 2	CS
Non-dairy* cattle	Suckling cows			Tier 2	CS
Non-dairy cattle	Less than 1 year old	Calves for slaughter		Tier 2	CS
		For breeding	Bulls	Tier 2	CS
			Heifers	Tier 2	CS
	From 1 to 2 years old	Bulls		Tier 2	CS
		Heifers	For slaughter	Tier 2	CS
			For breeding	Tier 2	CS
	2 years old and older	Bulls		Tier 2	CS
		Heifers	For slaughter	Tier 2	CS
			For breeding	Tier 2	CS
		Other cows		Tier 2	CS
Non-dairy* cattle	To 8 months	Bulls		Tier 2	CS
		Heifers		Tier 2	CS
	From 8 to12 months	Bulls		Tier 2	CS
		Heifers		Tier 2	CS
	From 1 to 2 years old	Bulls		Tier 2	CS
		Heifers		Tier 2	CS
	2 years old and older	Bulls		Tier 2	CS
		Heifers		Tier 2	CS
Sheep	Mature ewes and ewe lambs 1 and more years			Tier 2	CS
	Lambs to 12 months			Tier 2	CS
Sheep*	Mature sheep			Tier 2	CS
	Ewe lambs			Tier 2	CS
	Baa-lambs to 8 months			Tier 2	CS
	Rams			Tier 2	CS
Goats				Tier 1	IPCC
Horse				Tier 1	IPCC
Swine	Sows			Tier 2	CS

	Piglets < 2 months (< 20 kg)	Tier 2	CS
	Growing pigs (20-110 kg)	Tier 2	CS
	Pigs > 110 kg (8 months and >)	Tier 2	CS
	Boars	Tier 2	CS
	Gilts for breeding	Tier 2	CS
Rabbits		Tier 1	Russian emission factor
Nutria		Tier 1	Russian emission factor
Fur-bearing animals		Tier 1	Norwegian emission factor

* Since 2007 activity data was collected from the register of Agricultural Information and Rural Business Centre

Characterisation of animal populations

CH_4 emission calculations are based on the number of livestock population. Data on livestock number is provided by the Register of Agricultural Information and Rural Business Centre (AIRBC) and Statistics Lithuania. During the period 1990-2006 the number of livestock was obtained from the database of Statistics Lithuania (as of 1st of January). During the period 2007-2011 the average annual number of cattle and sheeps was provided by the AIRBC.

The data given in the database and publications of Statistics Lithuania is collected by applying continuous accountability for agriculture companies and applying sampling methods for farmers and households. The Register on livestock of AIRBC in cooperation with The State Food and Veterinary Service implements animal registration and identification system, in which all the changes between the animal subcategories are registered every month. Therefore it is assumed that data on animal population in the Register is more accurate than data provided in the database of Statistics Lithuania.

In Lithuanian inventory livestock category "cattle" (CRF 4.A) consists of "dairy cattle" and "non-dairy cattle". Calculating CH_4 emissions "dairy cattle" are taken in general, not dividing in to smaller sub-categories.

"Non-dairy cattle" sub-category includes purebred and hybrid suckling cows used for meat production. For the period 1990-2006 sub-category "Non-dairy" cattle consists of 11 subcategories according to database of Statistics Lithuania:

- calves less than 1 year old for slaughter,
- bulls less than 1 year old for breeding,
- heifers less than 1 year old for breeding,
- bulls from 1 to 2 years old,
- heifers from 1 to 2 years old for slaughter,
- heifers from 1 to 2 years old for breeding,
- bulls 2 years old and older,
- heifers 2 years old and older for slaughter,
- heifers 2 years old and older for breeding,
- other cows.

For the period 1990-1996 not all information on relevant 11 sub-categories was available in the database of Statistics Lithuania. At that period the only available data was on division to such sub-categories: bulls, dairy cattle, heifers from 1 to 2 years old, and heifers 2 years and older, therefore the data for this period was interpolated, based on the subsequent years division to sub-categories.

For the period 2007-2011 sub-category of "Non-dairy cattle" consists of 9 relevant sub-categories from the Registy of AIRBC:

- suckling cows,
- bulls to 8 months,
- heifers to 8 months,
- bulls from 8 to 12 months,
- heifers from 8 to 12 months,
- bulls from 1 to 2 years old,
- heifers from 1 to 2 years old,
- bulls 2 years old and older,
- heifers 2 years old and older.

The total number of cattle is given in Table 6-4, the number of non-dairy cattle by sub-categories in Tables 6-7 and 6-8.

Table 6-7. The number of non-dairy cattle by sub-categories in Lithuania during the period 1990-2006 (thous. heads)

Year	Cattle sub-categories										
	Suckling cows	Cattle less than 1 year old			Cattle from 1 to 2 years old			Cattle 2 years old and older			Dairy cattle for slaughter
		For slaughter	Bulls for breeding	Heifers for breeding	Bulls	Heifers for slaughter	Heifers for breeding	Bulls	Heifers for slaughter	Heifers for breeding	
1990	-	344,7	48,9	300,9	228,6	63,3	268,2	56,7	23,9	119,3	25,1
1991	-	318,0	45,1	277,5	210,9	58,4	247,4	52,3	22,0	110,0	23,1
1992	-	224,4	31,8	195,9	148,8	41,2	174,6	36,9	15,5	77,7	16,3
1993	-	164,6	23,3	143,6	109,1	30,2	128,0	27,1	11,4	56,9	12,0
1994	-	125,2	17,8	109,3	83,1	23,0	97,4	20,6	8,7	43,3	9,1
1995	-	111,6	15,8	97,4	74,0	20,5	86,8	18,4	7,7	38,6	8,1
1996	-	108,2	15,3	94,4	71,7	19,9	84,1	17,8	7,5	37,4	7,9
1997	-	105,5	15,0	92,1	70,0	19,4	82,1	17,3	7,3	36,5	7,7
1998	-	113,5	13,1	80,8	53,8	14,1	64,0	11,9	4,5	24,1	6,9
1999	-	113,4	16,0	80,7	60,9	21,6	61,9	12,9	5,7	24,7	5,7
2000	0,3	81,2	12,4	68,5	44,1	15,9	53,5	7,9	4,0	19,3	2,8
2001	0,8	81,3	10,6	72,1	42,5	12,0	55,3	9,0	2,8	20,1	3,4
2002	0,9	79,9	13,5	81,2	46,0	11,6	65,2	8,4	3,5	22,2	3,4
2003	1,7	83,7	14,7	90,5	45,0	13,0	73,6	9,1	4,4	24,8	3,5
2004	2,3	84,1	14,8	89,9	40,8	11,7	73,5	8,0	3,8	25,8	3,4
2005	4,5	90,6	17,0	93,0	45,4	15,2	76,0	8,9	4,0	26,7	2,5
2006	9,4	89,0	22,6	109,9	53,8	17,1	89,3	8,7	2,4	35,1	2,5

Table 6-8. The number of non-dairy cattle by sub-categories in Lithuania during the period 2007-2011 (thous. heads)

Year	Cattle sub-categories								
	Suckling cows	Cattle to 8 months		Cattle from 8 to12 months		Cattle from 1 to 2 years old		Cattle 2 years old and older	
		Bulls	Heifers	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers
2007	12,3	53,0	70,5	26,4	36,9	58,1	10,5	16,6	45,6
2008	14,9	49,6	70,2	20,8	33,6	41,4	92,7	11,9	44,12
2009	16,9	46,0	64,4	20,5	33,4	39,0	89,6	9,9	39,5
2010	19,1	45,9	64,6	19,5	30,7	38,1	86,9	9,1	39,2
2011	21,4	46,3	68,1	19,3	32,4	37,9	86,4	7,3	36,2

Other important parameter used in CH_4 emission calculation from enteric fermentation is average weight of non-dairy cattle. Average weight of non-dairy cattle is calculated in accordance with average weight of each non-dairy cattle sub-category proportionally to its number of population:

$$m_{average} = (\sum m_i * population_i)/population_{total}$$

wher:
$m_{average}$ – average weight of non-dairy cattle, kg;
m_i – average weight of each non-dairy cattle sub-category, kg;
$population_i$ – population of each non-dairy cattle sub-category, thous. heads;
$population_{total}$ – total population of non-dairy cattle sub-category, thous. heads.

Data on average weight of each non-dairy cattle sub-category was based on national references and expert judgment[30]. Data on average weight of non-dairy cattle is presented in Table 6-9 below.

Table 6-9. The average weight of non-dairy cattle during the period 1990-2011 (kg)

Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Weight	331,0	331,0	331,0	331,0	331,0	331,0	331,0	331,0	312,0	315,3	312,3
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Weight	312,2	313,4	314,1	312,1	313,6	319,3	319,3	322,4	323,9	326,2	321,7

Average weight of dairy cattle remains constant for the whole time period and is assumed to be 575,0 kg based on the expert judgement.

Based on expert judgement the average weight gain was estimated for each non-dairy cattle subcategory which remains constant for the whole time period. Basing on this data average weight gain of non-dairy cattle was estimated:

$$w_{average} = (\sum w_i * population_i)/population_{total}$$

[30] Gyvulininkystės žinynas. Baisogala, Institute of Animal Science of LVA, 2007

where:
$w_{average}$ – average weight gain of non-dairy cattle, kg/day;
w_i – average weight gain of each non-dairy cattle sub-category (excluding mature cows and bulls over 2 years), kg/day;
population$_i$ – population of each non-dairy cattle sub-category (excluding mature cows and bulls over 2 years), thous. heads;
population$_{total}$ – total population of non-dairy cattle sub-category (excluding mature cows and bulls over 2 years), thous. heads.

The average weight gain of non-dairy cattle for 2011 was estimated to be 0,7 kg/day.

The number of swine by sub-categories used in 1990 -2011 are presented in Tables 6-4 and 6-10. Information on swine population by sub-categories are obtained from the database of Statistics Lithuania.

Table 6-10. The number of swine by sub-categories in Lithuania during the period 1990-2011 (thous. heads)

Year	Swine sub-categories					
	Sows	Piglets till 2 months (20kg)	Growing pigs (20-110 kg)	Boars	Pigs>8 months	Gilts for breeding
1990	173,4	450,2	1564,7	8,1	186,8	52,8
1991	155,1	402,9	1400,2	7,3	167,1	47,2
1992	96,8	251,3	873,4	4,5	104,3	29,5
1993	85,1	221,1	768,4	4,0	91,7	25,9
1994	89,7	232,8	809,2	4,2	96,6	27,3
1995	90,4	234,7	815,8	4,2	97,4	27,5
1996	80,3	208,4	724,3	3,8	86,5	24,4
1997	92,2	220,5	759,5	4,5	94,6	33,8
1998	76,8	232,8	743,0	4,0	85,7	25,4
1999	63,2	159,4	608,2	3,9	79,8	21,6
2000	59,3	160,2	544,6	3,1	71,2	17,2
2001	73,7	188,5	653,1	3,6	69,7	22,2
2002	76,2	181,2	704,7	3,5	76,1	19,3
2003	78,6	194,3	691,4	2,2	75,3	15,6
2004	80,0	199,0	703,9	2,0	72,7	15,7
2005	82,4	222,0	720,4	1,9	71,5	16,4
2006	81,9	249,8	711,1	2,0	66,6	15,6
2007	62,3	191,5	578,0	1,3	70,7	19,3
2008	65,2	162,9	595,8	1,2	59,1	12,9
2009	67,9	229,0	559,5	1,4	55,0	15,4
2010	67,8	171,9	617,6	1,4	56,5	14,3
2011	53,1	138,6	528,2	1,1	54,1	15,2

The average weight of swine is estimated based on the same methodology as for average weight of non-dairy cattle.

Table 6-11. The average weight of swine during the period 1990-2011 (kg)

Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Weight	70,3	70,3	70,3	70,3	70,3	70,3	70,3	70,7	68,3	71,7	69,9
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Weight	69,5	70,3	71,4	70,8	69,4	67,7	67,8	68,8	67,0	67,9	68,3

The total number and the number by sub-categories of sheep population for the period 1990-2011 is reported in Tables 6-4 and 6-12. For the period 1990-2006 the number of sheep population was obtained form the database of Statistics Lithuania (as of 1st of January). For the period 2007-2011 the average annual number of sheep population by sub-categories is obtained from the Register of AIRBC.

The collection of data on population of sheep from different sources for the periods 1990-2006 and 2007-2011 is applied for the same reason as for the cattle.

The data basis of the Register of Agricultural Information and Rural Business Center provides data on mature sheep and other male and female sheep. In assumption that the birth rate of male and female lambs is almost equal and baa-lambs are kept up to 8 months old for meet while almost all of the ewe lambs are left for breeding, and there is 1 ram needed for the 25-30 ewes mating, the number of various age groups sheep was calculated. Population of sheep for the period 1990-2011 is presented in Table 6-12.

Table 6-12. The number of sheep by sub-categories in Lithuania during the period 1990-2011 (thous. heads)

Year	**Sheep sub-category**					
	Mature sheep and ewe over 1 years	**Lambs to1 years**	**Mature sheep**	**Ewe lambs**	**Baa-lambs to 8 month**	**Rams**
1990	36,2	20,3	-	-	-	-
1991	36,9	21,2	-	-	-	-
1992	32,7	19,0	-	-	-	-
1993	30,7	14,3	-	-	-	-
1994	27,4	12,6	-	-	-	-
1995	21,5	10,8	-	-	-	-
1996	19,6	8,6	-	-	-	-
1997	17,8	6,2	-	-	-	-
1998	10,6	5,2	-	-	-	-
1999	8,7	5,1	-	-	-	-
2000	7,5	4,0	-	-	-	-
2001	7,7	4,6	-	-	-	-
2002	8,4	5,2	-	-	-	-
2003	10,3	6,6	-	-	-	-
2004	14,4	7,7	-	-	-	-
2005	18,5	10,7	-	-	-	-
2006	21,6	15,0	-	-	-	-
2007	-	-	22,0	17,6	11,4	0,9

2008	-	-	23,4	18,2	11,2	0,9
2009	-	-	24,3	18,3	10,6	1,0
2010	-	-	25,0	19,4	10,3	1,0
2011			27,0	21,4	10,8	1,1

Calculation of CH_4 emission factors for cattle, swine and sheep

CH_4 emissions from enteric fermentation were calculated using the following equation[31]:

$$CH_4\ emission = EF \times Population / (10^6\ kg/Gg)$$

where:
EF – emission factor for each animal category, kg/head/yr;
Population – the number of head in the defined livestock population.

National emission factors for dairy and non-dairy cattle were calculated in accordance with the Tier 2 methodology provided in *IPCC GPG 2000*[32]:

$$EF = (GE \times Ym \times 365\ days/yr) / 55{,}65\ MJ/kg\ CH_4$$

where:
EF – emission factor, kg CH_4/head/yr;
GE – gross energy intake of the sub-category, MJ/head/day;
Ym – methane conversion rate ((percentage of gross energy that is converted to methane) (assumed to be 6%)). A CH_4 conversion factor for calves up to ten[33], lambs up to five[34] and piglets up to five-seven[35] days of age, consuming only milk was assumed to be zero.

To estimate the EF from dairy cattle in the period 1990-2006 gross energy (GE) was calculated using equation[36]:

$$GE = (NE_m + NE_a + NE_l + NE_p) / (NE_{ma}/DE) / (DE/100)$$

where:
NE_m – Net energy required by the animal for maintenance, MJ/head/day;
NE_a – Net energy for animal activity, MJ/head/day;
NE_l – Net energy for lactation, MJ/head/day;
NE_p – Net energy required for pregnancy, MJ/head/day;
NE_{ma}/DE – ratio of net energy available in a diet for maintenance to digestible energy consumed;
NE_{ga}/DE – ratio of net energy available for growth in a diet to digestible energy consumed;
DE – digestible energy expressed as a percentage of gross energy.

[31] *IPCC GPG 2000*. Agriculture. Eq. 4.12, p. 4.25
[32] *IPCC GPG 2000*. Agriculture. Eq. 4.14, p. 4.26
[33] Gyvulininkystės žinynas. Baisogala, Institute of Animal Science of LVA, 2007, p.104
[34] Zapasnikienė, B. *Mitybos normos avims ir ožkoms*. 2 lentelė, p. 11
[35] Gyvulininkystės žinynas. Baisogala, Institute of Animal Science of LVA, 2007, p. 281
[36] *IPCC GPG 2000*. Agriculture. Eq. 4.11, p. 4.20

The main sources of activity data used in CH_4 emission factor calculation from dairy cattle were: weight, feeding situation, milk production, fat content of milk, percentage of pregnant females, and feed digestibility.

Feeding data was obtained from the tables reported by the *IPCC GPG 2000*, milk production and fat content of milk were obtained from statistical databases. Average milk yield per cow are given in Table 6-13.

Table 6-13. Average milk yield (kg/head/day) and fat content of milk (%) during the period 1990-2011

Year	Milk yield (kg/head/day)	Fat content (%)
1990	10,23	4,10
1991	9,54	4,10
1992	8,44	4,10
1993	7,97	4,10
1994	8,01	4,10
1995	8,25	4,10
1996	8,47	4,10
1997	8,78	4,10
1998	9,27	4,12
1999	8,44	4,13
2000	10,06	4,13
2001	10,69	4,08
2002	10,97	4,06
2003	11,00	4,11
2004	11,44	4,14
2005	11,81	4,11
2006	12,28	4,12
2007	12,90	4,16
2008	13,09	4,16
2009	13,18	4,17
2010	13,43	4,17
2011	14,26	4,17

To estimate the EF from dairy cattle in the period 2008-2011 and non-dairy cattle in the period 1990-2011 gross energy of feed was calculated using equation[37]:

$$\text{Gross energy (MJ/kg feed)} = 0{,}0239 \times CP + 0{,}0398 \times C_{Fat} + 0{,}0201 \times C_{Fibre} + 0{,}0175 \times NFE$$

where:
CP – crude protein, g/kg in dry matter;
C_{Fat} – crude fat, g/kg in dry matter;
C_{Fibre} – crude fibre, g/kg in dry matter;
NFE – nitrogen-free extracts, g/kg in dry matter.

[37] Kulpys H., Šeškevičienė J., Jeroch H. *Žemės ūkio gyvulių ir paukščių mitybos fiziologinės reikmės*. Kaunas, 2004, p. 30

GE (MJ/head/day) was estimated by multiplying GE per kg of every feed from amount of the necessary feed in dry matter, then making GE sums and calculating the amount per day:

$$GE_{(MJ/head/day)} = GE_{(MJ/kg\ feed)}\ x\ (F_{quantity}\ x\ dry\ matter/kg\ feed)\ /\ 365$$

where:
$GE_{(MJ/kg\ feed)}$ – the amount of gross energy, MJ/kg feed;
$F_{quantity}$ x dry matter/kg feed – the amount of forage, necessary during a year, kg (counting as dry matter).

During the time-period 2007-2011 to estimate the EF for dairy and non-dairy cattle gross energy was calculated on the basis of feed accumulation standards indicated in the national reference book of livestock production[38]. The average daily feed intake for dairy cattle and for each subcategory of non-dairy cattle was calculated according to national zoo-technical activity data – milk yield and milk fat of dairy cows, weight and weight gain.

Most frequently used feedstuffs were included in calculation, namely, hay from cultivated meadows and pastures with different nutritive values, also clover and cereal grass hay, straw from different crops, cultivated meadow grass and silage from maize and perennial wilted grass, root-crops, grass from cultivated meadows and pastures with different nutritive values, also leguminous green feeds, concentrates with respect to the composition of every different type of feed, milk and milk replacers. Average gross energy intake for dairy cattle are presented in Table 6-14.

Table 6-14. Calculated average gross energy intake for dairy cattle in 1990-2011 (MJ/head/day)

Year	GE (MJ/head/day)
1990	230,4
1991	224,0
1992	213,7
1993	209,4
1994	209,8
1995	211,9
1996	214,1
1997	216,9
1998	221,7
1999	217,8
2000	229,2
2001	234,5
2002	236,8
2003	237,7
2004	242,2
2005	245,3
2006	249,8
2007	256,2
2008	260,7

[38] Gyvulininkystės žinynas. Baisogala, Institute of Animal Science of LVA, 2007, p. 616

2009	261,5
2010	263,1
2011	268,7

Average gross energy intake for non-dairy cattle subcategories are given in Tables 6-15 and 6-16.

Table 6-15. Calculated average gross energy intake for non-dairy cattle subcategories in 1990-2006 (MJ/head/day)

Cattle sub-categories		GE (MJ/head/day)
Suckling cows		221,4
Cattle less than 1 year old	For slaughter	90,8
	Bulls for breeding	100,4
	Heifers for breeding	78,6
Cattle from 1 to 2 years old	Bulls	181,5
	Heifers for slaughter	131,4
	Heifers for breeding	137,3
Cattle 2 years old and older	Bulls	177,3
	Heifers for slaughter	171,2
	Heifers for breeding	171,2
Dairy cattle for slaughter		192,6

Table 6-16. Calculated average gross energy intake for non-dairy cattle subcategories in 2007-2011(MJ/head/day)

Cattle sub-categories		GE (MJ/head/day)
Suckling cows		221,4
Cattle to 8 months	Bulls	84,2
	Heifers	70,4
Cattle from 8 to12 months	Bulls	134,9
	Heifers	106,2
Cattle from 1 to 2 years old	Bulls	181,5
	Heifers	137,3
Cattle 2 years old and older	Bulls	177,3
	Heifers	171,2

Pasture-cowshed time estimations are based on the data of the national zoo-technical activity data[39,40].

Emission factors of dairy cattle estimated using country specific data and Tier 2 method are presented in Table 6-17.

Table 6-17. Calculated emission factors used for calculation of CH_4 emission from enteric fermentation of dairy cattle during the period 1990-2011 (kg CH_4/head/year)

Year	EF (kg CH_4/head/year)
1990	90,7

[39] Gyvulininkystės žinynas. Mokslas, Vilnius, 1976, p. 98-99
[40] Tarvydas V. ir kt. *Šėrimo normos, pašarų struktūra ir sukaupimas galvijams*, Vilnius, 1995, p. 4

1991	88,1
1992	84,1
1993	82,4
1994	82,6
1995	83,4
1996	84,2
1997	85,4
1998	87,2
1999	85,7
2000	90,2
2001	92,3
2002	93,2
2003	93,5
2004	95,3
2005	96,5
2006	98,3
2007	100,8
2008	102,6
2009	102,9
2010	103,5
2011	105,7

Calculated emission factors for dairy cattle vary across the time period due to the changes in milk yield and feed consumption. EF of CH_4 during the period 1990-1993 has decreased due to the reduced productivity of dairy cattle. In time period 1994-1998 EF has increased but 1999 EF has decreased again as productivity of milk per head has increased.

Estimated emission factors of the relevant sub-categories of cattle are presented in Tables 6-18 and 6-19.

Table 6-18. Calculated emission factors used for calculation of CH_4 emission from enteric fermentation of non-dairy cattle sub-categories during the period 1990-2006 (kg CH_4/head/year)

Cattle sub-categories		**EF (kg CH_4/head/year)**
Suckling cows		87,13
Cattle less than 1 year old	For slaughter	34,75
	Bulls for breeding	38,43
	Heifers for breeding	30,08
Cattle from1 to 2 years old	Bulls	71,43
	Heifers for slaughter	51,71
	Heifers for breeding	54,03
Cattle 2 years old and older	Bulls	69,75
	Heifers for slaughter	67,37
	Heifers for breeding	67,37
Dairy cattle for slaughter		75,79

Table 6-19. Calculated emission factors used for calculation of CH_4 emission from enteric fermentation of non-dairy cattle sub-categories during the period 2007-2011 (kg CH_4 /head/year)

Non-dairy cattle sub-categories		**EF**
Suckling cows		87,10
Cattle to 8 months	Bulls	32,23
	Heifers	26,95
Cattle from 8 to12 months	Bulls	41,79
	Heifers	53,09
Cattle from 1 to 2 years old	Bulls	71,43
	Heifers	54,03
Cattle 2 years old and older	Bulls	69,75
	Heifers	67,37

Calculated emission factors for non-dairy cattle vary across the years due to the changes in allocation of subcategories, population size and feed consumption (Table 6-20).

Table 6-20. Calculated emission factors used for calculation of CH_4 emission from enteric fermentation of non-dairy cattle during the period 1990-2011 (kg CH_4/head/year)

Animal category	**Non-dairy cattle**
1990	49,00
1991	49,00
1992	49,00
1993	49,00
1994	49,00
1995	49,00
1996	49,00
1997	49,00
1998	47,04
1999	47,52
2000	47,05
2001	46,93
2002	47,05
2003	46,91
2004	46,62
2005	46,91
2006	47,66
2007	49,66
2008	50,26
2009	50,54
2010	50,68
2011	50,36

Determining CH_4 emission from swine, gross energy was also calculated on the basis of feed accumulation standards presented in the above mentioned national reference book for animal production. Most frequently used feedstuffs also were used for calculations: barley, wheat, triticale, dried pulses, rapeseed cake, soybean meal, milk replacers, fish meal and oil.

Gross energy for swine was calculated using the same methodology as for cattle. Calculated average gross energy intakes and emission factors in relevant sub-category of swine are given in Table 6-21.

Table 6-21. Calculated average gross energy intake (MJ/head/day) and emission factors (kg CH_4/head/year) used for calculation of CH_4 emission from enteric fermentation of swine during the period 1990-2011

Swine sub-category	GE (MJ/head/day)	EF (kg CH_4/head/year)
Sows	43,9	1,73
Piglets <2 month (<20 kg)	3,5	0,14
Growing pigs (20-110 kg)	29,2	1,15
Pigs > 110 kg (8 month and>)	47,3	1,86
Gilts for breeding	46,4	1,93
Boars	39,4	1,55

Calculated average gross energy and emission factors for swine are presented in Table 6-22.

Table 6-22. Calculated average gross energy intake (MJ/head/day) and emission factors of CH_4 emission from enteric fermentation of swine (kg CH_4/head year) during the period 1990-2011

Year	GE	EF
1990	27,28	1,07
1991	27,28	1,07
1992	27,28	1,07
1993	27,28	1,07
1994	27,28	1,07
1995	27,28	1,07
1996	27,28	1,07
1997	27,56	1,08
1998	26,77	1,05
1999	27,79	1,09
2000	27,29	1,05
2001	27,13	1,06
2002	27,50	1,08
2003	27,13	1,06
2004	27,02	1,06
2005	26,59	1,04
2006	25,89	1,01
2007	26,61	1,04
2008	27,05	1,06
2009	25,30	0,99
2010	26,89	1,05
2011	27,26	1,07

Calculated emission factors for swine vary across the years due to the changes of allocation of sub-categories, population and feed consumption.

Determining CH_4 emission from sheep, gross energy was calculated using the same methodology as for cattle, based on the feed accumulation standards.

Calculated average gross energy intakes for sheep are presented in Tables 6-23 and 6-24. Calculated emission factors for sheep are given in Tables 6-23 and 6-24.

Table 6-23. Calculated gross energy intake for sheep sub-categories during the period 1990-2006 (MJ/head/day)

Mature sheep and ewe over 1 year	Lambs to 1 year
32,79	14,87

Table 6-24. Calculated gross energy intake for sheep sub-categories during the period 2007-2011 (MJ/head/day)

Mature sheep	Ewe lambs for breeding	Baa-lambs to 8 months	Rams
34,66	21,82	11,93	36,44

Equation 4.14 from *IPCC GPG 2000* assumes an emission factor for the period of 365 days.

The life span of baa-lambs is shorter than 1 year and in most cases they are slaughtered after 8 months. Therefore CH_4 emission factors for baa-lamb sub-category in 2007-2011 was calculated for 240 days period.

Table 6-25. Calculated emission factors for sheep sub-categories during the period 1990-2006 (kg CH_4/head/year)

Mature sheep and ewe over 1 year	Lambs to 1 year
15,05	5,77

Table 6-26. Calculated emission factors for sheep sub-categories during the period 2007-2011 (kg CH_4/head/year)

Mature sheep	Ewe lambs for breeding	Baa-lambs to 8 months	Rams
15,91	8,59	3,09	16,73

Calculated average gross energy intake and average emission factors of CH_4 emission from enteric fermentation of sheep are given in Table 6-27.

Table 6-27. Calculated average gross energy intake (MJ/head/day) and emission factors of CH_4 emission from enteric fermentation of sheep (kg CH_4/head year) during the period 1990-2011

Year	GE (MJ/head/day)	EF (kg CH4/head/year)
1990	26,35	11,72
1991	26,25	11,67
1992	26,20	11,64
1993	27,10	12,10
1994	27,15	12,13
1995	26,80	11,95
1996	27,33	12,22
1997	28,15	12,65

1998	26,89	12,00
1999	26,17	11,62
2000	26,56	11,83
2001	26,09	11,58
2002	25,94	11,51
2003	25,79	11,43
2004	26,56	11,83
2005	26,21	11,65
2006	25,43	11,24
2007	25,33	10,58
2008	25,59	10,73
2009	25,91	10,91
2010	26,02	10,97
2011	26,06	11,00

Calculated emission factors for sheep vary across the time period due to the changes of allocation of subcategories, population and feed consumption.

Calculation of CH_4 emission factors from other animals

Comparing with cattle contribution of other livestock to the whole CH_4 emission from enteric fermentation is much smaller, therefore, CH_4 emission from enteric fermentation of goats and horses are estimated using Tier 1 method. Considering the rather small numbers of these animals the default emission factors pursuant to *IPCC 2006 Guidelines* were used[41]. As no default IPCC or national emission factors for fur-bearing animals, rabbits and nutria are available, the Norwegian[42] emission factor for fur-bearing animals and Russian[43] emission factors for rabbits and nutria were used in calculations (Table 6-28).

Table 6-28. Default emission factors for each animal category used for calculation of CH_4 emission from enteric fermentation[44, 45, 46](kg CH_4/head/year)

Animal category	EF (kg CH_4 / head /year)	Emission factor
Goat	5,0	IPCC default
Horse	18,0	IPCC default
Rabbits	0,59	Russian emission factor
Nutria	0,35	Russian emission factor
Fur-bearing animals	0,1	Norwegian emission factor

[41] *IPCC Guidelines 2006*. Agriculture, Forestry and Other Land Use. Table 10.10, p. 10.28
[42] Greenhouse gas emission in Norway 1990-2009, National inventory report, 2011, p. 214, Table 6.2
[43] Greenhouse gas emission in Russian Federation 1990-2009, National inventory report, 2011, p. 175, Table 6.5
[44] *Revised 1996 IPCC*. Agriculture. Workbook. Vol.1, Table 4-2, p. 4.3
[45] Национальный доклад о кадастре антропогенных выбросов из источников и абсорбции поглотителями парниковых газов не регулируемых Монреальским протоколом за 1990 – 2009 гг. Г. 2011. Часть 1. С.175. Таблица 6.5
[46] Greenhouse Gas Emissions 1990-2009. National inventory report. Norway. 2011, p. 214. Table 6.2

6.2.3 Uncertainties and time-series consistency

Uncertainties of CH_4 emissions from enteric fermentation are caused by the uncertainty of number of animals and emission factors uncertainty.

Activity data uncertainty

For the period 1990-2011 activity data, excluding data on number of cattle and sheep (this data since 2007 is being collected from the Register of AIRBC), was collected from Statistics Lithuania.

Data provided by Statistics Lithuania is collected by applying continuous accountability for agriculture companies and applying sampling methods for farmers and households. The object of research is about 10 000 farms, what constitutes about 4% of registered farms in the statistical database. The simple random stratified sampling has been chosen from the elements of population list for the research. If the livestock population is smaller than 1000 thous. heads, or if the population of cattle is smaller than 500 thous. heads, 5% accuracy requirements are applied according to the regulation of the European Community No. 1165/2008 on the data accuracy requirements.

Since becoming a member state of the European Union the registration and marking of animals with ear pins and individual ID numbers is obligatory in Lithuania. Therefore, for the last years (2007-2011) the data on number of cattle and sheep are obtained from the register of AIRBC. The precision of calculated emissions is influenced by the fact that it is impossible to divide the dairy cattle into sub-category. The weight of cattle for meat and their weight gain is established only in accordance with conclusions of experts and the indices of registers, therefore the data can be more uncertain as it is based on expert judgement.

Complete data on swine and non-dairy cattle herd structure is available only since 1997-1998 from the statistical sources, therefore for the calculations of gross energy intake of swine and non-dairy cattle categories the constant values of 1997-1998 herd structure data were used for the 1990-1996 period estimates.

Overall uncertainty for activity data for enteric fermentation is assumed to be ±3%.

Emission factors uncertainty

Emission factors which are not based on country-specific data may be highly uncertain. Emission factors estimated using simple Tier 1 method may be uncertain to ±50%[47],[48]. Emission factors estimated using the Tier 2 method are likely to be in the order of ±20%[49].

In order to increase the herd of sheep almost all ewe-lambs are grown for breed. However, since part of the ewe-lambs are slaughtered for meet, uncertainty of emission factors may be up to ±4%.

6.2.4 Source-specific QA/QC and verification

General QC procedures were applied for estimates from enteric fermentation. Furthermore, emission factors were compared with IPCC defaults and with emission factors of neighbouring countries. (Tables 6-29, 6-30 and 6-31).

[47] *IPCC GPG 2000.* Agriculture, p. 4.27
[48] *IPCC Guidelines 2006*. Emissions from livestock and manure management, p. 10.33
[49] *IPCC GPG 2000.* Agriculture, p. 4.28

Comparing results obtained in 2010 it can be seen that CH_4 emission factor from enteric fermentation of dairy cattle category is approximately comparable to Belarus and Poland's EFs (Table 6-29). Estonia and Latvia showed higher emission factors, however Estonia also showed higher productivity of cattle.

Table 6-29. Comparison of EF and other parameter for CH_4 emission calculation from enteric fermentation of dairy cattle

Country	EF (kg CH_4/head/year)	Milk yield (kg/head/day)	Weight (kg/animal)	Average gross energy intake (MJ/head/day)
Belarus	108,95	12,69	550	276,86
Estonia	130,38	19,24	587,81	332,16
Latvia	117,56	13,69	550	298,73
Lithuania	105,75	14,26	575	268,71
Poland	97,36	12,67	500	247,40
Revised 1996 IPCC [50] (Western Europe)	100	11,51	550	254,7

Emission factor of non-dairy cattle in Lithuanian is similar to the corresponding EF results for Belarus, Latvia and Poland (Table 6-30). Besides, those countries indicated similar gross energy intake as well.

Table 6-30. Comparison of EF and other parameter for CH_4 emission calculation from enteric fermentation of non-dairy cattle

Country	EF (kg CH_4/head/year)	Weight (kg/animal)	Average gross energy intake (MJ/head/day)
Belarus	51,43	NE	130,69
Latvia	52,16	500	132,54
Lithuania	50,36	321,69	128,65
Poland	49,21	320,96	125,05
Revised 1996 IPCC [51] (Western Europe)	48	-	-

The level of Lithuanian emission factor for swine is higher than corresponding results of Estonia and Denmark (Table 6-31), Estonia also indicated lower gross energy intake and lower average weight of swine. However Denmark indicated considerably high gross energy intake and high average weight of swine. The level of German emission factor for swine is considerably higher than corresponding factor of Lithuania while weight and gross energy of swine is slightly higher. Belarus, Latvia and Poland used IPCC default emission factor.

[50] *Revised 1996 IPCC*. Agriculture. Reference manual. Vol. 1.Table 4-4, p. 4.11; Vol. 2. Table A-1, p. 4.31; Table B-1, p. 4.39
[51] *Revised 1996 IPCC*. Agriculture. Reference manual. Vol. 1. Table 4-4, p. 4.11

Table 6-31. Comparison of EF and other parameter for CH_4 emission calculation from enteric fermentation of swine

Country	EF (kg CH_4/head/year)	Weight (kg/animal)	Average gross energy intake (MJ/head/day)
Belarus	1,5	NE	NE
Denmark	1,05	107,0	40,27
Estonia	0,99	44,47	25,08
German	1,18	70,60	30,07
Latvia	1,50	NA	NA
Lithuania	1,07	68,31	27,26
Poland	1,50	82	NA
Revised 1996 IPCC[52] (developed countries)	1,5	-	-

6.2.5 Source-specific recalculations

In order to increase consistency of used methodologies for calculation of emission from enteric fermentation, the following recalculations have been made during this submission:

- gross energy (GE) intake for dairy cattle for the period 2008-2011 was recalculated (Table 6-32).
- Emission from non-dairy cattle, sheep and swine for all time series were recalculated due to recalculation of CH_4 emission factors for young animals.

The changes of CH_4 emission factors and emissions from enteric fermentation are given in Tables 6-32 and 6-33.

Table 6-32. Comparison of calculated gross energy (MJ/head/day) and CH_4 emission factors from enteric fermentation for dairy cattle in previous and in this submission (kg CH_4/head/year)

Year	Previous submission		This submission		Relative difference, %
	Gross energy	CH_4 emission factors	Gross energy	CH_4 emission factors	
2008	259,36	102,07	260,73	102,61	0,53
2009	259,80	102,24	261,50	102,91	0,66
2010	260,79	102,63	263,11	103,54	0,89

Table 6-33. Reported in previous submission and recalculated CH_4 emissions from enteric fermentation during the period 1990-2011 (Gg)

Year	Previous submission	This submission	Absolute difference	Relative difference, %
1990	154,23	153,65	-0,58	-0,38
1991	145,32	144,79	-0,53	-0,36
1992	113,22	112,86	-0,36	-0,32
1993	94,14	93,89	-0,25	-0,27
1994	80,65	80,47	-0,18	-0,22
1995	75,80	75,63	-0,17	-0,22
1996	75,78	75,61	-0,17	-0,22

[52] *Revised 1996 IPCC*. Agriculture. Reference manual. Vol. 1. Table 4-3, p. 4.10

1997	78,07	77,90	-0,17	-0,22
1998	68,49	68,31	-0,18	-0,26
1999	64,44	64,25	-0,19	-0,29
2000	56,72	56,58	-0,14	-0,25
2001	58,00	57,86	-0,14	-0,24
2002	59,81	59,66	-0,15	-0,25
2003	61,82	61,66	-0,16	-0,26
2004	60,96	60,80	-0,16	-0,26
2005	61,18	61,03	-0,15	-0,25
2006	63,19	63,02	-0,17	-0,27
2007	64,55	64,47	-0,08	-0,12
2008	61,98	62,12	0,14	0,23
2009	58,77	58,96	0,19	0,32
2010	56,90	57,17	0,27	0,47

6.2.6 Source-specific planned improvements

The collection of more accurate data on cattle weight are planned for the next submission.

6.3 Manure management (CRF 4.B)

6.3.1 Manure management - CH_4 emission (CRF 4.B(a))

6.3.1.1 Source category description

CH_4 is produced from the decomposition of organic matter remaining in the manure under anaerobic decomposition. The amount of CH_4 produced from manure depends on: manure characteristics linked to animal type and diets, the amount of feed consumed, the digestibility of the feed, the type of waste management system and the climate conditions. Lithuania's climate conditions are described in Section 6.1.

Calculations of GHG emission from manure management were performed using the same livestock population data as described in section "Enteric fermentation" (see Section 6.2). The information on manure management systems have been provided by the Water Research Institute of the University of Agriculture of the Republic of Lithuania, also data of manure management systems use in Lithuania were collected during the experts investigation.

Calculated emissions

Total CH_4 emissions from manure management of domestic livestock contributed 9,6% of the total agricultural emissions or 29,0% of the total CH_4 emissions in 2011. In 2011, comparing with 2010, CH_4 emissions from manure management decreased by 6,6%. In 2011 the highest CH_4 emission from manure management systems among different categories of domestic animals was determined in swine breeding category (Table 6-34). The use of anaerobic digester for biogas-treatment in 2004-2010 is responsible for the lower CH_4 emissions; however, the increased number of swine partly counterbalances this effect.

Table 6-34. CH_4 emission from manure management by animal category during the period 1990-2011 (Gg)

Year	Dairy cattle	Non-dairy cattle	Sheep	Goats	Horses	Swine	Poultry	Fur-bearing animals, rabbits and nutria
1990	11,05	9,17	0,014	0,001	0,11	30,30	1,31	0,125
1991	10,89	8,71	0,014	0,001	0,11	27,25	1,33	0,124
1992	9,46	6,33	0,013	0,001	0,11	17,09	0,64	0,115
1993	8,73	4,77	0,011	0,001	0,11	15,11	0,68	0,082
1994	8,13	3,73	0,010	0,001	0,11	15,99	0,69	0,078
1995	8,02	3,42	0,008	0,002	0,11	16,20	0,66	0,074
1996	8,34	3,40	0,007	0,002	0,11	14,45	0,61	0,076
1997	9,02	3,40	0,006	0,002	0,11	15,68	0,58	0,074
1998	8,29	2,86	0,004	0,003	0,10	14,83	0,53	0,042
1999	7,60	3,10	0,003	0,003	0,10	12,40	0,50	0,037
2000	7,25	2,39	0,003	0,003	0,10	11,34	0,43	0,039
2001	7,63	2,43	0,003	0,003	0,09	13,20	0,51	0,042
2002	7,89	2,69	0,003	0,003	0,08	14,11	0,53	0,048
2003	8,17	2,94	0,004	0,003	0,09	13,94	0,63	0,072
2004	8,22	2,92	0,005	0,003	0,09	13,62	0,66	0,098
2005	8,15	3,24	0,007	0,003	0,09	14,01	0,73	0,126
2006	8,10	3,85	0,009	0,002	0,08	13,86	0,74	0,128
2007	8,44	4,22	0,012	0,002	0,08	11,63	0,77	0,119
2008	8,65	3,73	0,013	0,002	0,08	11,52	0,71	0,128
2009	8,35	3,63	0,013	0,002	0,07	11,22	0,73	0,091
2010	8,15	3,65	0,013	0,002	0,06	12,01	0,74	0,129
2011	8,19	3,72	0,015	0,002	0,05	10,30	0,70	0,139

Comparing to 1990 CH_4 emissions from manure management decreased by 55,6% in 2011 (Figure 6-3).

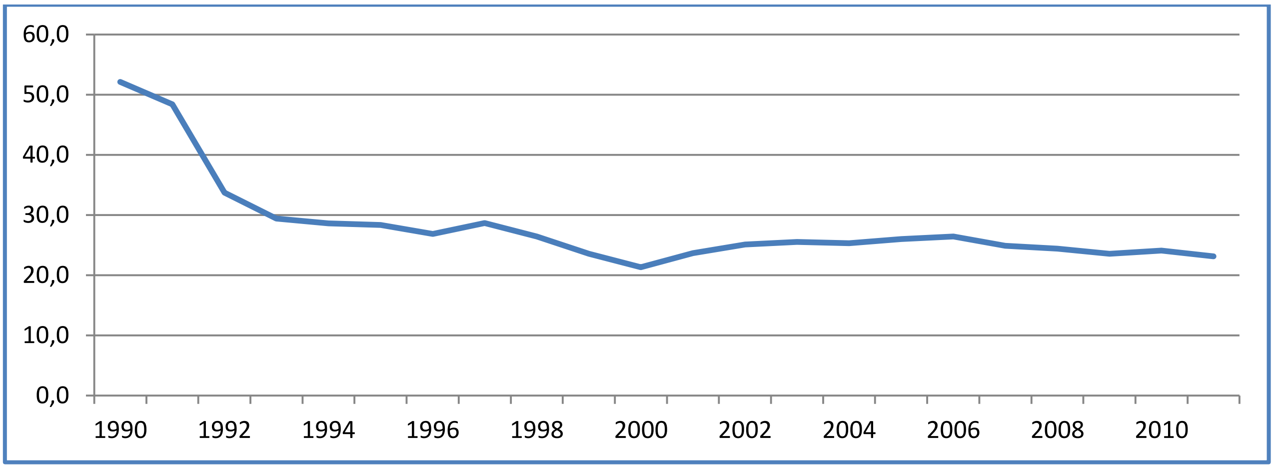

Figure 6-3. CH_4 emission from manure management during the period 1990-2011(Gg)

The overall reduction of CH_4 emissions from manure is caused by a decrease in total number of livestock population (excluding sheep, goats, rabbits and minks), but in the case of dairy and non-dairy cattle the attrition of animals is partly counterbalanced by increase in emissions per animal.

Emission increase was caused by increase of volatile solid excretion and related to gross energy intake.

6.3.1.2 Methodological issues

Choice of methods

CH_4 emissions from manure management systems of cattle, swine and sheep were calculated using Tier 2 method. Emissions from cattle and swine sub-categories represent a significant share of emissions.

Tier 2 method for estimation of CH_4 emission from manure management systems requires detailed information on animal characteristics and the manner in which manure is treated. Emission from goats, horses, rabbits, nutrias, fur-bearing animals and poultry have a minor impact to the total CH_4 emission from manure management, therefore Tier 1 method has been applied to estimate CH_4 emissions of these livestock categories.

The summary of methods that were used for calculation of CH_4 emission from manure management are presented in Table 6-35.

Table 6-35. Methods and emission factors used for estimation of CH_4 emission from manure management

Animal category	Method applied	Emission factor
Dairy cattle	Tier 2	CS
Non-dairy cattle	Tier 2	CS
Sheep	Tier 2	CS
Goats	Tier 1	IPCC 1996
Horses	Tier 1	IPCC 1996
Swine	Tier 2	CS
Poultry	Tier 1	IPCC 1996
Rabbits	Tier 1	IPCC 2006
Nutria	Tier 1	IPCC 2006
Minks	Tier 1	IPCC 2006
Foxes	Tier 1	IPCC 2006
Polar foxes	Tier 1	IPCC 2006

Characterization of manure management systems

Assumption on manure remaining on pasture was based on grazing time of dairy and non-dairy cattle. Bulls, partly calves and cows for slaughter, normally are kept in stalls all the time. Calves, heifers for breeding and milk production and beef cattle are grazed in pastures for approximately 145 days per year, the same as dairy cattle[53, 54]. For cattle category, the average duration of grazing on pasture periods and the average time spent in milking stalls are used to divide excrement into pasture and stable portions.

[53] Gyvulininkystės žinynas. Mokslas: Vilnius, 1976, p. 98-99

[54] Tarvydas, V. ir kt. *Šėrimo normos, pašarų struktūra ir sukaupimas galvijams*. Vilnius, 1995, p. 4

In 2012 data about manure management systems were updated[55]. It was found that during the stable period 39,8% of cow manure goes to the solid manure management systems and 20,2% goes to the liquid manure management systems. About 40% of cow manure stays in the pastures.

In the other animal categories, 46,8%, 24% and 1,7% of manure goes to solid, liquid and deep bedding manure management systems respectively. 27,5% of manure stays in the pastures.

The most widely used system in swine farms is the liquid manure management system, which accounts for 83,5% of total manure management systems. 16,5% of manure is managed as solid manure including 5% manure managed in pits below confinements as deep bedding. However, pits below animal confinements are not included in CRF reporter. Therefore, this type of swine manure management system is reported as "Other manure management system".

Since 1990 almost all fur-bearing animals, rabbits and nutrias breeders use solid manure management systems. Liquid manure management systems have been started to be used only during the past few years in four fur–bearing animals farms.

Methane conversion factors (MCF) for manure management systems were taken as default values from the *IPCC GPG 2000*[56] (Table 6-36). Data on manure management used in calculations for dairy cattle, non-dairy cattle and swine are provided in Figures 6-4, 6-5 and 6-6.

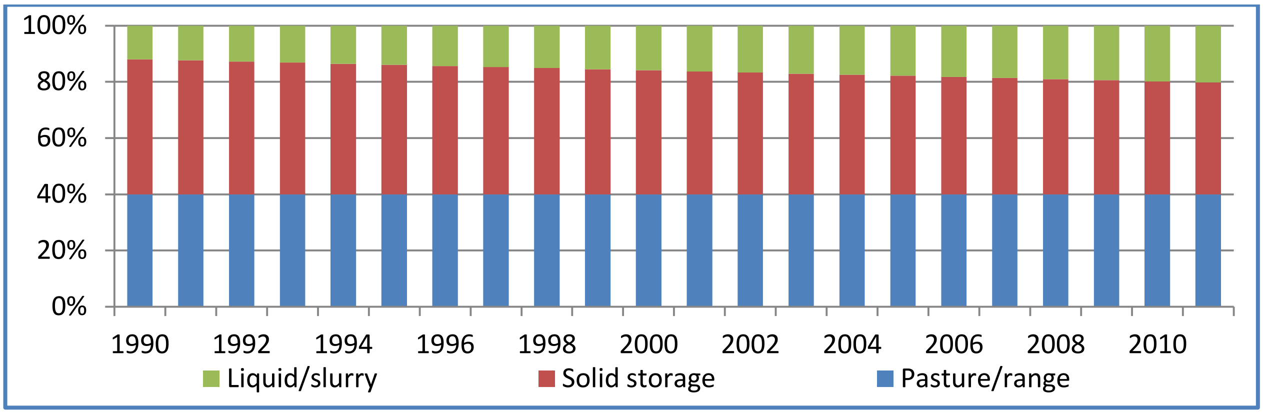

Figure 6-4. Data on manure management systems for dairy cattle (%)

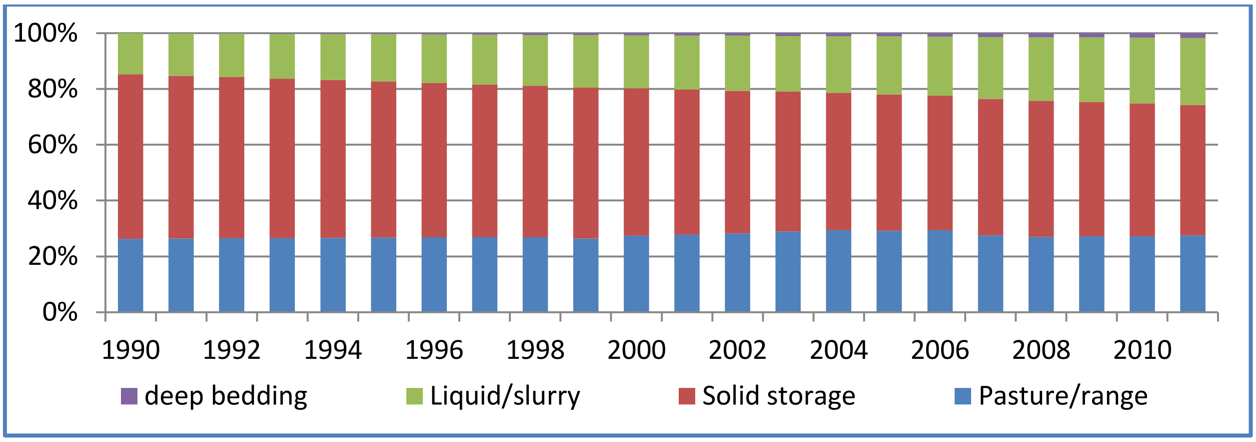

Figure 6-5. Data on manure management systems for non-dairy cattle (%)

[55] Studija "Lietuvos mėšlo tvarkymo sistemose susidarančių metano ir azoto suboksido kiekio tyrimai ir įvertinimas". 2012

[56] *IPCC GPG 2000*. Agriculture. Table 4.10-4.11, p. 4.36-4.37

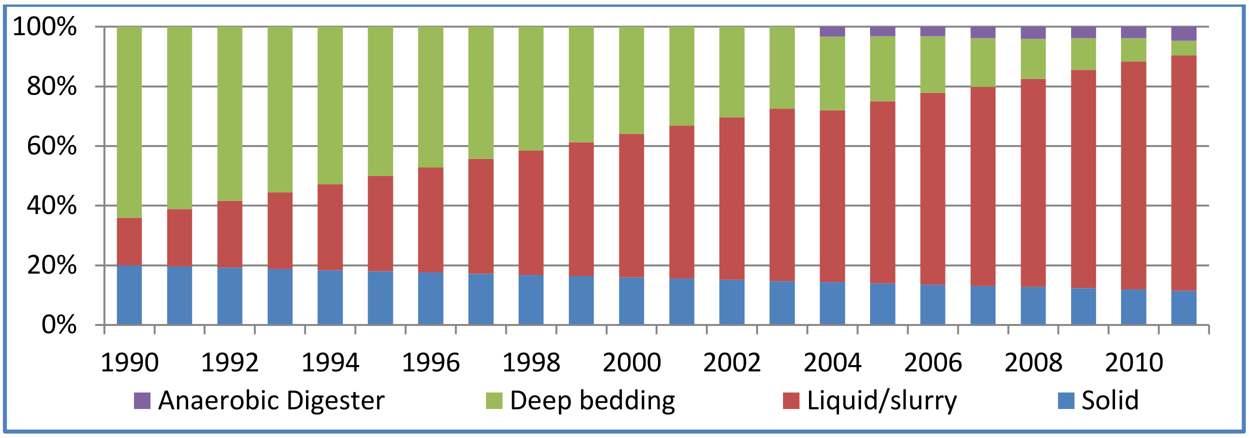

Figure 6-6. Data on manure management systems for swine (%)

Calculation of CH_4 emissions

CH_4 emissions from manure management were calculated using the following equation:[57]

$$CH_{4\ EMISSIONS} = EF \times Population / (10^6\ kg/Gg)$$

where:
EF – emission factor for defined livestock population, kg/head/year;
Population – the number of head in the defined livestock population.

CH_4 emissions from horses, goats, poultry, rabbits, nutria and fur-bearing animals were calculated using Tier 1 method. Default IPCC emission factors for each relevant livestock category are used to calculate emissions from manure (Table 6-36).

Table 6-36. Emission factors used for calculation of CH_4 emission from manure management (kg CH_4/head/year)[58, 59]

Animal category	EF
Goats	0,12
Horses	1,39
Poultry	0,078
Rabbits	0,08
Nutria	0,68
Fur-bearing animals	0,68

Methane emission factors for cattle, swine and sheep were determined using the fallowing equation:[60]

$$EF = VS \times 365\ days/year \times B_0 \times 0{,}67\ kg/m^3 \times \Sigma MCF \times MS$$

[57] *IPCC GPG 2000*. Agriculture. Eq. 4.15, p. 4.30
[58] *Revised 1996 IPCC* . Agriculture. Workbook. Vol. 1, Table 4-4, p. 4.6
[59] *IPCC 2006 Guidelines*. Table 10.16, p. 10.41
[60] *IPCC GPG 2000*. Agriculture. Eq. 4.17, p. 4.34

where:
EF – annual emission factor for defined livestock population, kg;
VS – daily VS excreted for an animal within defined population, kg;
B_0 – maximum CH_4 producing capacity for manure produced by an animal within defined population, m^3/kg of VS;
MCF – methane conversion factor for each manure management system;
MS – fraction of animal species/category manure handled using manure system.

The VS excretion rate, calculated for dairy and non-dairy cattle, sheep and swine were estimated from feed intake levels [61]:

$$VS = GE \times (1\ kg\text{-}dm/18{,}45\ MJ) \times (1 - DE/100) \times (1 - ASH/100)$$

where:
GE – estimated daily average feed intake, MJ/day;
DE – digestible energy of the feed, %;
ASH – ash content of manure, %.

Gross energy consumption values for dairy cattle, non-dairy cattle, swine and sheep were used the same as calculated in section 6.2 „Enteric fermentation" (CRF 4.A). Volatile solid excretion rate for cattle was calculated using digestible energy of the feed (65% for cattle, 75% for swine and 60% for sheep), ash content of manure (8% for cattle, 2% for swine and 8% for sheep) is provided in *IPCC GPG 2000*[62] and *Revised 1996 IPCC*[63] respectively.

The following table shows the applicable distributions for the various manure management systems. Daily VS excretions for dairy cows, other cattle, swine and the VS excretions calculated for cattle, swine and sheep are shown in Tables 6-37.

Table 6-37. Daily VS excretions for dairy, non-dairy cattle, swine and sheep (kg-dm/day)

Year	Cattle		Swine	Sheep
	Dairy	Non-dairy		
1990	4,02	2,19	0,36	0,53
1991	3,91	2,19	0,36	0,52
1992	3,73	2,19	0,36	0,52
1993	3,65	2,19	0,36	0,54
1994	3,66	2,19	0,36	0,54
1995	3,70	2,19	0,36	0,53
1996	3,74	2,19	0,36	0,55
1997	3,79	2,19	0,37	0,56
1998	3,87	2,11	0,36	0,54
1999	3,80	2,13	0,37	0,52
2000	4,00	2,11	0,36	0,53
2001	4,09	2,10	0,36	0,52
2002	4,13	2,11	0,37	0,52

[61] *IPCC GPG 2000*. Agriculture. Eq. 4.16, p. 4.31
[62] *IPCC GPG 2000*. Agriculture. Tables 4-10, 4.11, p. 4.31-4.32
[63] *Revised 1996 IPCC*. Agriculture. Reference Manual. Vol. 3,Table B-7, p.4.47

2003	4,15	2,10	0,36	0,51
2004	4,23	2,09	0,36	0,53
2005	4,28	2,10	0,35	0,52
2006	4,36	2,13	0,34	0,51
2007	4,47	2,21	0,35	0,51
2008	4,55	2,24	0,36	0,51
2009	4,56	2,25	0,34	0,52
2010	4,59	2,26	0,36	0,52
2011	4,69	2,25	0,36	0,52
Revised 1996 IPCC [64] (Western Europe)	5,1	2,7	0,5	0,4

Calculated VS value shown in Table 6-37 is lower than the default values shown in the IPCC methodology for cattle and swine, however this value for sheep in our calculation is higher.

Methane producing capacities B_0 (0,24 m^3 CH_4/kg VS for dairy cows, 0,45 for swine) were also taken from *IPCC GPG 2000*. Value of Methane producing capacities B_0 = 0,17 ± 0,02 m^3 CH_4/kg VS for non-dairy cattle, comparable to the value indicated in the *IPCC GPG 2000* we determined in our study in 2012[65].

Table 6-38. Methane conversion factors (MCF) for manure management systems (%)[66]

Animal waste management system (AWMS)				
Solid storage	**Pit storage below confinements > month**	**Liquid/slurry**	**Pasture/range and paddock**	**Anaerobic lagoon**
1	39	39	1	0

Animal manure treatment in a biogas device has reduced emission of CH_4, In our estimations it was considered that all the biogas were collected and digested in the anaerobic digester, therefore, amount of CH_4 used as fuel was not included into the total emission.

The emission factor for dairy cattle has increased as a result of the increasing milk yield and the changes in housing types of animals when solid manure management was replaced by slurry-based system (Table 6-39). Methane conversion factor for slurry manure is higher than solid manure MCF.

Table 6-39. Calculated emission factors used for calculation of CH_4 emission from manure management for dairy cattle (kg CH_4/head/year)

Year	**EF**
1990	13,12
1991	13,10
1992	12,82
1993	12,88

[64] *Revised 1996 IPCC*. Agriculture. Reference Manual. Vol. 3,Tables B-3, B-4, B-6,B-7, p. 4.43, 4.44, 4.46, 4.47
[65] Studija "Lietuvos mėšlo tvarkymo sistemose susidarančių metano ir azoto suboksido kiekio tyrimai ir įvertinimas". 2012 m./*Revised 1996 IPCC*. Agriculture. Reference Manual. Vol. 3, Table B-4, p. 4.44
[66] *IPCC GPG 2000*. Agriculture. Table 4.10, p. 4.36

1994	13,22
1995	13,68
1996	14,14
1997	14,66
1998	15,32
1999	15,39
2000	16,54
2001	17,27
2002	17,80
2003	18,24
2004	18,95
2005	19,56
2006	20,31
2007	21,21
2008	21,98
2009	22,44
2010	22,98
2011	23,88

Tables 6-40, 6-41, 6-42 and 6-43 shows the changes in emission factors for non-dairy cattle, swine and sheep.

Table 6-40. Calculated emission factors used for calculation of CH_4 emission from manure management for non-dairy cattle sub-categories during the period 1990-2006 (kg CH_4/head/year)

Year	Non-dairy cattle	EF by cattle sub-categories										
		Suckling cows	Cattle less than 1 year old			Cattle from1 to 2 years old			Cattle 2 years old and older			Dairy cattle for slaughter
			For slaughter	Bulls for breeding	Heifers for breeding	Bulls	Heifers for slaughter	Heifers for breeding	Bulls	Heifers for slaughter	Heifers for breeding	
1990	6,20	-	4,66	6,26	3,17	11,33	5,30	5,54	11,06	6,91	6,91	10,97
1991	6,38	-	4,78	6,47	3,27	11,69	5,46	5,71	11,42	7,11	7,11	11,30
1992	6,57	-	4,90	6,67	3,36	12,06	5,62	5,87	11,78	7,32	7,32	11,63
1993	6,76	-	5,01	6,87	3,46	12,43	5,78	6,04	12,14	7,53	7,53	11,96
1994	6,94	-	5,13	7,08	3,55	12,79	5,94	6,21	12,49	7,74	7,74	12,29
1995	7,13	-	5,24	7,28	3,65	13,16	6,10	6,37	12,85	7,95	7,95	12,62
1996	7,32	-	5,36	7,48	3,74	13,53	6,26	6,54	13,21	8,16	8,16	12,95
1997	7,50	-	5,47	7,69	3,84	13,89	6,42	6,71	13,57	8,36	8,36	13,28
1998	7,40	-	5,59	7,89	3,94	14,26	6,58	6,88	13,93	8,57	8,57	13,62
1999	7,69	-	5,71	8,09	4,03	14,63	6,74	7,04	14,29	8,78	8,78	13,95
2000	7,69	16,18	5,82	8,29	4,13	15,00	6,90	7,21	14,64	8,99	8,99	14,28
2001	7,85	16,54	5,94	8,50	4,22	15,36	7,06	7,38	15,00	9,20	9,20	14,61
2002	8,00	16,89	6,05	8,70	4,32	15,73	7,22	7,54	15,36	9,41	9,41	14,94
2003	8,08	17,25	6,17	8,90	4,41	16,10	7,38	7,71	15,72	9,61	9,61	15,27
2004	8,15	17,61	6,28	9,11	4,51	16,46	7,54	7,88	16,08	9,82	9,82	15,60
2005	8,43	17,96	6,40	9,31	4,61	16,83	7,70	8,04	16,44	10,03	10,03	15,93
2006	8,75	18,32	6,51	9,51	4,70	17,20	7,86	8,21	16,79	10,24	10,24	16,26

Table 6-41. Calculated emission factors used for calculation of CH_4 emission from manure management for non-dairy cattle sub-categories during the period 2007-2011 (kg CH_4/head/year)

Year	EF by cattle sub-categories									
	Non-dairy cattle	Cattle sub-category								
		Suckling cows	To 8 months		From 8 to12 months		From 1 to 2 years old		2 years old and older	
			Bulls	Heifers	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers
2007	9,65	18,68	8,15	4,30	13,06	6,48	17,56	8,38	17,15	10,45
2008	9,80	19,04	8,32	4,38	13,33	6,61	17,93	8,55	17,51	10,66
2009	10,04	19,11	8,49	4,47	13,60	6,74	18,30	8,71	17,87	10,86
2010	10,26	19,18	8,66	4,55	13,87	6,87	18,66	8,88	18,23	11,07
2011	10,48	21,14	8,83	4,64	14,15	7,00	19,03	9,05	18,59	11,28

Table 6-42. Calculated emission factors used for calculation of CH_4 emission from manure management for swine during the period 1990-2011 (kg CH_4/head/year)

Year	EF
1990	12,44
1991	12,50
1992	12,57
1993	12,63
1994	12,69
1995	12,75
1996	12,82
1997	13,01
1998	12,70
1999	13,25
2000	13,07
2001	13,06
2002	13,30
2003	13,18
2004	12,69
2005	12,57
2006	12,30
2007	12,59
2008	12,84
2009	12,09
2010	12,92
2011	13,03

Table 6-43. Calculated emission factors used for calculation of CH_4 emission from manure management for sheep during the period 1990-2011 (kg CH_4/head/year)

Year	EF
1990	0,244
1991	0,243
1992	0,243
1993	0,251

1994	0,252
1995	0,248
1996	0,253
1997	0,261
1998	0,249
1999	0,243
2000	0,246
2001	0,242
2002	0,240
2003	0,239
2004	0,246
2005	0,243
2006	0,236
2007	0,235
2008	0,237
2009	0,240
2010	0,241
2011	0,242

Emission factor for non-dairy cattle and swine has also increased as a result of increasing number of housing types of animals when solid manure management was replaced by slurry-based system. Calculated emission factors for sheep vary throughout the years due to the changes in livestock populationin sub-categories.

6.3.1.3 Uncertainties and time-series consistency

CH_4 emission from manure management was calculated based on activity data and emission factors. Overall uncertainties result from animal number inaccuracy (Chapter 6.2.3), data of manure management systems and emission factors. However, the data on excretion and distribution of manure among the management systems are less reliable.

2006 IPCC Guidelines indicates that for the Tier 1 method there is a larger uncertainty range for the default factors. For Tier 1 method uncertainty for CH_4 is estimated to be ±30%. Improvements achieved by Tier 2 methodologies are estimated to reduce uncertainty ranges in emission factors to ±20%. The uncertainty of the manure management system usage data can be 10% or less[67].

Uncertainties in estimates of B_0 from cattle and swine are ±15%[68]. In study on experimental research and evaluation of country specific methane producing capacity (B_0) in Lithuania Uncertainties in estimates of B_0 from non dairy cattle are ±12%[69]. Overall uncertainty for B_0 ±14,5%. Overall uncertainty for activity data assumed to be ±17,65%.

[67] *IPCC 2006 Guidelines*. Emissions from Livestock and Manure management, p. 10.48
[68] *IPCC 2006 Guidelines*. Emissions from Livestock and Manure management, Table 10A-4, p. 10.77
[69] Studija "Lietuvos mėšlo tvarkymo sistemose susidarančių metano ir azoto suboksido kiekio tyrimai ir įvertinimas". 2012 m.

6.3.1.4 Source-specific QA/QC and verification

QA/QC includes checking of activity data, emission factors and methods applied. If errors are found they are corrected. These activities are implemented every year in preparation of agriculture inventory. In addition, emission factors were compared with EF of other countries'.

Data in Table 6-44 shows that Lithuania uses significantly higher emission factors for calculation of emission from manure management than neighbouring countries. While these countries use MCF 10% for the calculation of emission from liquid/slurry most often, Lithuania uses MCF 39%[70]. Also, other countries use relatively more solid manure management system than the liquid/slurry systems.

Table 6-44. Comparison of EF and GE for CH_4 emission calculation from manure management of cattle, swine and sheep

		Belarus	Estonia	Latvia	Lithuania	Poland
Dairy cattle	EF (kg CH_4/head/yr)	5,14	10,43	10,60	23,88	13,76
	GE intake (MJ/head/day)	276,86	332,16	298,73	268,71	247,40
Non-dairy cattle	EF (kg CH_4/head/yr)	20,39	-	4,0	10,48	2,56
	GE intake (MJ/head/day)	130,69	-	132,54	128,65	125,05
Swine	EF (kg CH_4/head/yr)	4,45	2,06	4,0	13,03	5,97
	GE intake (MJ/head/day)	NE	25,08	NA	27,26	NA
Sheep	EF (kg CH_4/head/yr)	0,19	0,19	0,19	0,24	0,16
	GE intake (MJ/head/day)	NE	20,0	NA	26,06	17,75

6.3.1.5 Source-specific recalculations

In order to ensure consistency of methodologies used to estimate CH_4 emission from manure management, the following recalculations have been made:

- Due to update of manure management systems for cattle and swine there were three recalculations made in this submission: emissions from dairy cattle, non-dairy cattle and swine (Table 6-45);
- Since the national data of manure management systems for sheep were used, emissions from animals in these categories were recalculated;
- Due to updated of gross energy data for dairy cattle for the period 2008-2010 emissions of CH_4 were recalculated;
- Due to usage of new methodology for calculation of emission factors for sheep emissions of CH_4 were recalculated.

[70] *IPCC GPG 2000*. Agriculture. Tables 4-10, p. 4.31

Table 6-45. Comparison of recalculated CH_4 emission factors from manure management for cattle, swine and sheep in previous and this submission (kg CH_4/head/year)

Year	Dairy cattle		Non-dairy cattle		Swine	
	Previous submission	This submission	Previous submission	This submission	Previous submission	This submission
1990	13,12	13,12	6,20	6,20	12,47	12,44
1991	13,05	13,10	6,33	6,38	12,47	12,50
1992	12,73	12,82	6,47	6,57	12,47	12,57
1993	12,74	12,88	6,60	6,76	12,47	12,63
1994	13,04	13,22	6,74	6,94	12,47	12,69
1995	13,45	13,68	6,87	7,13	12,47	12,75
1996	13,86	14,14	7,01	7,32	12,47	12,82
1997	14,32	14,66	7,14	7,50	12,60	13,01
1998	14,92	15,32	7,02	7,40	12,23	12,70
1999	14,95	15,39	7,26	7,69	12,70	13,25
2000	16,03	16,54	7,22	7,69	12,29	13,07
2001	16,70	17,27	7,33	7,85	12,40	13,06
2002	17,17	17,80	7,43	8,00	12,56	13,30
2003	17,55	18,24	7,48	8,08	12,39	13,18
2004	18,20	18,95	7,53	8,15	12,09	12,69
2005	18,74	19,56	7,74	8,43	11,75	12,57
2006	19,42	20,31	7,99	8,75	11,47	12,30
2007	20,24	21,21	8,59	9,65	11,61	12,59
2008	20,83	21,98	8,71	9,80	11,68	12,84
2009	20,86	22,44	8,77	10,04	10,78	12,09
2010	20,94	22,98	8,82	10,26	11,56	12,92

The results of recalculated CH4 emissions dering the period 1990-2010 are given in Table 6-46.

Table 6-46. Reported in previous submission and recalculated CH_4 emissions from manure management in 1990-2010 (Gg)

Year	Previous submission	This submission	Absolute difference	Relative difference, %
1990	52,14	52,08	-0,06	-0,12
1991	48,24	48,44	0,20	0,41
1992	33,45	33,76	0,31	0,93
1993	29,10	29,50	0,40	1,37
1994	28,23	28,74	0,51	1,81
1995	27,85	28,48	0,63	2,26
1996	26,29	27,00	0,71	2,70
1997	28,00	28,87	0,87	3,11
1998	25,75	26,66	0,91	3,53
1999	22,85	23,76	0,91	3,98
2000	20,50	21,55	1,05	5,12
2001	22,83	23,92	1,09	4,77

2002	24,11	25,37	1,26	5,23
2003	24,48	25,85	1,37	5,60
2004	24,42	25,62	1,20	4,91
2005	24,83	26,35	1,52	6,12
2006	25,15	26,78	1,63	6,48
2007	23,50	25,26	1,76	7,49
2008	22,91	24,83	1,92	8,38
2009	21,82	24,10	2,28	10,45
2010	22,23	24,75	2,52	11,34

6.3.1.6 Source-specific planned improvements

Collection of more accurate data on manure storage systems used in Lithuanian agriculture will be proceed.

6.3.2 Manure management - N_2O emission (CRF 4.B(b))

6.3.2.1 Source category description

During manure storage and handling manure emits nitrous oxide through nitrification or denitrification. The amount of emitted N_2O depends on: nitrogen and carbon content of manure, type of manure storage system, duration of time manure is stored, climatic condition during the storage. N_2O is the most potent agricultural greenhouse gas with warming potential 310 times greater than that of carbon dioxide.

The emission of N_2O is calculated based on the amount of nitrogen excretion per animal and animal waste management system. The emission estimates from manure deposits on grass are described in the section "Pasture, range and paddock manure" (see Section 6.5.2).

N_2O emissions from manure management were 268,3 Gg CO_2 eq. or 5,3% of the total agriculture emissions in 2011. In 2011, comparing with 1990, N_2O emissions from manure management decreased by 69,7% (Figure 6-7). Calculated N_2O emissions from different manure management systems are presented in Table 6-47.

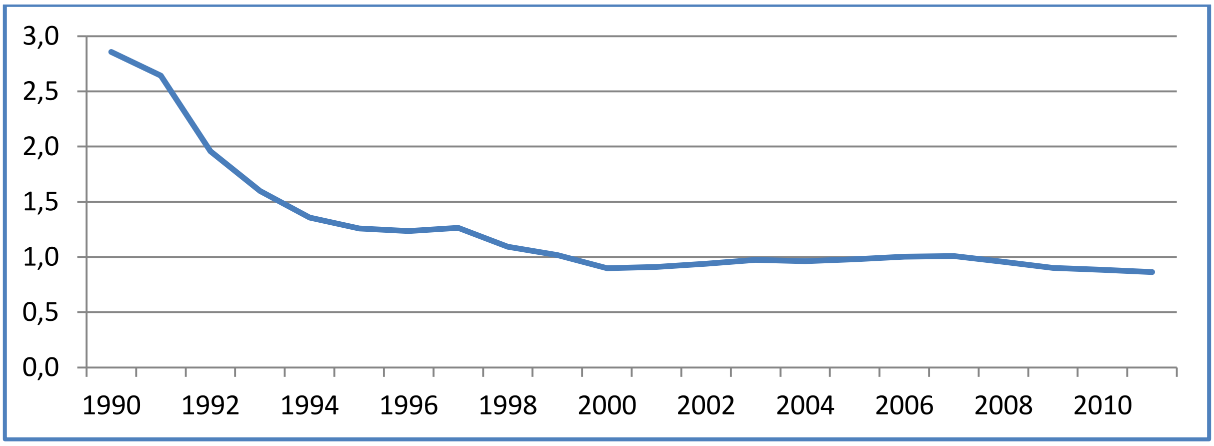

Figure 6-7. Nitrous oxide emission from manure management during the period 1990-2011 (Gg)

Table 6-47. Calculated N2O emissions for different manure management systems (Gg)

Year	AWMS			
	Liquid system	Solid storage and dry lot	Anaerobic digester	Other systems
1990	0,04	2,73	-	0,08
1991	0,04	2,52	-	0,08
1992	0,03	1,89	-	0,04
1993	0,03	1,53	-	0,04
1994	0,03	1,29	-	0,04
1995	0,03	1,19	-	0,04
1996	0,03	1,18	-	0,04
1997	0,03	1,20	-	0,04
1998	0,03	1,04	-	0,03
1999	0,02	0,97	-	0,03
2000	0,02	0,86	-	0,03
2001	0,02	0,86	-	0,03
2002	0,03	0,89	-	0,03
2003	0,03	0,92	-	0,03
2004	0,03	0,90	0,001	0,03
2005	0,03	0,91	0,001	0,04
2006	0,03	0,94	0,001	0,04
2007	0,03	0,94	0,001	0,04
2008	0,03	0,89	0,001	0,03
2009	0,03	0,84	0,001	0,03
2010	0,03	0,82	0,001	0,03
2011	0,03	0,80	0,001	0,03

6.3.2.2 Methodological issues

To estimate N_2O emissions from manure management the Tier 1 method was used. To estimate N_2O emissions from manure management entails multiplying the total amount of N excretion (from all animal species/categories) in each type of manure management system by an emission factor for that type of manure management system. Emissions are then summed over all manure management systems.

Activity data

The data on population of livestock were obtained from the Register of Agricultural Information and Rural Business Centre (2007-2011) and from the database of Statistics Lithuania (1990-2006).

Fractions of the total annual excretion of livestock managed in specific manure management systems are presented in the Figure 6-3, Figure 6-4, Figure 6-5 in the above mentioned section "Manure management – CH_4 emission (CRF 4.B(a))" and in the Table 6-48.

Table 6-48. Percentage of manure production per animal waste management systems (%)

Year	Solid storage and dry lot	Liquid system	Pasture, range and paddock	Other systems
Sheep				
1990-2011	54,8		45,2	
Goats				
1990-2011	54,8		45,2	
Horses				
1990-2011			92	8
Poultry				
1990-2011		28	1	71
Rabbits				
1990-2011	100			
Fur-bearing animals				
1990-2006	100			
2007	93	7		
2008	85	15		
2009-2011	78	22		
Nutria				
1990-2011	100			

Calculation of N_2O emissions

N_2O emissions from manure management are calculated by multiplying the total amount of N excretion (from all animal categories) in each type of manure management system by an emission factor for that type of manure management system[71]:

$$(N_2O\text{-}N)(mm) = \Sigma_{(S)} ((\Sigma_{(T)} (N_{(T)} \times Nex_{(T)} \times MS_{(T,S)})) \times EF_{3(S)})$$

where:
$(N_2O\text{-}N)(mm)$ – N_2O-N emissions from manure management in the country (kg N_2O-N/yr);
$N_{(T)}$ – Number of head of livestock species/category T in the country;
$Nex_{(T)}$ – Annual average N excretion per head of species/category T in the country (kg N/animal/yr);
$MS_{(T,S)}$ – Fraction of total annual excretion for each livestock species/category T that is managed in manure management system S in the country;
$EF_{3(S)}$ – N_2O emission factor for manure management system S in the country (kg N_2O-N/kg N in manure management system S);
S – Manure management system;
T – Species/category of livestock.

Conversion of $(N_2O\text{-}N)(mm)$ emission to $N_2O(mm)$ emission for reporting purposes is performed by using the following equation:

$$N_2O(mm) = (N_2O\text{-}N)(mm) \times 44/28$$

[71] *IPCC GPG 2000*. Agriculture. Eq. 4.18, p. 4.42

For calculation of total nitrogen excretion IPCC default annual average nitrogen excretion rates for each animal category were used (Table 6-49).

Table 6-49. Default N excretion values for livestock categories[72,73]

Animal category	Nitrogen excretion (kg N/head/year)
Sheep, goats	16
Horses	25
Poultry	0,6
Rabbits	8,1
Minks, nutria	4,59
Foxes, polar foxes	12,09

The annual amount of N excretion per head for dairy cattle was calculated on the total annual N intake and total annual N retention of the animal[74]. The annual amount of N excretion per head for non-dairy cattle and swine was calculated on the total annual N intake and total annual N retention for productivity of the animal. Annual average N intake per head for cattle and swine were calculated in accordance with the tables[75] of forage sustenance and ration. The difference between intake and retention is N excretion (Table 6-50). The emission factors for each manure management system were taken from IPCC Guidelines (Table 6-51).

Table 6-50. N excretion factors used in the estimates of N_2O emissions from cattle and swine (kg N/head/yr)

Animal category	Dairy cattle	Non-dairy cattle	Swine
1990	82,67	52,56	11,05
1991	79,30	52,56	11,05
1992	73,94	52,56	11,05
1993	72,78	52,56	11,05
1994	72,78	52,56	11,05
1995	73,02	52,56	11,05
1996	74,12	52,56	11,05
1997	75,61	52,56	11,21
1998	78,09	50,58	10,77
1999	76,11	51,05	11,29
2000	84,07	50,42	11,09
2001	84,78	50,27	10,95
2002	85,96	50,29	11,05
2003	86,50	50,06	10,90
2004	88,91	49,70	10,83
2005	90,74	49,85	10,66
2006	92,88	50,27	10,14
2007	96,22	49,92	10,80
2008	97,18	50,42	10,80

[72] *Revised 1996 IPCC*. Agriculture. Workbook. Vol. 1, Table 4-6, p. 4.10
[73] *2006 IPCC Guidelines*. Table 10.19, p. 10.59
[74] *IPCC GPG 2000*. Agriculture. Eq. 4.19, p. 4.45
[75] Gyvulininkystės žinynas. Baisogala, Institute of Animal Science of LVA. 2007, p. 584-601

2009	97,70	50,36	10,22
2010	98,92	50,49	10,72
2011	103,02	49,96	10,91

Table 6-51. Default emission factors for N_2O estimation from manure management[76]

Manure management system	Emission factor (kg N_2O-N/kg nitrogen excreted)
Pasture/range/paddock	0,02
Solid storage and dry lot	0,02
Liquid system, pits below confinements	0,001
Other management systems:	
For swine	0,001
For sheep, goats, horses and poultry	0,005

6.3.2.3 Uncertainties and time-series consistency

N_2O emission from manure management was calculated based on the livestock population. N excretion and N emission factors related to manure management systems. *IPCC GPG 2000* (Table 4.12) refers that uncertainty range for the default emission factors for N_2O from manure management is estimated to be -50%/+100%[77]. The uncertainty of nitrogen excretion for categories of livestock is ±28%. The uncertainties associated with the N excretion rates related with the N intake and N retention of animals may be as low as ±25%[78]. Overall uncertainty for activity data assumed to be ±28%.

6.3.2.4 Source-specific QA/QC and verification

QA/QC includes checking of activity data, emission factors and methods applied. These activities are implemented every year in preparation of agriculture inventory. If errors are found they are corrected. Comparing results obtained in 2010 it can be seen that gross energy consumption in dairy cattle category occupied an intermediate position between Belarus and Poland, while Lithuania shows higher N_{ex} rate (Table 6-52).

Table 6-52. Comparison of GE and N excretion values for N_2O emission calculation from manure management of cattle and swine

Country	Dairy cattle		Non-dairy cattle		Swine	
	Nex (kg N/head/yr)	GE (MJ/head/ day)	Nex (kg N/head/yr)	GE (MJ/head/ day)	Nex (kg N/head/yr)	GE (MJ/head/ day)
Belarus	77,09	276,86	36,43	130,69	9,95	NE
Denmark	138,63		43,15	130,27	7,65	40,27
Estonia	120,10	332,16	-	-	10,42	25,08
Latvia	70,0	298,73	50,0	132,54	10,0	NA
Lithuania	103,02	268,71	49,96	128,65	10,91	27,26
Poland	86,70	247,40	58,12	125,05	13,56	NA

In non-dairy cattle sub-category the levels of gross energy intakes are similar to those of Belarus and Denmark, however N_{ex} rates in these countries are lower.

[76] *Revised 1996 IPCC*. Agriculture. Workbook. Vol. 1, Table 4-8, p. 4.14
[77] *IPCC GPG 2000*. Agriculture. Table 4.13, p. 4.43
[78] *IPCC GPG 2000*. Agriculture, p. 4.46

In swine category the level of gross energy intakes and N_{ex} rates in Lithuania are similar to those of Estonia.

6.3.2.5 Source-specific recalculations

N_2O emission was recalculated due to updated of gross energy intake and protein consumption for the period 2008-2010 and N retention for dairy cattle according to *IPCC GPG 2000*[79] metodology for entire time series (Table 6-53). Similarly N_2O emission was recalculated due to updated data for manure management systems.

Table 6-53. Comparison of recalculated N_2O emission from manure management in previous and this submission for the period 1990-2010 (Gg)

Year	Previous submission	This submission	Absolute difference	Relative difference, %
1990	2,82	2,86	0,04	1,42
1991	2,61	2,64	0,03	1,15
1992	1,93	1,96	0,03	1,55
1993	1,57	1,60	0,03	1,91
1994	1,34	1,36	0,02	1,49
1995	1,24	1,26	0,02	1,61
1996	1,23	1,22	-0,01	-0,81
1997	1,26	1,27	0,01	0,79
1998	1,10	1,10	0,00	0,00
1999	1,02	1,02	0,00	0,00
2000	0,90	0,90	0,00	0,00
2001	0,93	0,92	0,01	1,08
2002	0,96	0,94	-0,02	-2,08
2003	1,00	0,98	-0,02	-2,00
2004	0,99	0,97	-0,02	-2,02
2005	1,01	0,98	-0,03	-2,97
2006	1,04	1,01	-0,03	-2,88
2007	1,04	1,01	-0,03	-2,88
2008	0,99	0,96	-0,03	-3,03
2009	0,94	0,90	-0,04	-4,26
2010	0,93	0,89	-0,04	-4,30

6.3.2.6 Source-specific planned improvements

Collection of more accurate data on manure utilization and appliance to biogas plants in Lithuania is planned. Additional data should enable better and more reliable judgments on N_2O emissions from manure management.

6.4 Rice cultivation (CRF 4.C)

Rice is not cultivated in Lithuania, emissions are reported as „NO" in CRF reporter.

[79] *IPCC GPG 2000*. Agriculture. Eq. 4,19, p. 4.45

6.5 Agricultural soils (CRF 4.D)

This source category includes direct and indirect nitrous oxide emissions from agricultural soils and emissions from manure deposited on pastures (Table 6-54). Agricultural soils represent a large source of nitrous oxide. N_2O emission from agricultural soils contributed 61,1% of the total GHG emission from agriculture sector. N_2O emissions from Agricultural soils subsector were also identified as a key category (see Table 6-1).

Table 6-54. Nitrous oxide emissions from agricultural soils during the period 1990-2011 (Gg)

Year	Direct soil emissions	Pasture manure	Indirect emissions
1990	8,72	1,59	6,09
1991	7,93	1,50	5,37
1992	5,19	1,18	3,20
1993	4,48	1,00	2,40
1994	4,07	0,87	1,99
1995	4,07	0,82	1,90
1996	4,87	0,83	2,39
1997	5,02	0,85	2,47
1998	5,00	0,76	2,34
1999	5,09	0,71	2,40
2000	5,18	0,66	2,34
2001	5,29	0,66	2,43
2002	5,66	0,68	2,65
2003	5,77	0,71	2,71
2004	5,85	0,71	2,72
2005	5,95	0,71	2,77
2006	5,75	0,73	2,84
2007	6,46	0,73	3,27
2008	5,89	0,70	2,87
2009	6,04	0,66	2,93
2010	5,99	0,64	3,00
2011	6,13	0,64	3,03

6.5.1 Direct emissions from agricultural soils (CRF 4.D.1)

6.5.1.1 Source category description

This source category includes direct N_2O emissions from agricultural soils. Assessing direct N_2O emissions from agricultural soils, anthropogenic nitrogen inputs were considered from: application of synthetic fertilizers and animal manure, cultivation of N-fixing crops, incorporation of crop residues into soils, soil nitrogen mineralization due to cultivation of organic soils. A major direct source of nitrous oxide from agricultural soils is the use of synthetic fertilizer (Figure 6-8). Similarly the use of animal manure as fertilizer can lead to substantial emissions of N_2O from agricultural soils.

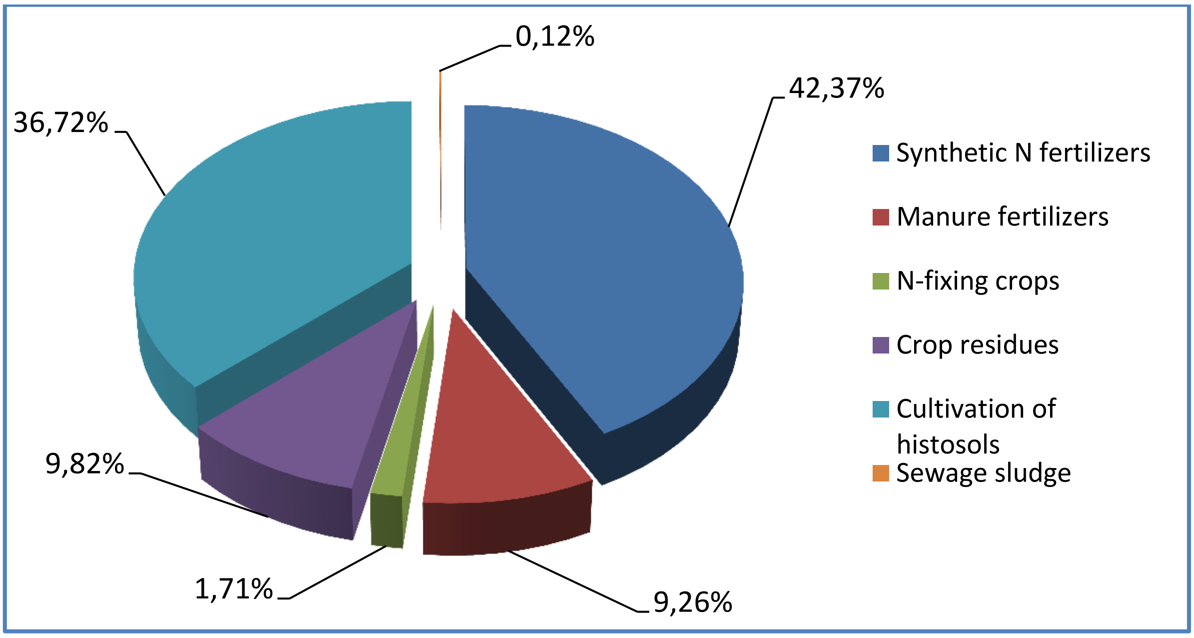

Figure 6-8. Direct N_2O emissions from agricultural soils in 2011 (%)

As shown in Figure 6-8 the biggest share of N_2O emissions in 2011 were from application of synthetic fertilizers and cultivation of histosols. The share of N_2O emissions from synthetic N fertilizers took more than 42% ant N_2O emissions from cultivation of histosols took 36,7% of the total N_2O emissions from agricultural soils subsector. The situation of emissions from each source comparing with 2010 has changed due to recalculations that were made using a higher Tier method for crop residue and N-fixing crops and recalculations made for cultivation of histosols. In addition, N_2O emissions from application of sewage sludge as soil amendment were included in this year submission.

For the variation of N_2O emission from agricultural soils in 1990-2011 the biggest influence had usage of nitric fertilizers and soil nitrogen mineralization due to cultivation of organic soils including grasslands. Emissions of N_2O from sewage sludge as fertilizer amounted to 0,007 Gg N_2O in 2011 and contributed only 0,12% of total N_2O emissions from Direct soil emissions (CRF 4.D.1).

Table 6-55 gives direct N_2O emissions from agricultal soils subsector for the the whole time period 1990-2011 by each source category.

Table 6-55. Direct N_2O emissions from agricultural soils by source category during the period 1990-2011(Gg)

Year	Synthetic N fertilizers	Manure fertilizers	N-fixing crops	Crop residues,	Cultivation of histosols
1990	4,33	1,59	0,39	0,46	1,94
1991	3,61	1,48	0,38	0,47	1,99
1992	1,67	1,03	0,18	0,26	2,04
1993	1,02	0,86	0,17	0,34	2,09
1994	0,73	0,77	0,15	0,27	2,14
1995	0,71	0,73	0,15	0,28	2,19
1996	1,40	0,70	0,18	0,37	2,21
1997	1,43	0,72	0,19	0,42	2,25

1998	1,47	0,64	0,17	0,41	2,30
1999	1,66	0,59	0,13	0,34	2,35
2000	1,73	0,52	0,13	0,37	2,42
2001	1,80	0,55	0,12	0,32	2,49
2002	2,03	0,58	0,13	0,37	2,54
2003	2,05	0,60	0,13	0,39	2,59
2004	2,07	0,61	0,13	0,43	2,61
2005	2,10	0,63	0,16	0,43	2,62
2006	2,16	0,64	0,11	0,30	2,54
2007	2,72	0,64	0,14	0,49	2,45
2008	2,26	0,61	0,14	0,51	2,35
2009	2,40	0,59	0,15	0,60	2,28
2010	2,53	0,59	0,10	0,51	2,27
2011	2,60	0,57	0,10	0,60	2,25

6.5.1.2 Methodological issues

Nitrogen inputs to soils from the main sources were calculated using *IPCC GPG 2000* Tier 1a methods.

Direct N_2O emissions from agricultural soils have been calculated using the following equation[80]:

$$N_2O_{DIRECT} – N = ((F_{SN} + F_{AM} + F_{BN} + F_{CR} + F_{SL}) \times EF_1) + F_{OS} \times EF_2$$

where:
N_2O_{DIRECT} – N – emission of N_2O in units of nitrogen;
F_{SN} – annual amount of synthetic fertilizer nitrogen applied to soils adjusted to account for the amount that volatilizes as NH_3 and NO_x;
F_{AM} – annual amount of animal manure nitrogen intentionally applied to soils adjusted to account for the amount that volatilizes as NH_3 and NO_x;
F_{BN} – amount of nitrogen fixed by N-fixing crops cultivated annually;
F_{CR} – amount of nitrogen in crop residues returned to soils annually;
F_{SL} - annual amount of sewage sludge fertilizer nitrogen applied to soils adjusted to account for the amount that volatilizes as NH_3 and NO_x;
F_{OS} – area of organic soils cultivated annually;
EF_1 – emission factor for emissions from N inputs (kg N_2O-N/kg N input);
EF_2 – emission factor for emissions from organic soil cultivation (kg N_2O-N/ha/yr).

Conversion of N_2O-N emissions to N_2O emissions for reporting purposes is performed by using the following equation[81]:

$$N_2O = N_2O\text{-}N \times 44/28$$

Synthetic N fertilizers (F_{SN}) (CRF 4.D.1.1)

Data about consumption of synthetic fertilizers were collected from different sources:

- for the period 1990-1994 data was obtained from Statistics Lithuania;
- for the period 1995-2006 from International Fertilizer Industry Association (IFA)[82];

[80] *IPCC GPG 2000*. Agriculture. Eq. 4.20, p. 4.54
[81] *IPCC GPG 2000.* Agriculture, p. 4.54

- for the period 2007-2011 from UAB Agrochema.

Synthetic Fertilizer Nitrogen, adjusted for Volatilization (F_{SN}) was estimated by determining the total amount of synthetic fertilizer consumed annually (N_{FERT}), and then adjusting this amount by the fraction that volatilizes as NH_3 and NO_x ($Frac_{GASF}$)[83]:

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

where:
N_{FERT} – total use of synthetic fertilizer, kg N/yr;
$Frac_{GASF}$ – fraction of total synthetic fertilizer nitrogen that is emitted as $NOx+NH_3$, kg N/kg N.

$$N_2O_{DIRECT} = F_{SN} \times EF_1 \times 44/28$$

To calculate annual amount of synthetic fertilizer nitrogen applied to soils default factors from *Revised 1996 IPCC* were used (Table 6-56).

Table 6-56. Default factors used for estimation of synthetic fertiliser nitrogen[84]

Factor	Unit
EF_1	0,0125 kg N_2O-N/kg N
$Frac_{GASF}$	0,1 kg NH_3-N + NO_x-N/kg of synthetic fertilizer nitrogen applied

N_2O emission from Synthetic N fertilizer application to soil has decreased by 40% in 2011 comparing with the base year (Figure 6-9).

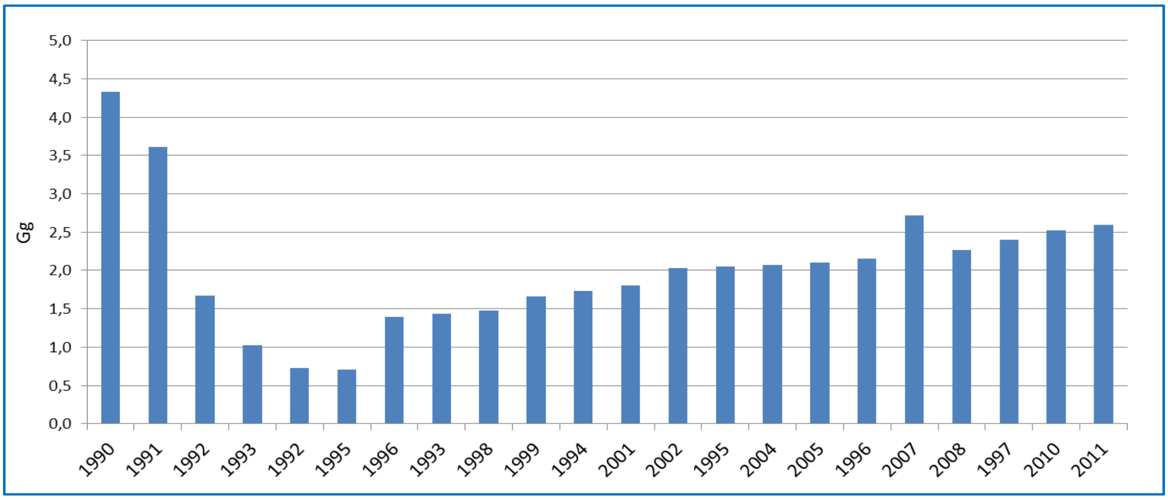

Figure 6-9. Nitrous oxide emission from Synthetic N fertilizers during the period 1990-2011 (Gg)

Animal manure applied to soils (CRF 4.D.1.2)

The main activity data for this source is number of livestock population. Data about livestock population were taken from Statistics Lithuanian and the Register of Agricultural Information and Rural Business Center. Information about distribution between manure management systems was taken from the Water Research Institute of the University of Agriculture of the Republic of Lithuania, also from the investigations made in previous years.

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[82] International Fertilizer Industry Association (IFA). Available from: *http://www.fertilizer.org/*
[83] *IPCC GPG 2000*. Agriculture. Eq. 4.22, p. 4.56
[84] *Revised 1996 IPCC*. Reference Manual, Agriculture, p. 4.89, 4.94

Animal manure nitrogen (F_{AM}) emits from agricultural soil through manure application to fields as organic fertilizer and animal pastures by grazing of animals. N_2O emissions were estimated by determining the total amount of animal manure nitrogen produced annually and then adjusting this amount to account for the animal manure that is volatilized as NH_3 and NO_x ($Frac_{GASM}$)[85]:

$$F_{AM} = \Sigma_T (N_{(T)} \times Nex_{(T)}) \times (1 - Frac_{GASM}) [1 - Frac_{FUEL\text{-}AM} + Frac_{PRP}]$$

where:
$N_{(T)}$ – number of head of livestock category T;
$Nex_{(T)}$ – annual average N excretion per head of category T (kg N/animal/yr);
$Frac_{FUEL}$ – fraction of livestock nitrogen excretion contained in animal manure that is burned for fuel;
$Frac_{PRP}$ (or $Frac_{GRAZ}$) – animal manure, deposited onto soils by grazing livestock.

This country specific value was calculated according to *Revised 1996 IPCC* methodology[86]:

$$Frac_{PRP} = N_{past} / N_{total}$$

N_{past} – amount of N from manure per animal waste management systems - pasture range and paddock 4.D.2, wich was applied tosoils (Gg/yr);
N_{total} – amount of N from manure per all animal waste management systems in Lithuania (Gg/yr).

$$N_{total} = N_L + N_S + N_{past} + N_{oth}$$

where:
N_L – amount of N from manure per animal waste management systems - liquid system (Gg/yr);
N_S – amount of N from manure per animal waste management systems - solid storage and drylot (Gg/yr);
N_{oth} – amount of N from manure per animal waste management systems – other system (Gg/yr).

$$N_2O_{DIRECT} = F_{AM} \times EF_1 \times 44/28$$

To calculate annual amount of Animal manure nitrogen (F_{AM}) applied to soils *Revised 1996 IPCC* default factors were used (Table 6-57, 6-58).

Table 6-57. Default factors used in estimation of N_2O emission from animal manure applied to soils[87]

Factor	Unit
$Frac_{GASM}$	0,2 kg NH_3-N + NOx-N/kg of N excreted by livestock
N_2O EF	0,0125 kg N_2O-N/kg N
$Frac_{FUEL}$	0,0 kg N/kg nitrogen excreted[88]

The background data used for calculation of fraction of animal manure that is deposited onto soils by grazing livestock ($Frac_{PRP}$) is provided in the Figures 6-4, 6-5, 6-6 (percentage of manure production per animal waste management systems), Tables 6-49 and 6-50 (N excretion values) and Tabale 6-51 (default emission factors for N_2O estimation from manure management).

[85] *IPCC GPG 2000*. Agriculture. Eq. 4.23, p. 4.56
[86] *Revised 1996 IPCC*. Reference Manual, Agriculture, Table 4-21, p. 4.101
[87] *Revised 1996 IPCC*. Reference Manual, Agriculture, Table 4-18, p 4.89; Table 4-19, p. 4.94
[88] *Revised 1996 IPCC*. Workbook, Agriculture, Table 4-17, p. 4.35

The fraction of livestock nitrogen that was excreted and deposited on soil during grazing ($Frac_{PRP}$) is presented in Table 6-58.

Table 6-58. Fraction of livestock nitrogen excreted and deposited on soil during grazing in Lithuania ($Frac_{PRP}$)

Year	Fraction excreted on pasture
1990	0,268
1991	0,270
1992	0,289
1993	0,292
1994	0,287
1995	0,286
1996	0,294
1997	0,294
1998	0,295
1999	0,296
2000	0,304
2001	0,297
2002	0,294
2003	0,294
2004	0,293
2005	0,287
2006	0,289
2007	0,289
2008	0,290
2009	0,288
2010	0,283
2011	0,289

N_2O emission from Manure fertilizer application to soil has decreased by 64,5% in 2011 comparing with 1990 (Figure 6-10). This decrease is associated with reduction of livestock population.

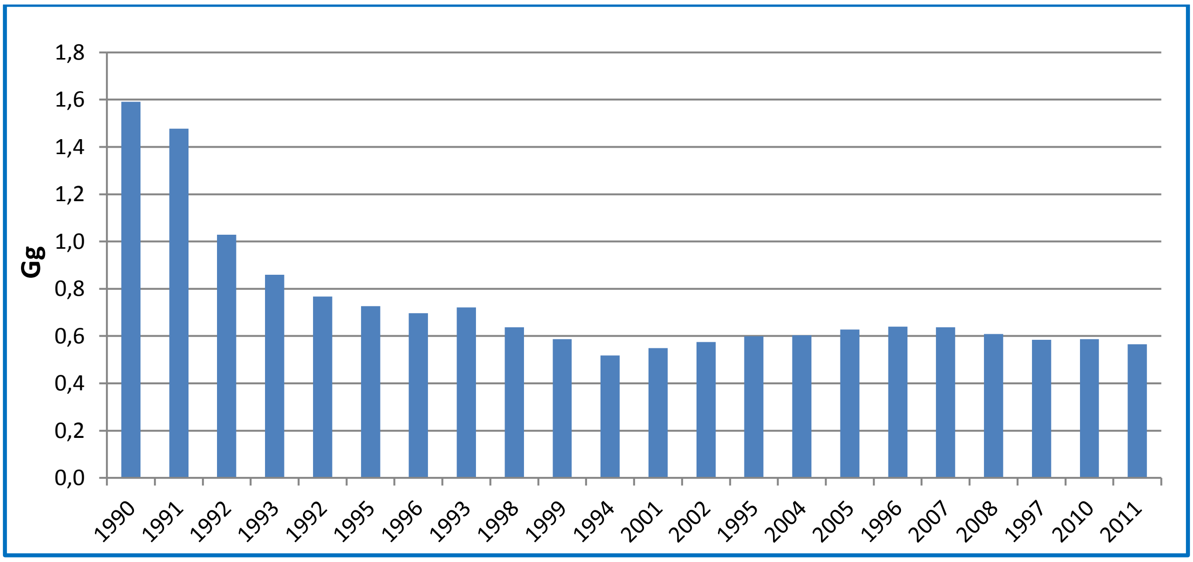

Figure 6-10. Nitrous oxide emission from Manure fertilizers during the period 1990-2011 (Gg)

N-fixing crops (CRF 4.D.1.3)

The main activity data that was used for calculation of N_2O emissions – harvested crops (thous. tonnes) by type of crop. This data was provided by database of Statistics Lithuania.

The main crops that were taken in to account and amount of harvest ($Crop_{BF}$) are presented in Table 6-59.

Table 6-59. Harvested crops in Lithuania during the period 1990-2011 (thous. tonnes)

Year	Harvested crops								
	Peas	Beans	Lupine	Vetches	Grain legume mixtures	Lucerne hay	Lucerne silase	Clover-grass mixture hay	Clover and their mixture silase
1990	113,5	4,6	1,8	65,2	15,1	10,7	187,6	499,1	1476,3
1991	103,3	3,7	1,3	70,6	15,3	10,1	177,5	472,3	1396,9
1992	13,9	0,1	0,2	10,5	2,8	7,8	137,4	365,7	1081,7
1993	11,1	1,2	1,0	17,4	4,6	6,4	111,9	297,6	880,3
1994	13,9	9,0	0,4	20,1	0,0	5,3	93,1	247,8	732,9
1995	21,4	2,7	1,0	18,2	4,2	4,9	86,1	229,0	677,3
1996	40,1	6,9	3,1	26,5	10,8	4,8	85,2	226,6	670,3
1997	65,6	4,5	2,6	2,9	30,8	4,9	86,3	229,6	679,2
1998	72,5	5,5	1,8	19,6	4,7	4,3	75,0	199,5	590,0
1999	46,5	1,9	0,8	11,5	3,1	4,1	72,5	193,0	570,9
2000	49,7	2,7	1,6	16,8	2,2	3,4	60,5	160,9	475,9
2001	30,0	4,1	1,5	14,3	2,3	3,5	60,7	161,6	478,0
2002	37,0	4,0	1,7	15,3	4,9	3,6	63,0	167,5	495,5
2003	21,6	4,5	2,8	4,2	15,4	3,5	67,4	191,6	517,8
2004	22,0	5,3	2,8	2,0	25,4	5,0	67,8	183,7	404,6
2005	21,1	5,8	4,9	4,5	22,6	3,0	54,9	279,1	434,1
2006	15,8	3,0	4,8	1,5	9,8	2,3	59,2	176,4	440,9
2007	24,2	2,7	7,9	3,3	18,3	3,5	69,9	183,9	583,4
2008	29,1	4,3	7,3	1,6	20,0	6,0	74,4	162,3	568,1
2009	50,3	5,1	10,6	1,5	18,2	4,2	56,8	138,9	732,2
2010	42,5	5,0	6,8	3,1	12,7	1,6	56,8	50,8	305,7
2011	47,5	7,4	6,5	3,2	13,4	2,4	56,8	46,6	400,9

To estimate the amount of nitrogen that is fixed by N-fixing crops cultivated annually (F_{BN}) the following equation has been used[89]:

$$F_{BN} = \sum_i [Crop_{BFi} \cdot (1 + Res_{BFi}/Crop_{BFi}) \cdot Frac_{DMi} \cdot Frac_{NCRBFi}]$$

where:
$Crop_{BF}$ – production of pulses, kg dry biomass/yr;
$Res_{BF}/Crop_{BF}$ – residue to crop product mass ratio specific to each type;

89 *IPCC GPG 2000*. Agriculture. Eq. 4.26, p. 4.57

$Frac_{DM}$ – the fraction of dry matter in the aboveground biomass of each crop type
$Frac_{NCRBF}$ – fraction of nitrogen in N-fixing crop, kg N/kg of dry biomass.

Crops that were used for forage amount of nitrogen that is fixed was assessed using the following equation[90]:

$$F_{BN} = \sum_i (Crop_{BFi} \cdot Frac_{DMi} \cdot Frac_{NCRBFi})$$

This equation is being used because such crops as alfalfa where the entire plant is harvested as product $Res_{BF}/Crop_{BF}$ will be equal 0[91].

Total emissions of N2O from N-fixing crops are calculated using the following equation:

$$N_2O_{DIRECT} = F_{BN} \times EF_1 \times 44/28$$

These equations represents Tier 1b method which requires country specific values and default factors for each crop type. Table 6-60 represents the main factors that were used in calculations. These values mainly represents country specific data, some used factors are taken from *IPCC GPG 2000* and *Revised 1996 IPCC*, and some from other countries.

Table 6-60. Factors used for calculation of the nitrogen content in crop residues returned to soils[92,93,94,95,96,97]

Crop type	Factor		
	$Res_{BF}/Crop_{BF}$	**$Frac_{DM}$**	**$Frac_{NCRBF}$**
Peas	1,5	0,87	0,0142
Beans	2,1	0,87	0,0230
Lupine	2,1	0,89	0,0230
Vetches	2,1	0,85	0,0230
Grain legume mixtures	2,1	0,87	0,0230
Lucerne hay	0,0	0,86	0,0180
Lucerne silase	0,0	0,36	0,0300
Clover-grass mixtures hay	0,0	0,86	0,0150
Clover and their mixtures silase	0,0	0,345	0,0052

Emission factor (EF_1) that was used for calculation of N_2O emission – 0,0125 kg N_2O-N/kg N[98].

[90] *IPCC GPG 2000*. Agriculture. Eq. 4.27, p. 4.57
[91] *IPCC GPG 2000*. Agriculture, p. 4.57
[92] *Revised 1996 IPCC*. Reference Manual. Agriculture, Table 4-19, p. 4.94
[93] Gyvulininkystės žinynas. Baisogala, Institute of Animal Science of LVA. 2007
[94] *IPCC GPG 2000*. Agriculture, Table 4.16, p. 4.58
[95] National Inventory Report of Hungary, 2011. Table 6.20, p. 132
[96] National Inventory Report of Estonia, 2012. Table 6.53, p. 251
[97] National Inventory Report of Denmark, 2009, Table 6.25, p. 271
[98] *Revised 1996 IPCC*. Reference Manual. Agriculture, Table 4-18, p. 4.89

Crop residue (CRF 4.D.1.4)

The annual production of residue N is also estimated using Tier 1b method. The amount of nitrogen returning to soils annually through incorporation of crop residues (F_{CR}) were estimated by determining the total amount of crop residue N produced (from both non-nitrogen-fixing crops (Table 6-61 and 6-62) and N-fixing crops (Table 6-59)). For calculations the following equation was used[99]:

$$F_{CR} = \sum_i [(Crop_{0i} \cdot Res_{0i}/Crop_{0i} \cdot Frac_{DMi} \cdot Frac_{NCR0i}) \cdot (1 - Frac_{BURNi} - Frac_{FUEL-CRi} - Frac_{CNST-CRi} - Frac_{FODi})] + \sum_j \left[\left(Crop_{BFj} \cdot Res_{BFj}/Crop_{BFj} \cdot Frac_{DMj} \cdot Frac_{NCRBFj}\right) \cdot \left(1 - Frac_{BURNj} - Frac_{FUEL-CRj} - Frac_{CNST-CRj} - Frac_{FODj}\right)\right]$$

where:
$Crop_0$ and $Crop_{BF}$ – production of non-N-fixing crops, kg dry biomass/yr;
$Res_0/Crop_0$ and $Res_{BF}/Crop_{BF}$ – the residue to crop product mass ratio;
$Frac_{DM}$ – the dry matter content of the aboveground biomass;
$Frac_{NCR0}$ and $Frac_{NCRBF}$ – the nitrogen content of the aboveground biomass, kg N/kg of dry biomass;
$Frac_{BURN}$ – the fraction of residue burned in the field before and after harvest;
$Frac_{FUEL-CR}$ – the fraction of residue used as fuel;
$Frac_{CNST-CR}$ – the fraction of residue used for construction;
$Frac_{FOD}$ – the fraction of residue used as fodder, N/kg crop-N.
Non of the harvested crops used in calculations were burned in field, used as fuel or material for construction therefore indicated as 0 in equation. Some of the crops were used for fodder.

Table 6-61. Harvested crop yield by type in Lithuania during the period 1990-2011 (thous. tonnes)

Year	Harvested crop yield						
	Wheat	Triticale	Rye	Barley	Oats	Other cereals	Buckwheat
1990	1183,7	0,0	470,2	1196,4	195,7	18,7	0,2
1991	854,9	0,0	344,8	1699,2	232,9	21,3	0,2
1992	833,8	0,0	342,4	955,1	50,9	15,2	0,2
1993	890,6	39,3	434,1	1207,9	77,7	21,6	1,3
1994	549,4	50,6	313,0	1090,5	69,0	25,5	0,2
1995	637,3	46,6	239,3	891,5	66,7	24,5	0,6
1996	936,2	77,6	286,8	1176,6	101,6	34,8	1,5
1997	1127,4	114,1	348,2	1193,5	111,7	46,9	3,5
1998	1031,0	94,9	348,7	1104,3	97,2	32,7	8,0
1999	870,9	85,1	260,9	741,6	67,1	14,2	8,6
2000	1237,6	130,9	311,4	859,6	82,9	19,8	14,7
2001	1076,3	143,8	231,1	776,2	84,3	19,8	12,7
2002	1217,6	145,3	170,2	871,1	97,5	18,5	10,6
2003	1204,1	214,2	147,1	899,8	114,6	28,6	14,7
2004	1430,2	263,4	140,6	859,8	117,7	31,6	13,0
2005	1415,4	201,1	108,3	948,3	114,1	39,0	15,7
2006	809,8	110,4	90,0	743,8	62,8	27,0	8,9
2007	1390,7	227,6	165,2	1013,7	119,5	52,6	20,9
2008	1722,5	311,0	204,9	970,4	140,8	19,2	20,9
2009	2100,2	426,0	207,9	858,2	142,5	33,2	14,7

[99] *IPCC GPG 2000*. Agriculture. Eq. 4.29, p. 4.59

2010	1710,4	258,4	87,0	550,0	93,9	34,6	14,0
2011	1869,3	237,0	85,0	759,8	128,5	47,0	26,0

Table 6-62. Harvested crop yield by type in Lithuania during the period 1990-2011 (thous. tonnes)

Year	Harvested crop yield						
	Maize for grain	Linseed	Sugar beet	Rape seed	Potatoes	Vegetables	Feed beet
1990	0,0	10,2	718,1	28,0	1531,1	295,0	2678,8
1991	0,0	10,2	811,2	12,5	1508,3	398,4	2446,0
1992	0,0	3,1	621,5	7,6	1079,2	259,8	1417,6
1993	0,0	1,2	855,3	3,1	1772,6	376,0	1998,3
1994	0,0	3,5	461,5	13,2	1096,4	282,6	1324,7
1995	0,0	6,5	692,4	18,9	1593,5	368,7	2188,9
1996	0,0	3,2	795,5	22,6	2044,3	432,6	1718,4
1997	0,0	2,9	1001,9	37,2	1829,8	415,0	1829,7
1998	0,0	2,7	949,2	71,9	1849,2	436,9	2026,0
1999	0,0	3,7	869,9	115,1	1708,1	325,1	1573,3
2000	0,0	2,7	881,6	81,0	1791,6	329,4	1399,4
2001	0,0	0,9	880,4	64,8	1054,4	322,0	1382,9
2002	8,3	2,7	1052,4	105,6	1531,3	290,0	1136,2
2003	8,7	2,7	977,4	119,5	1445,2	549,3	944,7
2004	3,0	1,8	904,9	204,7	1021,4	379,4	385,3
2005	4,9	2,0	798,5	201,2	894,7	369,2	375,7
2006	4,7	0,7	717,1	169,6	457,1	225,5	195,5
2007	26,0	0,3	799,9	311,9	576,1	281,9	164,6
2008	32,0	0,2	339,1	330,2	716,4	310,4	134,3
2009	23,8	0,2	682,0	415,8	662,5	321,7	113,3
2010	47,5	0,2	706,7	416,7	476,9	188,6	40,8
2011	71,9	0,4	877,8	484,3	587,7	315,0	50,5

The values that were used for calculations are presented in Table 6-63. These factors represents country specific values, IPCC default values and values of other countires`.

Table 6-63. Factors used for calculation of the nitrogen content in crop residues returned to soils[100,101,102,103,104]

Crop type	Factor			
	$Res_0/Crop_0$	$Frac_{DM}$	$Frac_{NCR0}$	$Frac_{FOD}$
Wheat	1,3	0,850	0,0028	0,07
Triticale	1,3	0,880	0,0028	0,07
Rye	1,6	0,850	0,0048	0,00
Barley	1,2	0,853	0,0043	0,07
Oats	1,3	0,860	0,0070	0,07
Other cereals	1,3	0,850	0,0150	0,07

[100] *Revised 1996 IPCC*. Agriculture, Table 4-18 and 4-19, p. 4.89, 4.94
[101] Gyvulininkystės žinynas. Baisogala, Institute of Animal Science of LVA. 2007
[102] *IPCC GPG 2000*. Agriculture, Table 4.16, p. 4.58
[103] National Inventory Report of Hungary, 2011. Table 6.20, p. 132
[104] National Inventory Report of Austria, 2011. Table 196, p. 293

Buckwheat	1,3	0,850	0,0150	0,00
Maize for grain	1,0	0,860	0,0081	0,00
Linseed	1,0	0,910	0,0150	0,00
Sugar beet	0,3	0,230	0,0228	0,00
Rapeseed	2,1	0,880	0,0150	0,00
Potatoes	0,4	0,220	0,0110	0,00
Vegetables	0,8	0,200	0,0150	0,00
Feed beet	0,3	0,120	0,0228	0,70

For calculation of N_2O emissions the same emission factor of 0,0125 N_2O-N/kg N was used as for N-fixing crops.

Cultivation of histosols (CRF 4.D.1.5)

For assessment of organic soils (histosols)[105] data of the National Forest Inventory was used: area of cropland and grassland (Chapter 7) and percentage of organic soils in these land use categories. NFI provided that area of organic soils in croplands is 0,7% and area of organic soils in grasslands – 10,5%. According to *IPCC 2003* Cropland land use category consist of arable land and orchards and berry plantations. To estimate N2O emissions from cultivation of histosols only arable land was used. To identify total arable land area the area of orchards and berry plantations were eliminated. This data was obtained from the register of Agriculture Information and Rural business center.

N_2O emissions from histosols are based on the area with organic soils multiplied by the emission factor and conversion of N_2O-N to N_2O emissions:

$$N_2O_{Direct} = Area \times EF_2 \times 44/28$$

where:
EF_2 – 8 kg N_2O-N/ha/year[106].
Area – total are of organic soils in Lithuania, ha.

Sewage Sludge applied to soils (CRF 4.D.1.6)

Sewage sludge from wastewater treatment plants is used as soil amendment in Lithuania. For calculations of N_2O emissions data of R10 sludge (dry matter) amounted in Lithuanian were used. R10 is a recovery operation code.[107] The sludge corresponding to this code is a municipal sewage sludge used for land treatment that results in benefit to agriculture or ecological improvement. In Estonian National Inventory Report (2012)[108] data of both R10 type waste and R3 type waste were used for calculations. In Lithuania, however, there are no precise data on how many tons of R3 type of waste is used in agriculture. Therefore, it was decided to concentrate on the data of R10 type of waste.

Data on the amount of R10 sewage sludge for the periods 1991-1999 and 2004-2011 and on total nitrogen concentration (%) in sewage sludge for the period 2004-2009 was obtained from Lithuanian Environmental Protection Agency (EPA) . Data on N concentration in sewage sludge for

[105] Lietuvos pelkių ekonominis vertinimas. Ataskaita, Aplinkos apsaugos politikos centras, 2010
[106] *IPCC GPG 2000*. Agriculture. Table 4-16, p. 4.60
[107] Žin., 2011, Nr. 57-2721; 2011, Nr. 150-7100; 2012, Nr. 16-697
[108] National Inventory Report of Estonia, 2012, p. 255

the period 1990-2003 was not available as at that time such data was not collected in Lithuania. Information on N concentration in sewage sludge for the years 2010-2011 was not available at the time of inventory preparation. For calculation of N_2O emissions from sewage sludge application the arithmetic average of N concentration (3,75%) of the period 2004-2009 was used.

The data of the years 1990, 2000-2003 on R10 waste application in Lithuania are not reliable. It is not clear how much sewage sludge has been used on agricultural land in Lithuania. As a result, it was decided to use the annual average amounts of sewage sludge of the periods 1991-1999 and 2004-2011 to fill the gaps of the period 2000-2003. It was assumed that annual amount of sewage sludge in 1991 issimilar to that of 1991.

The following equation was used for calculation of nitrogen input from sewage sludge application to agricultural soils:[109]

$$N_{SEWSLUDGE} = S_{SLUDGE} * S_N/100$$

where:
$N_{SEWSLUDGE}$ – annual amount of nitrogen intentionally input to agricultural soils by sewage sludge application, Gg N/year;
S_{SLUDGE} – annual amount of sewage sludge applied to agricultural soils, Gg/year;
S_N – nitrogen content in dry matter, %.

Sewage sludge fertilizer nitrogen, adjusted for volatilization (F_{SL}) was estimated by determining the total amount of sewage sludge fertilizer consumed annually ($N_{SEWSLUDGE}$), and then adjusting this amount by the fraction that volatilizes as NH_3 and NO_x ($Frac_{GASF}$)[110,111]:

$$F_{SL} = N_{SEWSLUDGE} \times (1 - Frac_{GASF})$$

where:
$Frac_{GASF}$ – fraction of total sludge nitrogen that is emitted as NO_x+NH_3, kg N/kg N.

$$N_2O_{DIRECT} = F_{SL} \times EF_1 \times 44/28$$

EF_1 – emission factor.

To calculate annual amount of sewage sludge fertiliezer nitrogen applied to soils default factors from *IPCC GPG 2000* were used:

Table 6-64. Default factors used for estimation of sewerage sludge fertiliser nitrogen[112]

Factor	Unit
EF_1	0,0125 kg N_2O-N/kg N
$Frac_{GASF}$	0,1 kg NH_3-N + NO_x-N/kg of sewage sludge fertilizer nitrogen applied

In Lithuania application of sewage sludge as fertilizer is relatively small. Emissions of N_2O from this subcategory amounted to 0,007 Gg N_2O in 2011 and contributed only 0,12% of N_2O emissions from category 4.D Agricultural soils (Figure 6-11).

[109] National Inventory Report of Poland, 2012, p. 141
[110] National Inventory Report of Estonia, 2012, Eq. 6.29, p. 256
[111] *IPCC GPG 2000*. Agriculture, Eq. 4.22, p. 4.56
[112] *IPCC GPG 2000*. Agriculture. Eq. 4.20, p. 4.54, Table 4.17, p. 4.60

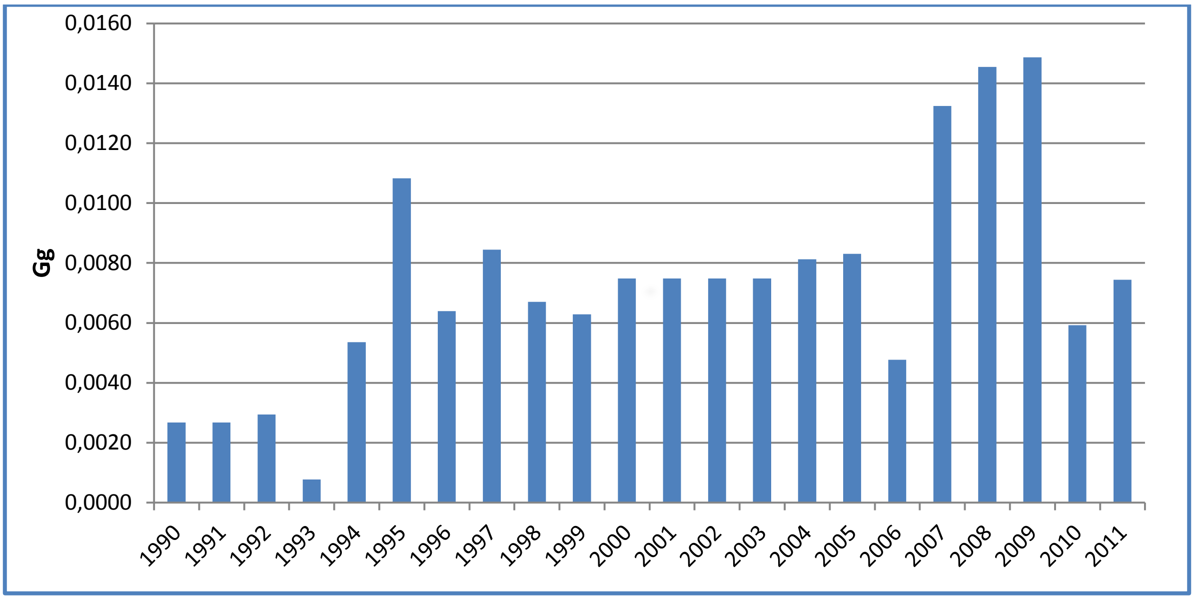

Figure 6-11. Nitrous oxide emission from sewage sludge N fertilizers during the periods 1990-2011 (Gg)

6.5.1.3 Uncertainties and time-series consistency

Uncertainties in estimates of direct emissions of N_2O from agricultural soils were caused by uncertainties related to the activity data and emission factors. Based on expert judgement, N_2O emission factors uncertainty was assumed to be ±100%, activity data uncertainty ±20%.

6.5.1.4 Source-specific QA/QC and verification

A sector specific QA/QC includes the QC measures outlined in QA/QC plan. These measures are implemented every year during the agricultural inventory. If errors or inconsistencies are found they are documented and corrected.

6.5.1.5 Source-specific recalculations

Recalculations of direct N_2O emission from agricultural soils were performed in this submission due to:

- Activity data on Synthetic N fertilizers (4.D.1.1) were updated, particulary year 2007, 2008 and 2010;
- Recalculations were done in manure management – N_2O subsetros what caused recalculations in subsector animal manure applied to soils. Also reestimation of FracGRAZ were performed in this submission (4.D.1.2);
- Recalculations were done in subsectros N-fixing crops (4.D.1.3) and crop residues (4.D.1.4) because a higher Tier method was used in this submission switching from Tier 1a to Tier 1b;
- Following the recommendations of ERT during in country review 2012 recalculations were performed in subsector histosols (4.D.1.5) by adding additional area of organic drained grasslans as previously this area was not included in to calculations. Also recalculations were made as area of arable land and area of organic soils in cropland and grassland were harmonized with LULUCF sector.
- N_2O emission calculation from sewage sludge was included in this submission (4.D.16).

Recalculations are presented in Table 6-65.

Table 6-65. Reported in previous submission and recalculated N_2O emission from direct emissions from agricultural soils (Gg)

Year	Previous submission	This submission	Absolute difference	Relative, %
1990	7,79	8,72	0,93	11,92
1991	6,91	7,93	1,02	14,77
1992	3,89	5,19	1,30	33,33
1993	3,24	4,48	1,24	38,14
1994	2,57	4,07	1,50	58,53
1995	2,59	4,07	1,48	56,99
1996	3,51	4,87	1,36	38,70
1997	3,65	5,02	1,37	37,49
1998	3,55	5,00	1,45	40,94
1999	3,47	5,09	1,62	46,62
2000	3,55	5,18	1,63	46,05
2001	3,67	5,29	1,62	44,09
2002	3,89	5,66	1,77	45,45
2003	3,95	5,77	1,82	45,96
2004	3,93	5,85	1,92	48,97
2005	3,95	5,95	2,00	50,52
2006	3,75	5,75	2,00	53,29
2007	4,21	6,46	2,25	53,43
2008	4,01	5,89	1,88	46,91
2009	4,35	6,04	1,69	38,75
2010	4,36	5,99	1,63	37,49

6.5.1.6 Source-specific planned improvements

Collection of more accurate data on area of organic soils and total area of arable land are planned.

6.5.2 Pasture, range and paddock manure (CRF 4.D.2)

6.5.2.1 Source category description

In 2011 N_2O emission from pasture, range and paddock manure during the time-period decreased by 59,5% since 1990 due to decrease of livestock population (Figure 6-12).

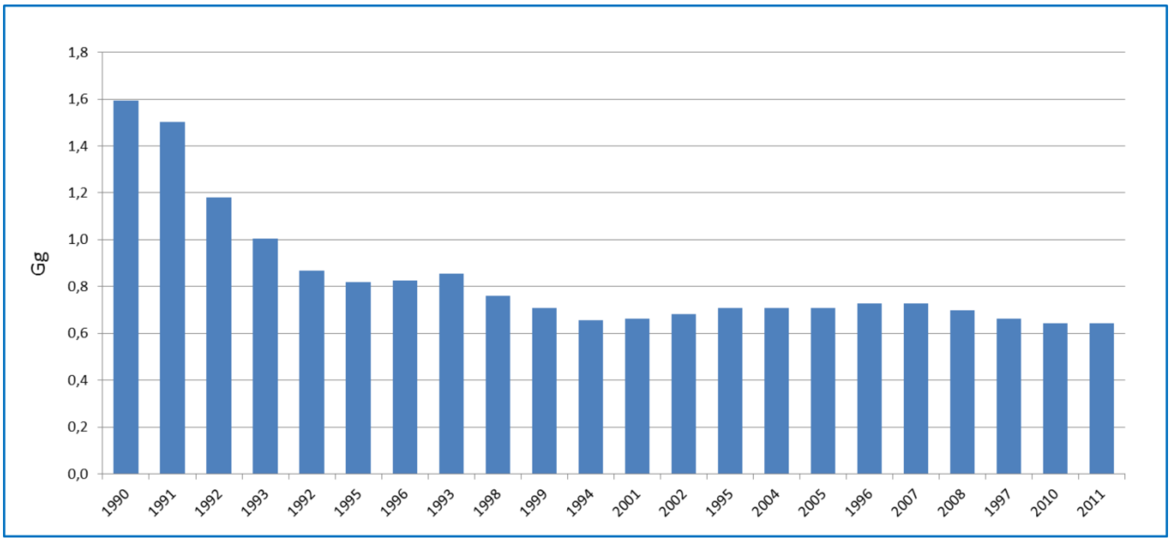

Figure 6-12. Nitrous oxide emission from Pasture, range and paddock manure during the period 1990-2011 (Gg)

6.5.2.2 Methodological issues

Direct N_2O emissions from pasture, range and paddock manure were calculated according to the same methodology as used for estimation of N_2O emissions from manure management (see Chapter Manure management – N_2O emissions (CRF 4.B (b))).

6.5.2.3 Uncertainties and time-series consistency

Uncertainties in estimates of emission of N_2O from pasture, range and paddock manure are caused by uncertainties related to the activity data and emission factor. Based on expert judgement, N_2O emission factor uncertainty was assumed to be ±100%, activity data uncertainty ±20%.

6.5.2.4 Source-specific QA/QC and verification

Source specific QA/QC includes checking of activity data based on Tier 1 method according to QA/QC plan.

6.5.2.5 Source-specific recalculations

N_2O emissions from pasture, randge and paddock manure (4.D.2) were recalculated due to recalculations made in subsector manure management – N_2O (4.B.(b)), but relative difference between this and previous submission was minor (Table 6-66).

Table 6-66. Reported in previous submission and recalculated N_2O emissions from pasture, range and paddock manure (Gg**)**

Year	Previous submission	This submission	Absolute difference	Relative, %
1990	1,57	1,59	0,02	1,3
1991	1,47	1,50	0,03	2,0
1992	1,15	1,18	0,03	2,6
1993	0,98	1,00	0,02	2,0

1994	0,85	0,87	0,02	2,4
1995	0,80	0,82	0,02	2,5
1996	0,80	0,83	0,03	3,8
1997	0,83	0,85	0,02	2,4
1998	0,74	0,76	0,02	2,7
1999	0,69	0,71	0,02	2,9
2000	0,63	0,66	0,03	4,8
2001	0,65	0,66	0,01	1,5
2002	0,67	0,68	0,01	1,5
2003	0,70	0,71	0,01	1,4
2004	0,70	0,71	0,01	1,4
2005	0,70	0,71	0,01	1,4
2006	0,72	0,73	0,01	1,4
2007	0,74	0,73	-0,01	-1,4
2008	0,71	0,70	-0,01	-1,4
2009	0,68	0,66	-0,02	-2,9
2010	0,66	0,64	-0,02	-3,0

6.5.2.6 Source-specific planned improvements

No improvements are planned.

6.5.3 Agricultural soils (CRF 4.D.3) – indirect emissions

6.5.3.1 Source category description

Indirect N_2O emissions from agricultural soils consists of emissions from leaching and runoff of the applied or deposited on soils nitrogen and atmospheric deposition on soils of NO_X and ammonium.

Figure 6-13 shows total emission of N_2O from indirect emissions of agricultural soils and distribution between two subcategories – atmospheric deposition (4.D.3.1) and nitrogen leaching and run-off (4.D.3.2).

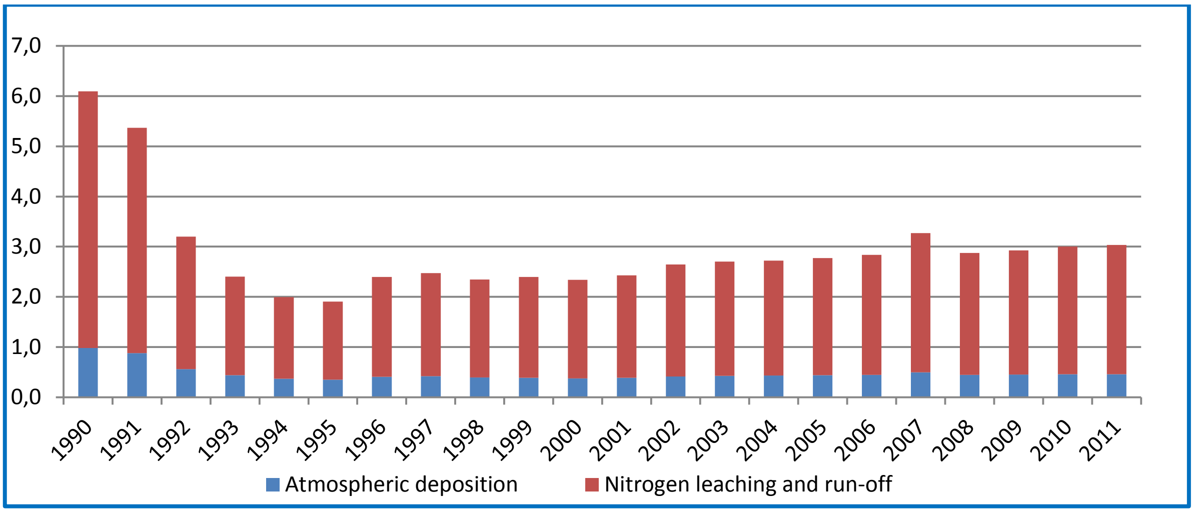

Figure 6-13. Indirect N_2O emissions from agricultural soils during the period 1990–2011 (Gg)

The total indirect N_2O emissions from agricultural soils were 3,03 Gg in 2011. N_2O emission from atmospheric deposition and nitrogen leaching and run-off in 2011 decreased by 53,4% and 49,6% respectively comparing to 1990 due to decrease of consumption of synthetic fertilizers and number of livestock population (Figure 6-13).

6.5.3.2 Methodological issues

Activity data used to estimate indirect N_2O emissions from agricultural soils were amount of nitrogen applied to soils from synthetic fertilizers, animal manure and sewage sludge fertilizers excreted. Amount of sewage sludge (R10) and nitrogen (N) concentration in sludge were used for calculations same as were used in the "Sewage Sludge applied to soils (CRF 4.D.1.6)[113].

Atmospheric deposition (4.D.3.1)

Atmospheric deposition in our calculations includes the emission from livestock manure, use of synthetic fertilizers and sewage sludge applied to agricultural soils.

Following ERT recommendation related to inclusion of sewage sludge applied on agricultural soils the *Tier 1b* method and equation 4.32 were used for estimating emissions of N_2O from atmospheric deposition:[114]

$$N_2O_{(G\text{-}SOIL)}\text{-}N = \{(N_{FERT} * Frac_{GASF}) + [(\Sigma T(N_{(T)} * Nex_{(T)}) + N_{SEWSLUDGE}] * Frac_{GASM}\} * EF_4$$

where:
$N_2O_{(G\text{-}SOIL)}$ – N_2O produced from atmospheric deposition of N, Gg N/yr;
N_{FERT} – total amount of synthetic nitrogen fertilizer applied to soils, Gg N/yr;
$Frac_{GASF}$ – fraction of synthetic N fertiliser that volatilises as NH_3 and NO_x, kg NH_3-N and NO_x-N/kg of N input;
$\Sigma_T(N_{(T)} * Nex_{(T)})$– total amount of animal manure nitrogen excreted in a country, Gg N/yr;
$N_{SEWSLUDGE}$ – annual amount of nitrogen intentionally used to agricultural soils by sewage sludge application, Gg N/year;
$Frac_{GASM}$ – fraction of animal manure N that volatilises as NH_3 and NO_x, kg NH_3-N and NO_x-N/kg of N excreted;
EF_4 – emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, kg N_2O-N/kg NH_3-N and NO_x-N emitted.

Conversion of N_2O-N emissions to N_2O emissions is performed by the following equation:

$$N_2O = N_2O\text{-}N \times 44/28$$

Table 6-67. IPCC default factors used in estimation of indirect nitrous oxide emissions from atmospheric deposition[115]

Factor	Unit
N_2O EF	0,01 kg N_2O-N/kg NH_4-N & NO_x-N deposited
$Frac_{GASF}$	0,1kg NH_3-N + NO_x-N/kg of synthetic fertilizer N applied
$Frac_{GASM}$	0,2kg NH_3-N + NO_x-N/kg of N excreted by livestock

[113] *IPCC GPG 2000*. Agriculture. Footnote 21, p. 4.70
[114] *IPCC GPG 2000*. Agriculture. Eq. 4-32, p. 4.70
[115] *Revised 1996 IPCC*. Agriculture, p. 4.94, 4.105

Leaching and runoff (4.D.3.2)

Part of the nitrogen is lost from agricultural soils through leaching and runoff, and gets to the groundwater, rivers and wetlands resulting in biogenic production of N_2O. Following ERT recommendation related to inclusion of sewage sludge applied on agricultural soils the *Tier 1b* method was used for estimation of N_2O emissions from leaching and runoff:[116]

$$N_2O_{(L\text{-}SOIL)}\text{-}N = [N_{FERT} + (\Sigma_T(N_{(T)} * Nex_{(T)}) + N_{SEWSLUDGE}] * Frac_{LEACH} * EF_5$$

where:
$N_2O_{(L\text{-}SOIL)}$ – N_2O-N emissions produced from leaching and runoff of N, Gg N/yr;
N_{FERT} – total amount of synthetic nitrogen fertilizer applied to soils, Gg N/yr;
$\Sigma_T(N_{(T)} * Nex_{(T)})$ – total amount of animal manure nitrogen excreted in a country, Gg N/yr;
$N_{SEWSLUDGE}$ – annual amount of nitrogen intentionally used to agricultural soils by sewage sludge application, Gg N/year;
$Frac_{LEACH}$ – fraction of nitrogen applied on soils that leaches as NH_3 and NO_x, kg NH_3-N and NO_x-N/kg of N excreted;
EF_5 – emission factor for leaching and runoff, kg N_2O-N/kg N leaching and runoff.

Conversion of N_2O–N emissions to N_2O emissions is performed by the following equation:

$$N_2O = N_2O\text{–}N \times 44/28$$

Table 6-68. IPCC default factors used in the estimation of indirect nitrous oxide emissions from nitrogen leaching and run- off[117]

Factor	Unit
N_2O EF	0,025 kg N_2O-N/kg N
$Frac_{LEACH}$	0,3 kg NH_3-N + NO_x-N/kg of synthetic fertilizer N applied

6.5.4 Uncertainties and time-series consistency

Information about emission factors, leaching and volatilization fractions are sparse and highly variable. Expert judgment indicates that emission factor uncertainties are at least in order of magnitude and volatilization fractions of about ±100%, activity data uncertainty ±20%.

6.5.5 Source-specific QA/QC and verification

Source specific QA/QC includes checking of activity data based on Tier 1 method according to QA/QC plan.

6.5.6 Source-specific recalculations

Recalculations in the subsector "Indirect emissions from agricultural soils" are related to N_2O emission recalculations made in manure management subsector and activity data updates for calculation of emission from Synthetic fertilizer use subcategory. Changes in emissions were also caused by sewage sludge nitrogen ($N_{SEWSLUDGE}$) that was included in this submissions calculation.

[116] *IPCC GPG 2000*. Agriculture, Eq. 4-34, p. 4.71; National Inventory Report of Poland, 2012. p. 144; National Inventory Report of Estonia, 2012, Eq. 6-32, p. 264
[117] *Revised 1996 IPCC*. Agriculture, p. 4.105-4.106

Relative difference between emissions calculated in this submission and presented in previous submission are not very significant (Table 6-69).

Table 6-69. Reported in previous submission and recalculated indirect nitrous oxide emission from agricultural soils (Gg)

Submission	Previous submission	This submission	Absolute difference	Relative, %
1990	6,06	6,09	0,03	0,57
1991	5,33	5,37	0,04	0,67
1992	3,16	3,20	0,04	1,23
1993	2,37	2,40	0,03	1,38
1994	1,96	1,99	0,03	1,78
1995	1,87	1,90	0,03	1,73
1996	2,36	2,39	0,03	1,47
1997	2,44	2,47	0,03	1,25
1998	2,31	2,34	0,03	1,48
1999	2,37	2,40	0,03	1,09
2000	2,30	2,34	0,04	1,74
2001	2,41	2,43	0,02	0,85
2002	2,62	2,65	0,03	0,95
2003	2,68	2,71	0,03	0,94
2004	2,70	2,72	0,02	0,87
2005	2,75	2,77	0,02	0,90
2006	2,82	2,84	0,02	0,67
2007	2,98	3,27	0,29	9,72
2008	2,79	2,87	0,08	2,96
2009	2,91	2,93	0,02	0,62
2010	3,07	3,00	-0,07	-2,19

6.5.7 Source-specific planned improvements

No improvements are planned.

6.6 Prescribed burning of savannas (CRF 4.E)

Savannas do not exist in Lithuania.

6.7 Field burning of agricultural residues (CRF 4.F)

Field burning of agricultural residues is prohibited by the legislation (Order of the Minister of Environment No 269 concerning the environmental protection requirements for burning of dry grass, reeds, straw and garden waste as amended, In force from September 9, 1999)[118], therefore emission from field burning of agricultural residues is reported as "NO".

[118] LR aplinkos ministro 1999 m. rugsėjo 1 d. įsakymas Nr. 269 „Dėl Aplinkos apsaugos reikalavimų deginant sausą žolę, nendres, šiaudus bei laukininkystės ir daržininkystės atliekas patvirtinimo" / Valstybės Žinios, 1999, Nr. 75-2284,aktuali akto redakcija, galiojanti nuo 2010 07 04

7 LAND USE, LAND USE CHANGE AND FORESTRY (CRF Sector 5)

7.1 Overview of LULUCF

Several organizations and activities are responsible for provision of the official data concerning Land Use Land Use Change and Forestry (*LULUCF*) reporting in Lithuania. These organizations and activities are presented below:

- **National Land Service** (NLS) under the Ministry of Agriculture (www.nzt.lt) provides data on the Lithuanian Land Fund. Data is distributed between relevant land use groups.

- **Lithuanian State Forest Cadastre** (LSFC) managed by State Forest Service (SFS) provides data associated with registered areas of forest land and detail information about all forest holdings regardless their ownership[119].

- **National Forest Inventory** (NFI) executed by State Forest Service provides objective and known accuracy data associated with forest land, forest land use and forest resources (growing stock volume, its annual increment, fellings, dead wood etc.). Information for this dataset is collected by using sampling method since 1998.

Official statistics on relevant land use categories and their changes in Lithuania are provided by:

- **Statistics Lithuania** publishes all statistical information in their annual publications "Statistical Yearbook of Lithuania" and provides statistical databases on their website[120].

- Statistical data about Lithuanian forests and forestry are published in annual reports "**Forest assessment**", annual publications "**Lithuanian Statistical Yearbook of Forestry**", periodical publications of NFI[121] and National forest resources assessment (FRA) reports[122].

- **National Land Service** publishes annual statistical information on all land use categories in Lithuania in publication "Land Fund of the Republic of Lithuania"[123].

Several legal acts were adopted or amended during 2011 – 2012 in order to establish connections between different institutions, providing data for greenhouse gas accounting in LULUCF sector and to increase consistency, completeness and transparency of the methods and approaches used and reported by the country:

- **Resolution on forest land conversion to other land and compensation for converted forest land** / *Government resolution* – regulates human induced conversion of forest land to other land and compensation for lost forest land.

- **Regulation on National forest inventory by sampling method** / *Amendment of the Order of the Minister of Environment* – launches country wise sample based monitoring of all land use and land use changes.

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[119] *Available from: http://www.amvmt.lt*
[120] *Available from: http://www.stat.gov.lt/en/*
[121] *Available from: http://www.amvmt.lt*
[122] *Available from: http://www.fao.org/forestry/fra/en/*
[123] *Available from: http://www.zis.lt/download.php/fileid/73*

- **Harmonised principles for data collection and reporting on LULUCF** / *Order of the Minister of Environment* – sets the main principles for data collection and reporting on LULUCF.
- **Rules for afforestation of non-forest land** / *Amendment of the Minister of Environment and Minister of Agriculture* – determines human induced afforestation/reforestation registration routines**.**
- **Inventory and registration of natural afforestation of non-forest land** / *Order of the Minister of Environment and Minister of Agriculture* – determines natural afforestation/reforestation inventory and assessment routines.
- **Regulation on State Forest Cadastre** / *Amendment of the Government resolution* – sets State Forest Cadastre as the main data provider for KP LULUCF.
- **Harmonized methodology for GHG emissions and removals accounting under LULUCF** / *Order of the Minister of Environment and Minister of Agriculture* – sets the main requirements for data collection and accounting of greenhouse gases emissions and removals under LULUCF**.**

Following the requirements of *Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003*, (*IPCC 2003*) provision of official statistics has been improved substantially, and associated land-use area changes were assessed or is still in progress by the State Forest Service, using unique net of permanent sample plots of NFI:

1) For the period 1990-2011 results are presented using data of the special studies;
2) From 2012 all data concerning land use, land use changes will be based on direct annual field measurements executed by NFI.

Above mentioned data sources that have been used for determination of the total land area and to monitor the changes reported in the previous submissions, were not harmonised between themselves and data presented not always was precise or did not fulfil the requirements of the United Nations Framework Convention on Climate Change (UNFCCC). Most of results were fragmented and did not cover the required 1990-2011 period. Due to different inventory methodologies and land use categories definitions for each inventory, the results did not complied each other. Furthermore, land use definitions used by the statistics, on which basis land area was estimated, did not comply with the *IPCC 2003* (Table 7-5). For instance, meadows and natural pastures were assigned to croplands in national definition, though it comes under grassland category by *IPCC 2003* definition. Therefore, implementing UNFCCC and its Kyoto Protocol requirements in order to comprehensively identify and quantify areas specific to Land Use, Land Use Change and Forestry (LULUCF) activities annually in the period of 1990-2011, two studies were launched. The study "Forest land changes in Lithuania 1990-2011" (*Study-1*) was addressed to recover land use changes specifically to forests and study "Changes of areas of Croplands, Grasslands, Wetlands, Settlements and Other lands in Lithuania during 1990-2011" (*Study-2*) – addressed to track changes of croplands, grasslands, wetlands, settlements and other lands. Thus, by implementing these both studies Lithuania became able to identify land use areas and to monitor their changes for the required time period of 1990 – 2011. The main differences of these two studies comparing with the previous practice was recalculation of all area changes (and construction of yearly land transition matrix) using single data collection instrument – uniform network of NFI (launched in 1998) permanent sample plots and secondly – building all the computations and assumptions on the data, directly collected from the individual plots. Therefore, one of the fundamental outcomes of these two studies was creation of a single and comprehensive database of land use areas in Lithuania (Figure 7-1).

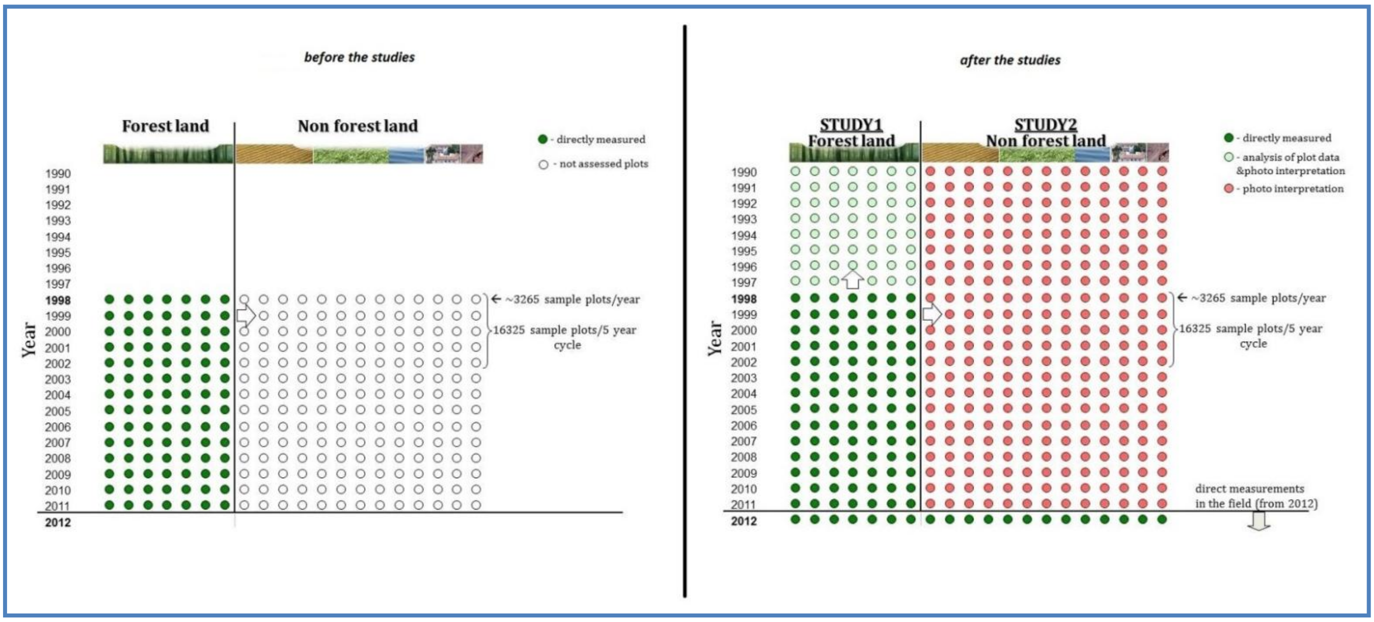

Figure 7-1. Data owned by the Party for the assessment of land-use changes before the studies (NFI data since 1998) and assessment of the land-use changes on NFI sample plots grid with the help of the studies for the period of 1990-2011

Furthermore, with the help of GIS techniques, analysing historical datasets of Lithuanian State Forest Cadastre, aerial photography archives, provided by State Land Fund and other available material, wall-to-wall areas of Afforestation, Reforestation and Deforestation were mapped, identified and classified during the *Study-1*.

According to NLS data total land area in Lithuania is 6530 thous. ha, forest land occupy 32,6%, croplands – 45,8%, grasslands – 7,3%, wetlands – 5,8%, settlements and other land covers 4,8% and 3,8% respectively, for the date 01.01.2012. According to completed *Study-1* and *Study-2* data, total land area is 6530 thous. ha. Forest land occupy 33,3%, croplands – 32,1%, grasslands – 24,1%, wetlands – 5,2%, settlements – 5,1% and other land – 0,2% of the total land area in Lithuania (Figure 7-2).

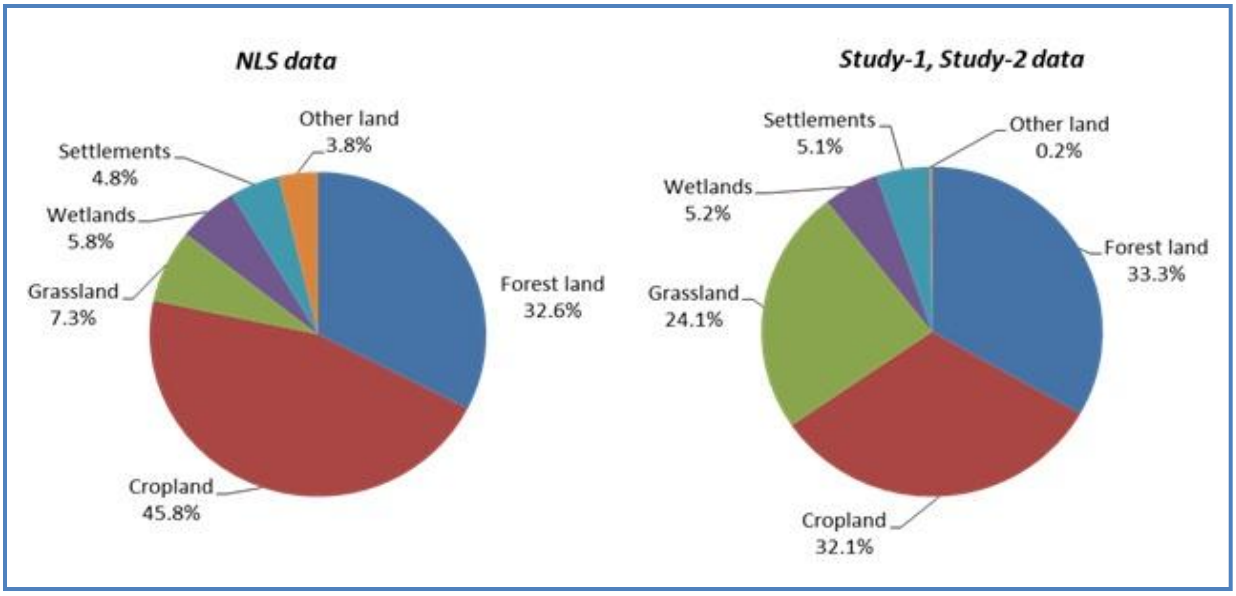

Figure 7-2. Comparison of land-use categories presented by NLS and Study-1, Study-2 data. 01.01.2012

Several emission sources in the LULUCF sector are identified as key categories. They are listed in Table 7-1 (including LULUCF, by Level and Trend assessment).

Table 7-1. Key category from Agriculture in 2011 by Level and Trend

IPCC source categoty	Gas	Identification criteria	Approach used
5.A.1 Forest Land remaining Forest Land	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
5.A.1 Forest Land remaining Forest Land	N_2O	Level	Tier 2
		Trend	-
5.A.2 Land Converted to Forest Land	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
5.B Cropland	CH_4	Level	Tier 1 / Tier 2
		Trend	Tier 2
5.C Grassland	CO_2	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
5.D Wetland	CO_2	Level	Tier 2
		Trend	-

7.1.1 Study "Forest land changes in Lithuania during 1990 – 2011" *(Study-1)*

The *Study-1* was carried out by the team of specialists of Aleksandras Stulginskis University (former Lithuanian University of Agriculture) together with NFI specialists and Lithuanian association of impartial timber scalers leaded by professor G. Mozgeris. The *Study-1* was completed in the middle of April of 2012 and explicit study results are available in the prepared report[124].

[124] *Darbo „Miško žemės plotų kaitos Lietuvoje 1990-2011 m. įvertinimas" ataskaita [en. Study „Estimation of forest land changes in Lithuania during 1990-2011" report] / Lietuvos nepriklausomų medienos matuotojų asociacija, Akademija, Kauno r., 2012. 100 p.*

The *Study-1* was splitted into two parts and was aimed (*a*) to identify annual forest land areas and their changes which occurred in Lithuania during the period of 1990-2011, following the *IPCC 2003* and the requirements of UNFCCC on the unique permanent sample plots grid of National Forest Inventory and (*b*) to achieve the annual wall-to-wall mapping of afforested, reforested and deforested land areas following requirements of the UNFCCC and its Kyoto Protocol (Figure 7-7). Forest land areas and their changes that were identified (annually in 1990-2011):

- forest land remaining forest land areas (FF);
- forest management areas (FM);
- forest land areas converted to forest land less than 20 years ago (LF);
- human induced afforested/reforested areas – where forest was growing before the afforestation for at least 50 years (A1), and where forest was growing before the reforestation for at least 50 years (R1) but ceased to be forest on 31 December 1989 and then converted (afforested/reforested) to forest.
- naturally afforested/reforested areas, where forest was growing before the afforestation for at least 50 years (A2), and where forest was growing before the reforestation for at least 50 years (R2), but ceased to be forest on 31 December 1989 and then converted (afforested/reforested) to forest;
- deforested areas (D).

To have a clear view on the forest land situation 50 years ago, GIS database was developed for storing boundaries of forest land in around 1950's. Orthophotos based on the aerial photographs mainly from 1946-1949 were used as the basic source material. Orthophotos were scanned, geo-referenced and the borders of forest land were manually digitized. The scale of orthophotos was 1:10 000, simultaneously, the developed database was meeting the requirements of mapping at a scale 1:10 000. In that sense, this data base is fully compatible with the geographic database of forest compartments kept at State Forest Cadastre and integrally with existing databases fits for the analysis of forest land area changes. Some gaps with missing orthophotos (mainly for country borderland and city areas) were filled using other map material, compatible in terms of scale, development date and content. Most of such maps were soviet time topographic maps, but there were also German, Polish, US military maps used for some areas. The developed database was crosschecked for any topological errors, like overlapping of polygons, gaps, etc. In addition to forest land, the database includes polygons identified as wooded areas on peat lands, city forests and parks, etc.

Further, annual identification of forest land covers and forest land-uses was carried out on 16325 systematically distributed NFI sample plots, focusing on the period of 1990-2011 and using the definitions of valid versions of Lithuanian Forest Law and *IPCC 2003*. All available auxiliary data sets (such as State Forest Cadastre data, maps from previous stand-wise forest inventories, topographic maps, orthophotos, satellite images, etc.) with the information gathered during direct field visits were used to facilitate the identification of land cover and land-use categories in a long-term. Data captured in National Forest Inventory databases 1998-2011 are used as well. Stand and tree age, and origin of stands, registered in permanent sample plots, combining with cartographical data were the main sources for identification of afforested/reforested stands, especially in the period of 1990-1998, before the original beginning of NFI. All sample plots were manually inspected and the solutions taken were based on the decisions of highly skilled engineers with the forest inventory practice.

To achieve the annual wall-to-wall mapping of forest land areas and detect the changes several types of source material were used: State Forest Cadastre, National Paying Agency's (NPA) information on afforested agricultural, non-agricultural and abandoned land, Lithuanian forest resource database at a scale of 1:50 000, all available country orthophotos that were developed during the analysed period, satellite maps from CORINE, USGS[125], other projects done by the contractors. The main data source used was the geographic data from the State Forest Cadastre. These data sets includes borders of all forest compartments in the country (around 1,3 mill polygons) and are associated with the data describing stand characteristics in the compartment. Age of all stands was updated to fit defined datum-line – the year 2011. Then, the year of forest stand becoming forest, according to definition used in Forest Law was estimated, subtracting the age of stand from 2011 (and adding 10 years for naturally regenerated forests). After, the origin of each compartment identifying whether the forest appeared on forest or other (i.e. non-forest) land was checked, two basic and one additional criteria were used: forest was assumed to be grown on non-forest land if it was attributed in a special attribute field as grown on non-forest land. However, such identification was completely dependent on the content and quality of the previous stand-wise forest inventories and there were numerous forest compartments, actually grown on non-forest land, omitted. Therefore, special spatial overlay and selection techniques were developed and applied to identify forests, that are currently available but were missing 50 years ago (according to developed database referring to 1950's). In case of failure ancillary solution how to identify afforestation/reforestation was determined. It was intended to use stand attribute from stand register and posit that forest compartment was first time inventoried during the last stand-wise forest inventory. However, such approach faced some limitations while reflecting newly established forests, as the SFC data was based on the information originating from stand-wise forest inventory. Stand-wise forest inventories in Lithuania are carried-out on a 10-years cycle base, thus, there were some regions with quite outdated information on the compartments and missing stands boundaries, established already after the stand-wise inventory. Several solutions were used to fill such gaps of information. First, information from the recent stand-wise forest inventories was acquired from forest inventory contractors, which had not been officially delivered to the SFS. Next, all non-forest compartments stored in the SFC database were checked for the records on potentially established forests there. Simultaneously, State forest enterprises were asked to confirm the facts on newly established forests. And, finally, data from National Paying Agency was acquired to represent the borders of afforested areas that were applied for EU subsidies. Special geo-processing technique was developed to eliminate overlapping in space and time of afforested/reforested areas, resulted by repeated identification of considered areas in independent input data sets.

The decision, whether the forest stand detected growing on non-forest land was either afforested or reforested, was taken based on simple spatial queries – verifying presence or absence of the forest land at the certain area in 1950's.

Several techniques were used to detect deforested areas during the last two decades. First off all, deforestation accounted in the SFC has been taken into account. Recent non-forest land areas, identified as forest stand during the previous forest inventories were candidates to be assigned to the deforestation category. Next, there were some records in the SFC attributed to officially registered deforestation category. And, finally, deforestation was manually mapped using available GIS, orthophotos and satellite images data. It was assumed, that the GIS database of

[125] *Available from: http://earthexplorer.usgs.gov/*

Lithuanian forest resources at a scale of 1:50 000 developed in 1998-1999 represents the year 1990 as it was based on SPOT satellite images from around 1990-1992 and stand-wise forest inventory maps compiled before 1991. The accuracy of forest cover identification in that database was confirmed by the NFI to be around 95%. Thus, the differences between the forest covers in the GIS database of Lithuanian forest resources at a scale of 1:50 000 and State Forest Cadastre were reasoned by the imperfections of the first data set or the deforestation. All such areas were visually checked and all deforestations were identified using orthophotos available for Lithuania (referring to 4 dates in the period from 1990).

GIS database was developed for storing forest land-use polygons, distributed by feature classes, representing forest land remaining forest land (F1), forest land remaining forest land, but where forest appeared less than 20 years ago (F2), human induced afforestation (A1), natural afforestation (A2), human induced reforestation (R1), natural reforestation (R2) and deforestation (D). Such feature classes were created to represent each year in the period of 1990-2011.

The *Study-1* (with *Study-2*) report contains an annual forest land-use change table (*matrix*, Table 7-2) for the period 1990-2011 which fits the requirements of *IPCC 2003*. The *Study-1* also resulted in enhancement of forest inventory, introducing mandatory registration of all forest compartments fitting the afforestation/reforestation requirements of *IPCC 2003*, and the development of GIS based forest cadastre information system following the principles of continuous forest management.

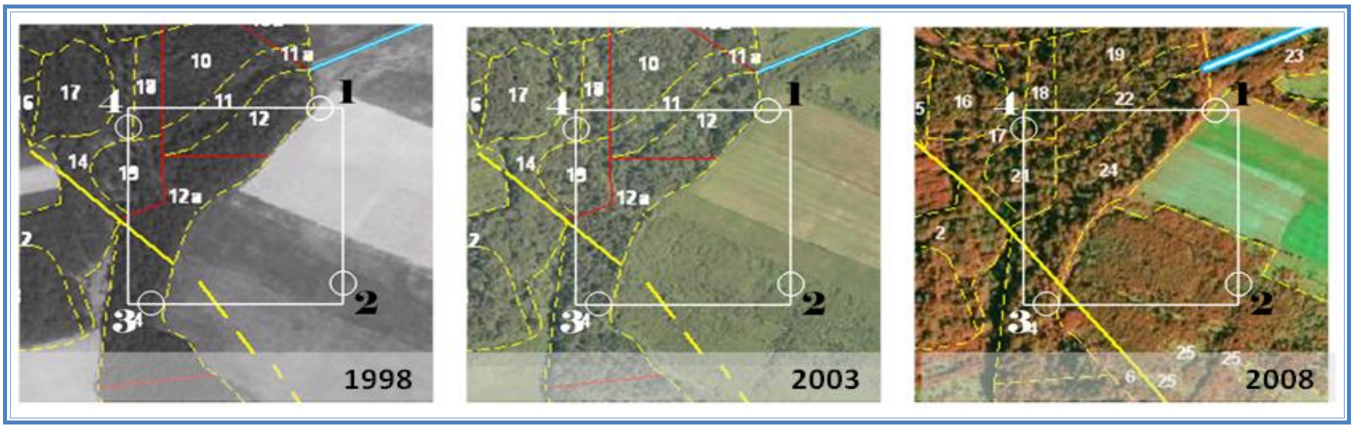

Figure 7-3. Land use changes according to NFI data

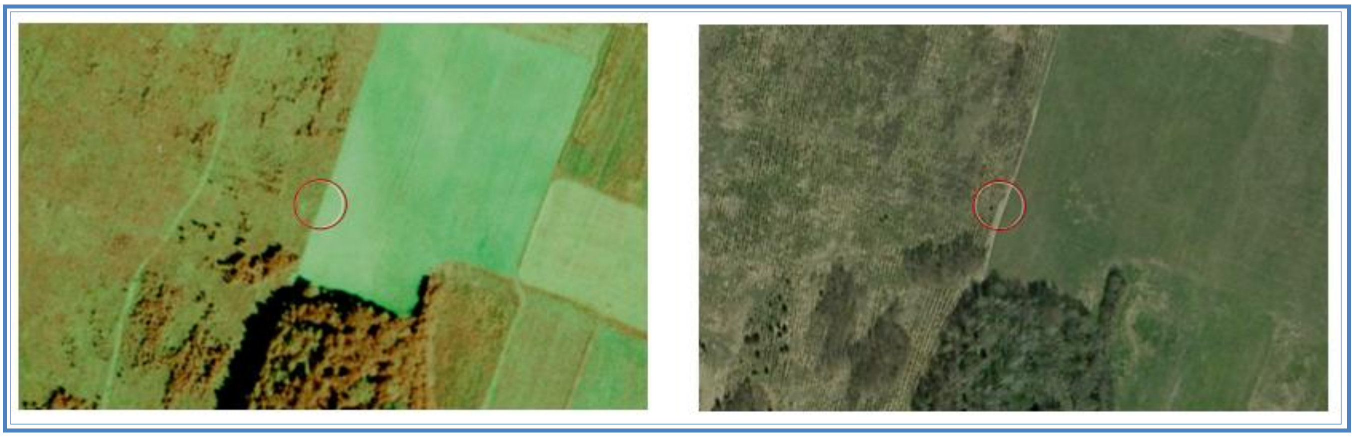

Figure 7-4. Grassland converted to Forest Land

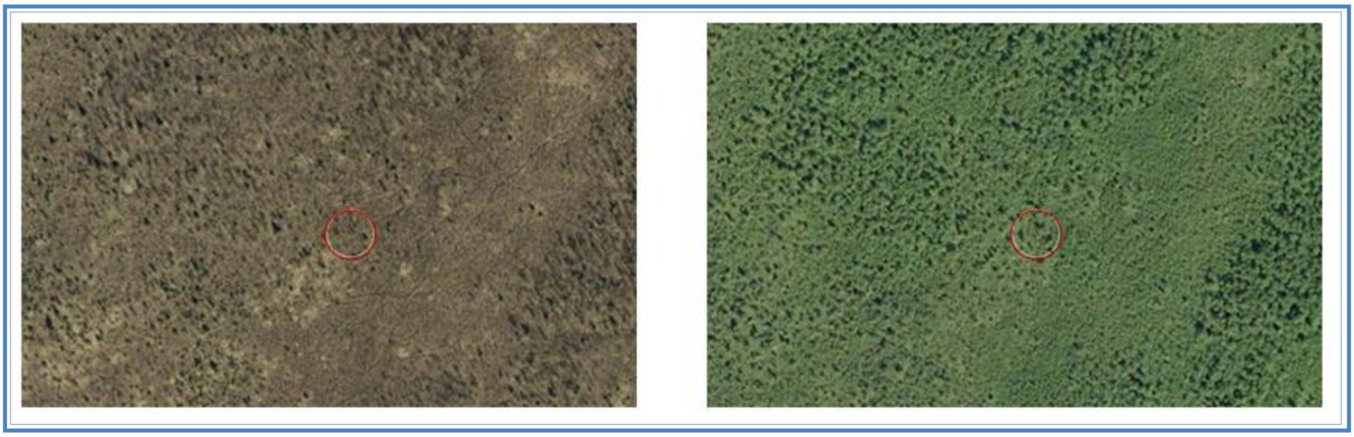

Figure 7-5. Wetland converted to Forest Land

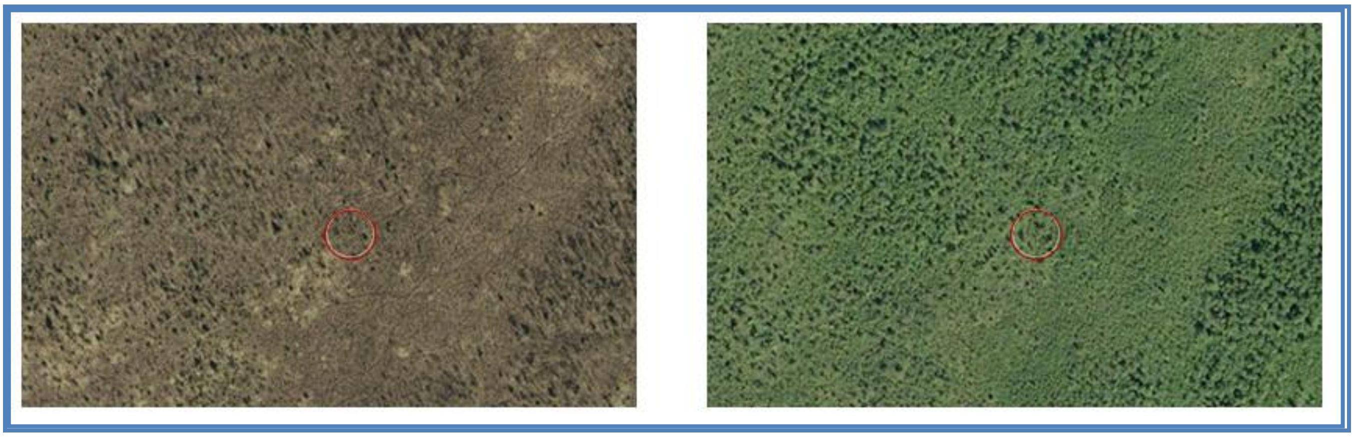

Figure 7-4. Wetland converted to Forest Land

7.1.2 Study "Changes of areas of Croplands, Grasslands, Wetlands, Settlements and Other lands in Lithuania during 1990-2011" (*Study-2*)

The *Study-2* was carried out by the specialists of State Land Fund. The study was completed in the end of April 2012.

It was aimed to identify annual Croplands, Grasslands, Wetlands, Settlements and Other land areas and the changes which occurred in Lithuania during the period of 1990-2011, following the requirements of *IPCC 2003*.
Annual identification of different land categories was carried out on 16325 systematically distributed sample plots available from Lithuanian National Forest Inventory focusing on the period of 1990-2011. Land use changes were identified analysing all available historical data on land uses in statistical and graphical form as well as assessing historical data collection methods. The following actions were performed:

- analysis of data sources and land use data collection;
- identification of land areas on sample plots;
- compilation of sample plots databases;
- analyses of Croplands, Grasslands, Wetlands, Settlements and Other lands statistical data;
- justification of research methodology and harmonization of applied methods.

The main data sources that were used: land areas analogical inventory plans of 1990; 1995 – 1998, 2005 – 2006, 2009 – 2010 digital orthophotomaps S 1:10 000 (ORT10LT), Lithuanian Land Fund statistical data, declaration database of land areas and croplands.
Land areas and their changes were assessed based on National Forest Inventory sample plots grid and statistical data provided by Land Fund together with digital orthophotomaps, satellite images and declarations database of land areas and croplands. In depth analysis was executed on approximately 11 thous. systematically distributed permanent sample plots falling on non-forest land.

In the course of analysis (with *Study-1*) land-use change matrix (annual change of areas of Croplands, Grasslands, Wetlands, Settlements and Other lands) in Lithuania during 1990-2011 was prepared (Table 7-2). Proposals on land use definitions harmonization used in 1990-2011 and the development of the harmonized methodology for the data evaluation and estimation of removals and emissions for LULUCF sector according to the UNFCCC requirements was elaborated.

Identification of land use categories using different available historical material is presented in Figure 7-6. The same tract of sample plots is depicted in every photo but in different time periods and was assessed by SLF specialists.

Data sources	NFI permanent plots			
	1	2	3	4
	Land use categories			
Land use plan, 1990	S	CL	GL	CL
Orthophoto map, 1995	S	CL	GL	CL
Orthophoto map, 2005	S	CL	GL	GL
Orthophoto map, 2009	S	CL	CL	GL
Land declaration database, 2010	S	CL	CL	GL

Figure 7-6. Identification of land use changes according to NFI permanent sample plots and cartographical data: a - land use plan, 1990; b, c and d - orthophoto maps 1995, 2005, 2009; e – map according to land declaration database, 2010

The study resulted in the following outputs (on annual bases for the period of 1990-2011):

- area calculations made and land use change matrix prepared (with *Study-1*);
- annual change of Croplands, Grasslands, Wetlands, Settlements and Other lands areas identified;
- report, showing considered land unit changes prepared;
- proposals on land use definitions harmonization and development of the harmonized methodology for the data evaluation and estimation of removals and emissions for LULUCF sector according to the UNFCCC requirements elaborated[126].

As the result of *Study-1* and *Study-2* which are based on point sampling method (NFI permanent sample plots) land transition matrix was compiled for each year for the period of 1990-2011 (Table 7-2; Annex VI).

Table 7-2. Yearly land transition matrix for 2011, ha (01.01.2011 - 01.01.2012)

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2166415	1997	4793	0	0	0	**2173205**	6790
Cropland	0	2076547	13979	0	0	0	**2090527**	5592
Grassland	0	6391	1560905	399	0	0	**1567695**	-11983
Wetlands	0	0	0	343096	0	0	**343096**	-399
Settlements	0	0	0	0	341897	0	**341897**	0
Other land	0	0	0	0	0	13580	**13580**	0
Initial	***2166415***	***2084935***	***1579678***	***343495***	***341897***	***13580***	***6530000***	0

The summary of the carbon stock change and GHG emissions/removals reported under the LULUCF sector is presented in Table 7-3.

Table 7-3. Reported emissions/removals and calculation methods for LULUCF sector

CRF category	Stock change reported	Emission / removal reported	Methods / Tiers used
5.A	carbon/CO_2	CO_2; N_2O; CH_4	*T1; T2*
5.B	carbon/CO_2	CO_2; N_2O; CH_4	*T1*
5.C	carbon/CO_2	CO_2; N_2O; CH_4	*T1*
5.D	carbon/CO_2	CO_2,	*T1*
5.E	carbon/CO_2	CO_2,	*T1*
5.F	carbon/CO_2	CO_2,	*T1*

Reconciliation of the executed studies

Both studies were launched in order to recover land use data until 1990, required by UNFCCC (*Study-2*), and to meet the requirements for the land identification under the Articles 3.3 and 3.4 of the Kyoto Protocol (*Study-1*). This was done considering available data since 1998, based on Lithuanian National Forest Inventory, which has been started at that time, and lacking data for the period of 1990-1997 as it is required by UNFCCC and Kyoto Protocol for GHG reporting.

[126] *Harmonized methodology for data collection and estimations of emissions and removals of greenhouse gases from LULUCF has been approved by the order of the Ministers of Environment and Agriculture, Nr. D1-819/3D-790 on 2012.10.09.*

Initially annual land use and land-use changes identification, which was done on sample plots basis, is a single study divided into two parts seeking to speed up and increase the quality of plots assignment to different land use categories. Connecting element for both studies was uniform National Forest Inventory sample plots grid covering all Lithuanian territory. NFI sample plots network was used as a basis for data collection on land use and land-use changes.

The analysis of NFI sample plots could be divided into three steps that were taken by qualified experts. First of all, recorded data on sample plots of NFI 1998 has been considered, such as stand characteristics (age, retrieved from tree borings etc.), site description, records on previous land use before the establishment of sample plot etc. Secondly, analysis of all available orthophoto maps and data from State Forest Cadastre for the unknown period (1990-1997) has been carried out. This was done trying to trace the exact moment in time when minimal characteristics of forest, as it is required by Law on Forests, were reached. Lastly, analysis of archive land planning maps and SFI material was implemented with the aim to identify and to synchronize land use categories with the recorded sample plot data. This analysis of plots, identified on Forest land (~6000) was carried out by State Forest Service together with Aleksandras Stulginskis University and all other plots (~10000) – by Lithuanian Land Fund. After the completion of assignment of all plots available on Lithuanian territory (16325) to different land use categories (*FL, CL, GL, WL, SL, OL*) by years (1990, 1991, … 2011), final decisions and required calculations were done by State Forest Service. Any overlaps were eliminated allowing only one answer (assignment to any land use category) for each plot for each year during the data processing.

The visual comparability of both studies is represented in Figure 7-7.

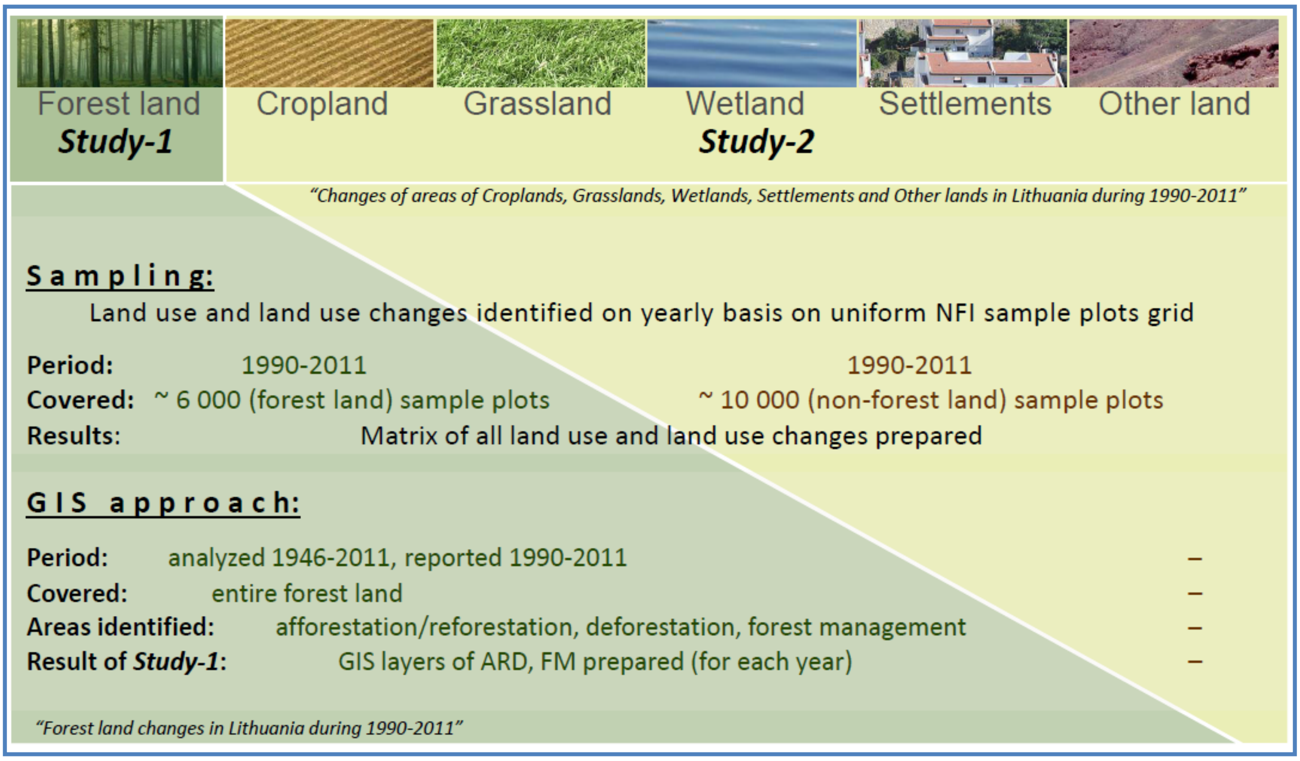

Figure 7-7. Studies on land use changes in 1990-2011

Accomplished studies presented required data for the time period of 1990-2011 according to UNFCCC and its Kyoto Protocol requirements. It also encouraged adopting relevant legislation (legal acts were adopted in 2011-2012, see *Chapter 7.1*), setting the rules, and also obliging, forest owners and managers to register newly afforested, reforested and deforested areas to State Forest Cadastre, which will serve as the main data provider for ARD areas identification reported under the Kyoto Protocol starting with 2012.

7.1.3 National definitions for all categories used in the inventory

The land areas used in the inventory are consistent with those defined in *IPCC 2003*. The national classification of land-use areas was adjusted to the requirements of *IPCC 2003*. However, some of the national definitions of land-use areas are broader than those required by *Good Practice Guidance* so they were merged (Table 7-5).

Forest land is defined according to Law on Forests of the Republic of Lithuania[127]: "Forest – a land area not less than 0,1 hectare in size covered with trees, the height of which in a natural site in the mature age is not less than 5 meters, other forest plants as well as thinned or vegetation-lost forest due to the acts of nature or human activities (cutting areas, burnt areas, clearings). Tree lines up to 10 meters of width in fields, at roadsides, water bodies, in living areas and cemeteries or planted at the railways protection zones as well as single trees and bushes, parks planted and grown by man in urban and rural areas are not defined as forests. The procedures for care, protection and use of these plantings shall be established by the Ministry of Environment." Forest stands with stocking level (approximately equivalent to crown cover) less than 30% are not acceptable for high productivity forestry. This threshold is used when including land areas into afforested land areas (Table 7-4).

Table 7-4. Selected parameters defining forest in Lithuania for reporting under LULUCF

Parameter	Value
Minimum land area	0,1 ha
Minimum crown cover	30 %
Minimum height at mature age	5 m

Cropland. The area of cropland comprises of the area under arable crops as well as orchards and berry plantations. According to national definitions - arable land is continuously managed or temporary unmanaged land, used and suitable to use for cultivation of agricultural crops, also fallows, inspects, plastic cover greenhouses, strawberry and raspberry plantations, areas for production of flowers and decorative plants. Arable land set at rest for one or several years (<5 years) before being cultivated again as part of an annual crop-pasture rotation is still included under cropland. Orchards and berry plantations are areas planted with fruit trees and fruit bushes (apple-trees, pear-trees, plum-trees, cherry-trees, currants, gooseberry, quince and others). Under this category only those orchards and berry plantations are included that are planted on other than household purpose land and mainly used for commercial purposes. Orchards and berry plantations planted in small size household areas and only used for householders' meanings are included under *Settlements* category. All croplands are managed land.

Grassland. Grassland includes meadows and natural pastures planted with perennial grasses or naturally developed, on a regular basis used for moving and grazing. Grasslands cultivated for less than 5 years, in order to increase ground vegetation, still remain grasslands. All grasslands are managed land.

[127] *Available from: http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=437404&p_query=&p_tr2=2*

<u>Wetlands.</u> Wetlands include peat extraction areas and peatlands which do not fulfil the definition of other categories. Water bodies and swamps (bogs) are also included under this category. Peat extraction areas are considered as managed land.

<u>Settlements.</u> All urban territories, power lines, traffic lines and roads are included under this category as well as orchards and berry plantations planted in small size household areas and only used for householders' meanings. Only the areas of settlements remaining settlements and lands converted to settlements are reported. Settlements are managed land.

<u>Other land.</u> All other land which is not assigned to any other category such as quarries, sand - dunes and rocky areas is defined as *Other land*. Only area of other land is reported.

Table 7-5. National definitions for land use categories and relevant land use category defined in IPCC 2003

<table>
<tr><th colspan="11">National definitions for land use categories and subcategories</th></tr>
<tr><th colspan="3">Agricultural land</th><th rowspan="2">Forest land</th><th rowspan="2">Roads</th><th rowspan="2">Settlements</th><th rowspan="2">Water bodies</th><th colspan="4">Other land</th></tr>
<tr><th>Arable land</th><th>Orchards and berry plantations</th><th>Meadows and natural pastures</th><th>Swamps (bogs)</th><th>Trees and bushes plantations in urban areas</th><th>Disturbed land</th><th>Unmanaged land</th></tr>
<tr><th colspan="11">Relevant category in IPCC 2003</th></tr>
<tr><td colspan="2">Cropland</td><td>Grassland</td><td>Forest land</td><td colspan="2">Settlements</td><td colspan="2">Wetlands</td><td>Settlements</td><td colspan="2">Other land</td></tr>
</table>

Information on extension of unmanaged forest and grassland

According to the Annex to draft decision -/CMP.1 (Land use, Land-use Change and Forestry) contained in document FCCC/CP/2001/13/Add.1 definitions of forest management and grazing land management are the following:

Forest management is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner.

Grazing land management is a system of practices on land used for livestock production aimed at manipulating the amount and type of vegetation and livestock produced.
In accordance with these definitions, all forest land and grassland in Lithuania is managed and there is no unmanaged forest land or grassland.

7.1.4 Land use changes

Forest coverage in Lithuania remains continuously increasing during the last decades (Figure 7-9). Natural and human induced afforestation increased forest land area by 111,8 thous. ha since 1990 (Table 7-7). Comparing with 1946, forest area increased more than one third and in some counties forest expansion almost doubled.

Declared croplands area in Lithuania was decreasing since 1990 to 2005. This is closely connected with Lithuanian history. Significant reforms were introduced in the early 90's, particularly after the restoration of independence with the purpose of re-establishment of private ownership and management in the agriculture sector. The legislations were adopted for dismemberment of the collective farms, but they did not ensure their replacement by at least equally productive private farms or corporations. Agricultural production decreased by more than 50% from 1989 to 1994. The farms were broken into small holdings, averaging 8,8 ha in size, often not large enough to be economically viable. Area of grasslands prevailed.

Croplands and Grasslands area has changed dramatically in Lithuania since 2005. This is the result of introduced Single Area Payment Scheme (SAPS) since 2004. SAPS is a form of support whereby direct payment is made for agricultural land irrespective of the type of production carried out on the land, and this might be one of the reasons of decrease in grasslands area. Furthermore, in 2004 when Lithuania became the member of EU, communities Structural Funds became available. In order to use funding from EU Structural Funds efficiently, the Single Programming Document (SPD) of Lithuania for 2004–2006 was prepared. The strategy provided in the SPD was divided into priorities and implemented on the basis of one or several measures. Support for Rural and Fisheries development was provided under the measures of the 4^{th} SPD priority. The main objective of the Rural and Fisheries Development priority is to develop an advanced agriculture, forestry, and fishery sector on the basis of natural resources and the traditions of inhabitants and by investing in alternative activities, traditional farming, and economic diversification. This support is a non-repayable grant of between 45% and 100% of eligible expenses. In 2004–2006, 191 million EUR was allocated to implement the measures of the Rural and Fisheries Development priority. According to the support contracts signed, the largest amount of funding (95 million EUR) was allocated to beneficiaries who submitted applications for the measure named "Investments into Agricultural Holdings". Both these measures resulted in people take up in agricultural land management, hence increment in croplands and decrease in grasslands that were ploughed for agricultural purposes.

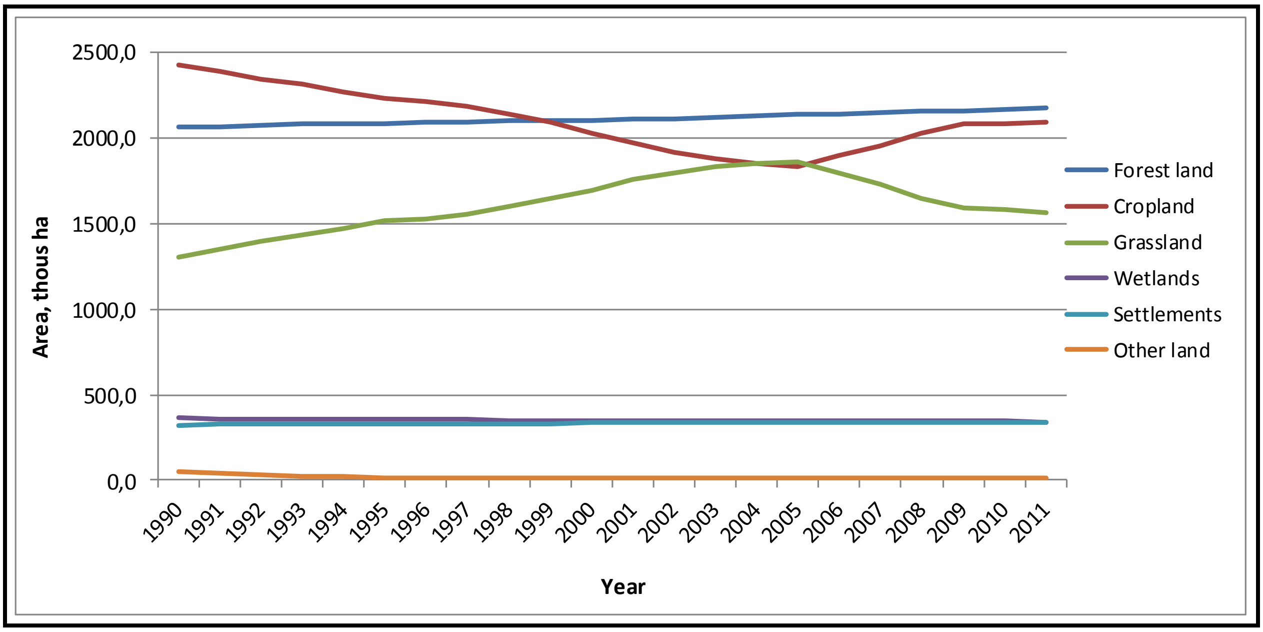

Figure 7-8. Land use changes

Table 7-6. National land use data for 1990-2011, thous. ha[128]

Years	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	TOTAL
1990	2061,4	2426,0	1307,7	363,1	324,3	47,5	6530
1991	2068,6	2386,5	1350,0	357,9	325,5	41,5	6530
1992	2074,5	2346,6	1392,0	356,3	327,1	33,6	6530
1993	2079,7	2311,0	1431,5	354,7	325,9	27,2	6530
1994	2082,5	2269,5	1473,0	354,7	329,1	21,2	6530
1995	2084,9	2233,1	1513,4	354,7	328,7	15,2	6530
1996	2090,1	2215,9	1527,4	352,7	327,5	15,2	6530
1997	2093,7	2183,6	1555,7	352,7	329,1	15,2	6530
1998	2097,3	2134,5	1600,4	352,3	330,3	15,2	6530
1999	2100,1	2088,5	1643,2	351,5	331,5	15,2	6530
2000	2105,7	2029,4	1697,1	348,7	334,3	14,8	6530
2001	2108,9	1967,5	1755,8	348,3	335,1	14,4	6530
2002	2113,3	1918,8	1799,4	349,1	335,9	13,6	6530
2003	2118,9	1876,8	1836,5	348,3	335,9	13,6	6530
2004	2126,9	1854,9	1850,9	347,9	336,3	13,2	6530
2005	2134,9	1835,3	1862,5	347,1	337,9	12,4	6530
2006	2142,1	1893,2	1796,2	345,5	339,9	13,2	6530
2007	2150,4	1952,7	1729,5	343,9	340,7	12,8	6530
2008	2157,2	2026,6	1647,2	343,9	341,5	13,6	6530
2009	2160,0	2080,5	1589,3	344,7	341,9	13,6	6530
2010	2166,4	2084,9	1579,7	343,5	341,9	13,6	6530
2011	2173,2	2090,5	1567,7	343,1	341,9	13,6	6530

Table 7-7. Land use changes between 1990 and 2011

Land use	1990	2011	LUC	Activity data provider
	thous. ha			
Forest Land (FL)	2061,4	2173,2	111,8	*Study-1*
Cropland (CL)	2426,0	2090,5	-335,5	*Study-2*
Grassland (GL)	1307,7	1579,7	260,0	*Study-2*
Wetland (WL)	363,1	343,1	-20,0	*Study-2*
Settlements (SL)	324,3	341,9	17,6	*Study-2*
Other Land (OL)	47,5	13,6	-33,9	*Study-2*

7.1.5 GHG sinks and releases

Annual CO_2 emissions and removals for the period 1990-2011 are provided in Table 7-8 (evaluated net CO_2 emissions and removals in LULUCF sector). LULUCF sector in Lithuania has continuously been CO_2 sink with the only emission of 1776,0 GgCO_2 in 1996 and 157,6 GgCO_2 in 1997. Removals were ranging from -3429,1 GgCO_2 to -12771,4 GgCO_2 during the accounting period. In average -6228,3 GgCO_2 are removed every year. Removal of CO_2 mainly corresponds to forest land. Changes in emissions/removals from cropland and grassland comparing with 2011 submission have been caused by new land categories estimations provided by National Land Fund after

[128] *Data used: Forest Land – Study-1; Cropland, Grassland, Wetland, Settlement, Other Land – Study-2.*

finalization of *Study-2* "Croplands, Grasslands, Wetlands, Settlements and Other land area changes in Lithuania during 1990-2011".

Table 7-8. Evaluated CO_2 emissions and removals in LULUCF sector, Gg

Year	Forest land	Croplands	Grasslands	Wetlands	Settlements	Other land	TOTAL
1990	-7819,5	5772,1	-2362,4	72,7	NE,NO	NE,NO	-4337,0
1991	-7757,3	5211,8	-2531,3	72,7	749,1	NE,NO	-4255,0
1992	-7622,6	5042,9	-2699,4	72,7	774,1	209,9	-4222,3
1993	-8219,2	4855,2	-2837,7	63,3	354,6	209,9	-5573,9
1994	-7672,3	4682,0	-3057,7	75,3	1313,9	248,4	-4410,4
1995	-5476,5	4494,0	-3151,0	74,9	524,6	104,8	-3429,1
1996	372,8	4326,4	-2997,8	74,7	NE,NO	NE,NO	1776,0
1997	-1063,4	4211,9	-3307,4	67,1	249,5	NE,NO	157,6
1998	-8437,6	4052,2	-3751,0	68,0	249,5	104,8	-7714,1
1999	-8239,6	3891,0	-4017,9	211,1	394,5	NE,NO	-7760,9
2000	-9617,5	3619,6	-4333,6	71,1	959,0	NE,NO	-9301,4
2001	-11970,0	3199,6	-4565,8	71,4	249,5	243,9	-12771,4
2002	-4036,0	3046,2	-4678,1	58,2	209,9	NE,NO	-5399,9
2003	-8243,5	2661,1	-4699,2	194,3	144,7	139,1	-9803,6
2004	-4836,2	2575,6	-4690,9	197,4	104,8	NE,NO	-6649,3
2005	-3065,6	2449,9	-4687,9	55,8	458,8	NE,NO	-4789,1
2006	-4639,5	3147,1	-4370,4	57,6	723,9	283,6	-4797,7
2007	-3196,5	3346,4	-4067,7	56,5	289,7	NE,NO	-3571,6
2008	-9295,3	3792,3	-3734,5	56,1	394,5	278,5	-8508,4
2009	-11868,2	3953,3	-3441,6	126,7	394,5	139,1	-10696,2
2010	-10854,5	3669,4	-3308,6	56,5	NE,NO	NE,NO	-10437,3
2011	-11143,8	3700,0	-3138,9	55,6	NE,NO	NE,NO	-10527,0

7.2 Forest land (CRF 5.A)

The definition of forest used in this submission is described in chapter 7.1.3 and is as following: land area not less than 0,1 hectare in size covered with trees, the height of which in a natural site in the mature age is not less than 5 meters, other forest plants as well as thinned or vegetation – lost forest due to the acts of nature or human activities (cutting areas, burnt areas, clearings). Tree lines up to 10 meters of width in fields, at roadsides, water bodies, in living areas and cemeteries or planted at the railways protection zones as well as single trees and bushes, parks planted and grown by man in urban and rural areas are not defined as forests. All forest land is considered as managed.

7.2.1 Source category description

Forest land area

Forest coverage in Lithuania was expanding continuously since 1948 (Figure **Klaida! Nerastas nuorodos šaltinis.**7-9). However data on forest coverage in Lithuania during inter-war period is very limited and the exact numbers are still unknown.

Expert judgement made by the authors of "The Chronicle of Lithuanian Forests. XX Century"[129] allows us to presume forest coverage to be around 21 percent in 1938, even though some authors argue that only small part of heavily afforested areas of Vilnius region (south-eastern part of Lithuania) were included into this number at that time, and some 150 thous. ha could be unaccounted.

The lowest forest coverage has been accounted during the II World War and tough occupation period, because no forest preservation policy has existed at that time.

During the times when Lithuania was belonging to Soviet Union, forest accounting was rather thorough – unfortunately only in State owned forests. Forests belonging to "kolkhozes" and being less than 10 ha were disregarded as well as those belonging to small farms and being less than 1 ha in size.

After restoration of independency in 1991, there were no legal obstacles for implementation of forest accounting. However, the land reform has been also started at that time, so the State Forest Inventory (SFI) has been suspended or even discontinued. In 1996, when the new cycle of SFI has been started there were founded numerous areas of naturally afforested areas that were missing in the previous inventories or in State land accounting related documents.

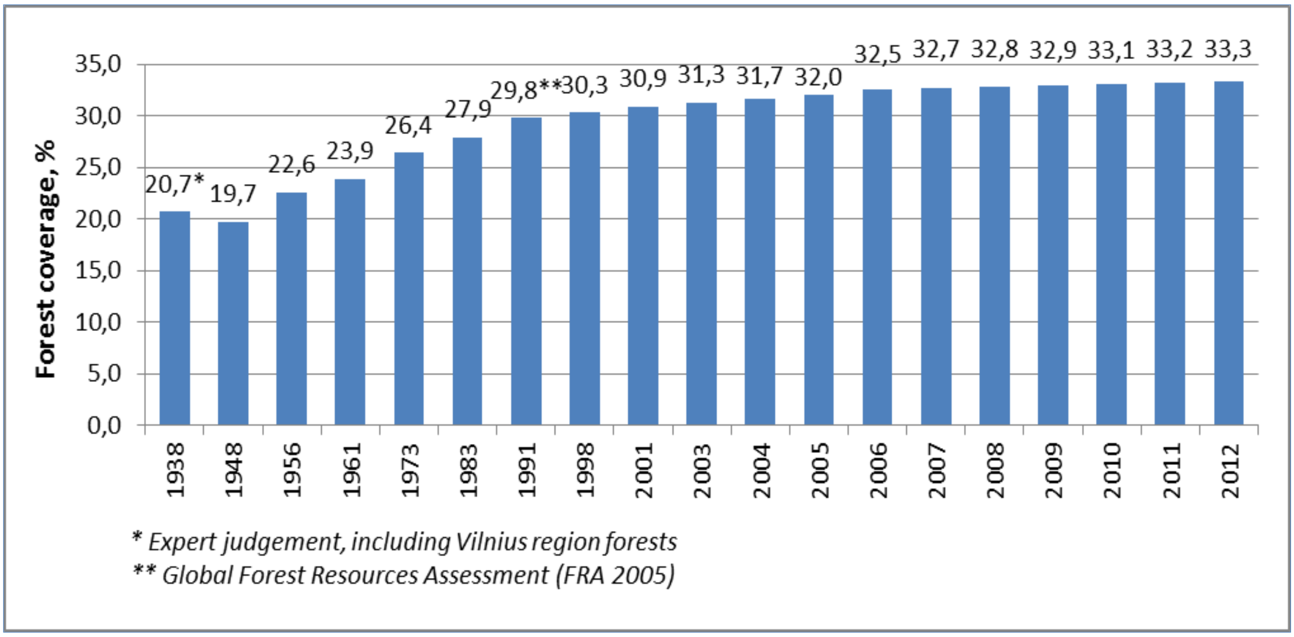

Figure 7-9. Forest coverage 1988-2012

According to the Lithuanian Statistical Yearbook of Forestry by 1st of January 2012, total forest land area was 2173,0 thous. ha, covering 33,3% of the country's territory. The average forest area per capita increased from 0,57 ha to 0,68 ha. Around half of all forest land in Lithuania is of State importance – 1076,5 thous. ha. 810,3 thous. ha of private forests are registered at the State enterprise Centre of Registers. After intersection of layers of all forests and private holdings the estimated area of private forests was slightly readjusted to 844,5 thous. ha. Since the 1st of January 2003, the forest land area has increased by 128,0 thous. ha corresponding to 2,0% of the total forest cover. During the same period, forest stands expanded by 104,0 thous. ha to 2055,0 thous. ha. Average annual increase in forest area is more than 5 thous. ha. Following prior official

[129] *Lietuvos Respublikos Aplinkos Ministerija, Miškų departamentas. Lietuvos miškų metraštis. XX amžius. Vilnius, 2003*

data of Forest Assessment[130] annual increase was more than 10 thous. ha. Huge difference in forest coverage is explained by insufficient data previously used by Forest Assessment. The up-to-date Forest Assessment that is based on data of State Forest Cadastre shows the same forest coverage as the National Forest Inventory, which is based on permanent sample plots data (Figure 7-10).

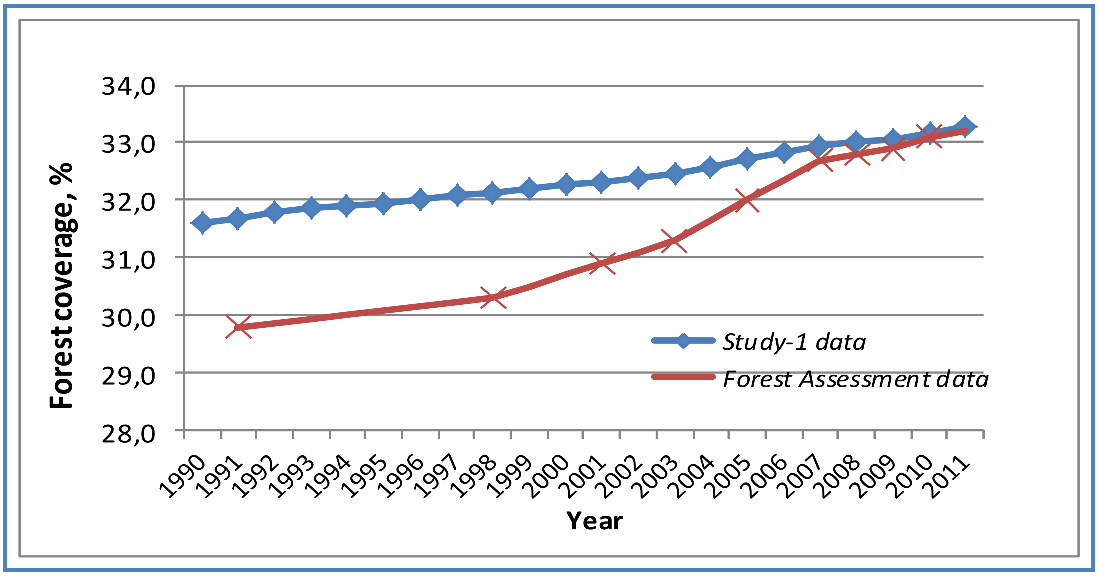

Figure 7-10. Changes in forest coverage in Lithuania 1990-2011[131]

All Lithuanian forests are distributed into four functional groups. In the beginning of 2012, distribution of forests by functional groups was as follows: group I (strict nature reserves): 26,3 thous. ha (1,2%); group II (ecosystems protection and recreational forests): 266,8 thous. ha (12,3%); group III (protective forests): 331,2 thous. ha (15,2%); and group IV (exploitable forests): 1548,6 thous. ha (71,3%) (Figure 7-11).

[130] *Kuliešis, A., Vižlenskas, D., Butkus, A. et al. 2010. Forest Assessment. State Forest Service.*
[131] *Data from Study-1* and *Forest Assessment (2010).*

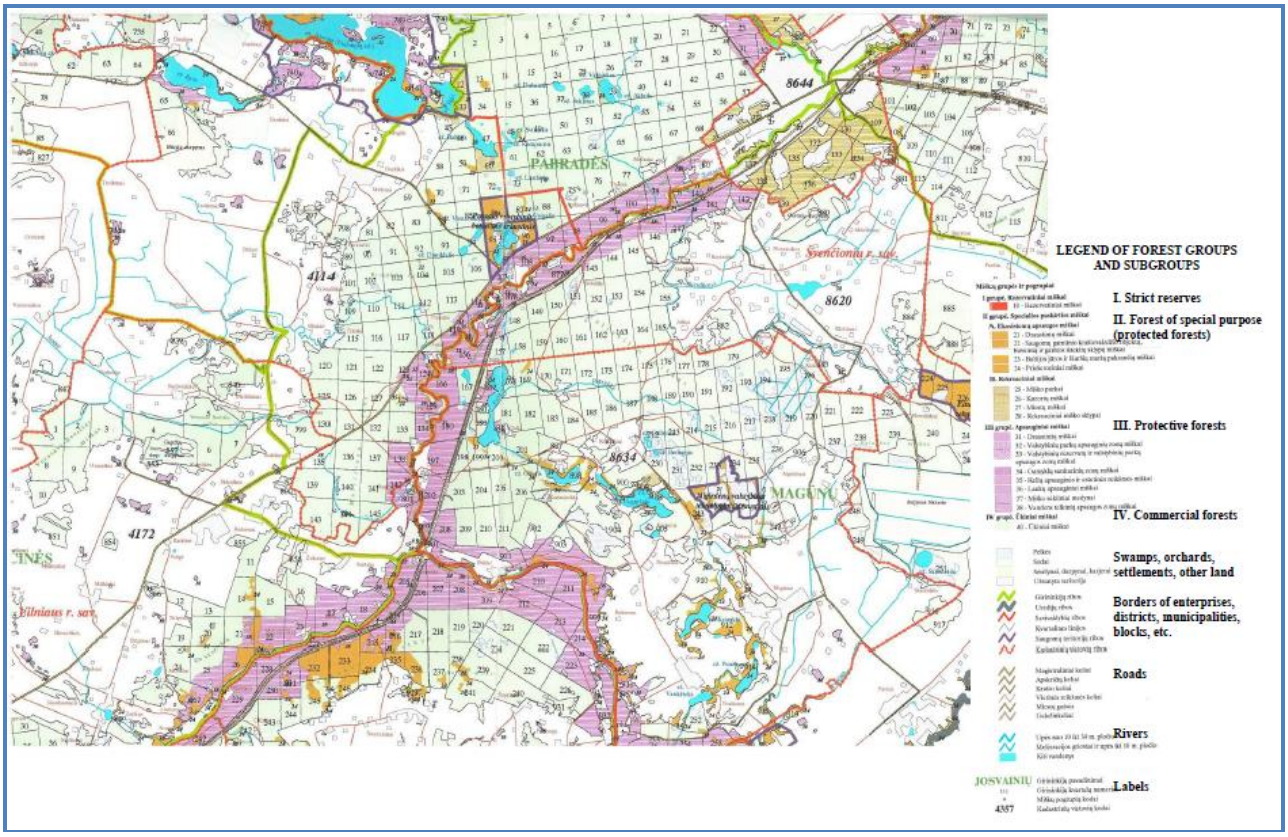

Figure 7-11. Scheme of forest distinguished by forest groups

Occupying 1153,2 thous. ha, coniferous stands prevail in Lithuania, covering 56,1% of the forest area (Figure 7-12). They are followed by softwood deciduous forests (818,5 thous. ha, 39,8%). Hardwood deciduous forests occupy 83,8 thous. ha (4,1%). Over the last nine years total area of softwood deciduous forests increased by 120,1 thous. ha. The area of hardwood deciduous has decreased by 8,8 thous. ha and coniferous forest by 6,8 thous. ha. Scots pine (*Pinus sylvestris*) occupies the biggest share in Lithuanian forests – 722,2 thous. ha. Compared to 2003, the area of pine expanded by 10,7 ha. Norway spruce (*Picea abies*) covers 428,4 thous. ha, with a reduction of 16,9 thous. ha. Birch (*Betula pendula)* covers the largest area among deciduous trees. Since 2003, it has increased by 66,6 thous. ha and reached 458,8 thous. ha by 2012. Area of Black alder (*Alnus glutinosa*) increased by 22,5 thous. ha to the total of 141,9 thous. ha. The area of grey alder (*Alnus incana*) expanded by 6,5 thous. ha i.e. less than the black alder, reaching 128,5 thous. ha. The area of aspen (*Populus tremula*) stands expanded by 20,9 thous. to 78,2 thous. ha. Oak (*Quercus robur*) forests increased from 35,7 thous. ha to 41,9 thous. ha. The area of ash (*Fraxinus excelsior*) stands diminished by 30% to 35,7 thous. ha.

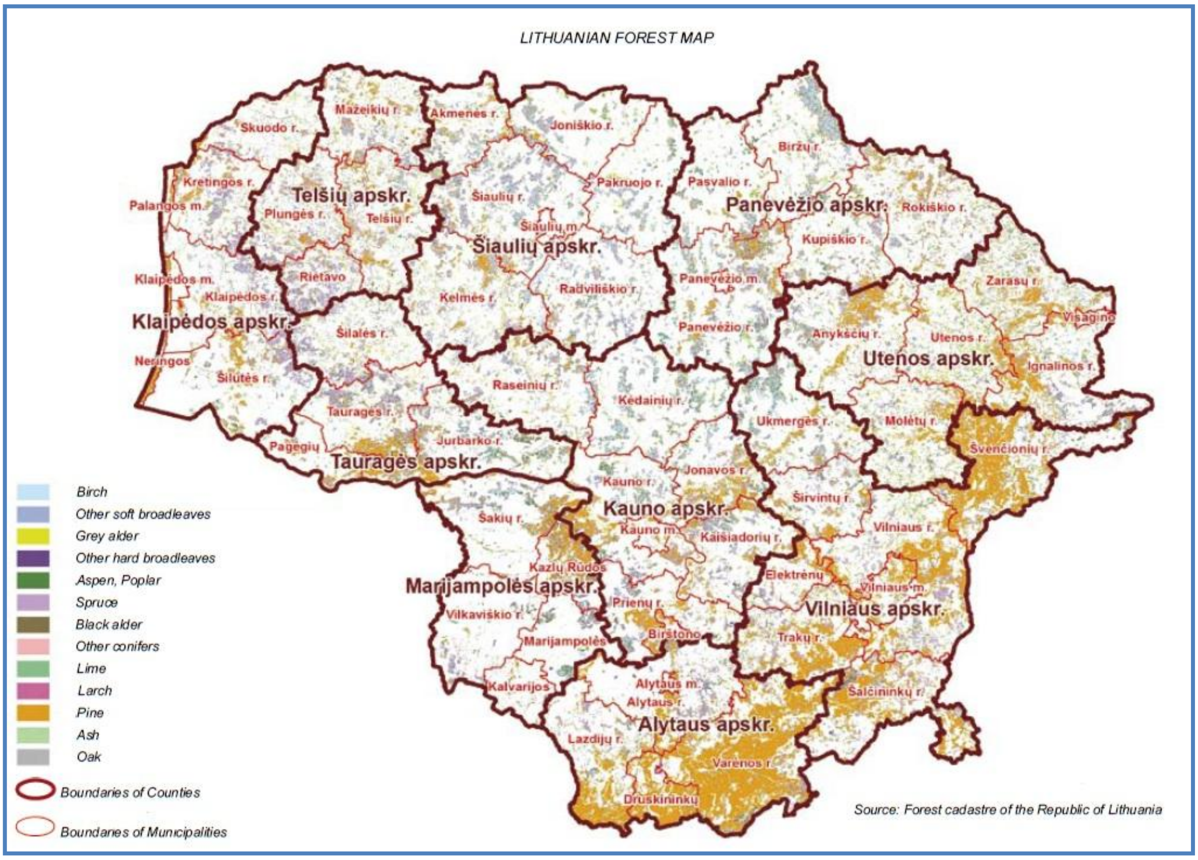

Figure 7-12. Lithuanian forest map by tree species

Forest Inventories

The traces of forest inventory in Lithuania date back to the middle of the 16th century, when Grigoryi Volovich wrote a report on ,,The inspection of woods and game crossing tracks..." in which he described state forest tracts of those times. In 19th century forest inventory on the territory of Lithuania was carried out by Russian, Polish and German specialists. Forest inventory and management planning came into existence in 1922 under the Department of Forestry at the Ministry of Agriculture. It employed 25 – 30 specialists. Primary inventory of state forests was completed by the year 1937. After World War II forest inventory renewed its functioning at the end of 1944. In 1955-1957 for the first time were inventoried all the forests of collective-farms and other stock – holders. Thus, in the second half of the 20th century all the forests of the Republic were inventoried. Repeated forest inventories took place in: 1958-1963, 1966-1977, 1978-1987, 1988-2001. The methods of Lithuanian forest inventory and management planning until 1966 were based on Russian forest inventory instructions adapted to the conditions of Lithuania. As a result of scientific research, experiments and soil investigations conducted in 1959-1966, forest management started to be planned on soil - typological basis. Owing to the joint efforts of forestry leaders of the Republic, researchers (*J. Kenstavičius and M. Vaičys*) and forest management planning specialists, "Rules of forest management planning on soil - typological basis" were worked out. The main principles of these regulations, being gradually improved, remained till the end of the 20th century. Aerophotos were introduced into forest management planning practice in 1950, simplified soil studies and mensuration based and sampling methods and angle count plots started since 1966. In 1969-1971 methodical principles were elaborated, programs were worked out and electronic calculating machines started to be used. In the last decade of the 20th century personal computers and geo-informational systems were introduced, mapping became fully automatized. Forest management planning had special sub-units: supervision of elaborated plans, hunting management, management planning of protected areas and recreational forests, technological planning of final fellings, application of remote sensing methods and geo-information system, state assessment of forests resources. The most significant for the strategic planning of forestry and the development of forest management was started in 1998 national inventory of Lithuanian forests by sampling method. The data obtained allowed to increase the accuracy and reliability of information on forest resources of the country by ownership categories, to define them with a required accuracy, to broaden essentially the scope of information.

After Lithuania regained its independency, the Ministry of Forestry made a decision obliging forest management planning specialists to carry out land reform and restore ownership rights on former private forests. This work comprised the greatest part (40%) of forest management planning activities at the end of the 20^{th} century and the beginning of the 21^{st} century.

Stand wise Forest Inventory

Standwise forest inventory by complete survey of forest lands (SFI) region by region covers whole country in 10 years. It is executed already 90^{th} years. Standwise Forest Inventory is obligatory to all ownership forms. During the inventory forest stands are singled out, their quantitative and qualitative characteristics are provided, forest health is assessed and silvicultural measures foreseen. Each year SFI inventoried area is nearly 200 000 - 250 000 ha what is 10% of the total forest land area of the country (Figure 7-13).

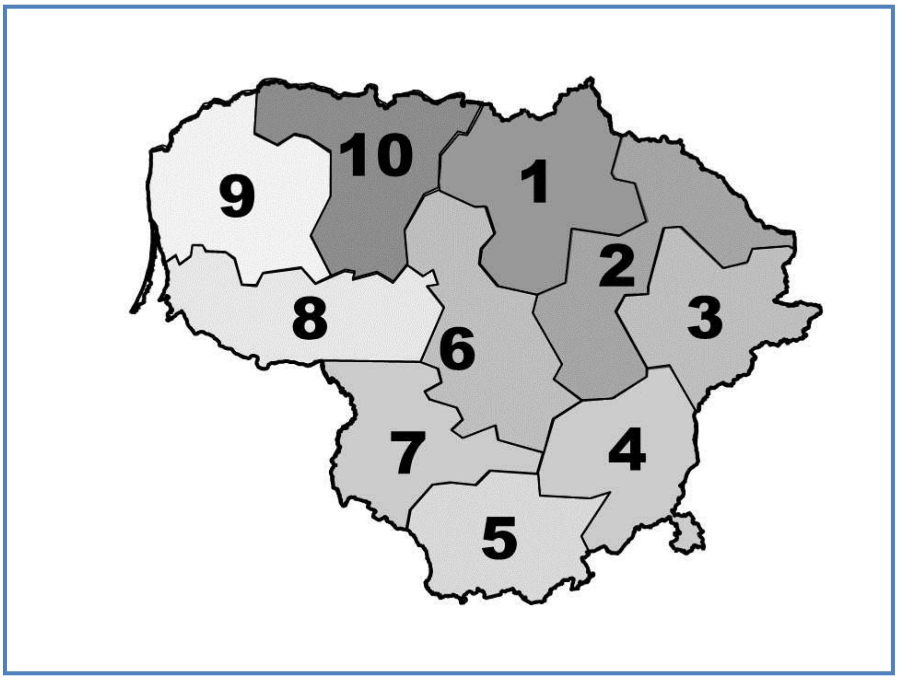

Figure 7-13. Execution of SFI over ten years period on the whole territory of Lithuania

Based on the inventory results forest management plans (Figure 7-14) are prepared for forest enterprises, state parks, recreational and protected areas. Some of the archived cartographical material owned by SFI is represented in figures below.

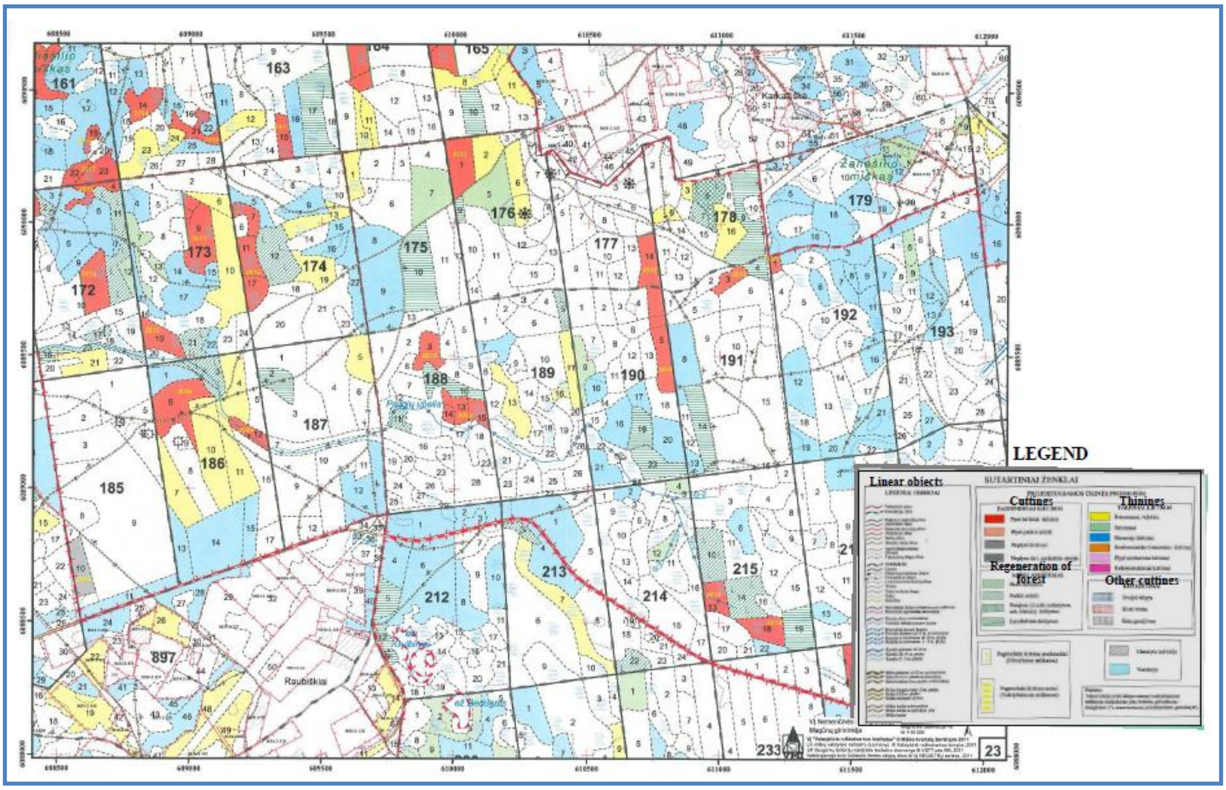

Figure 7-14. Forest management plan (planned forestry activities presented on scheme of forest blocks and compartments; S1:10 000)

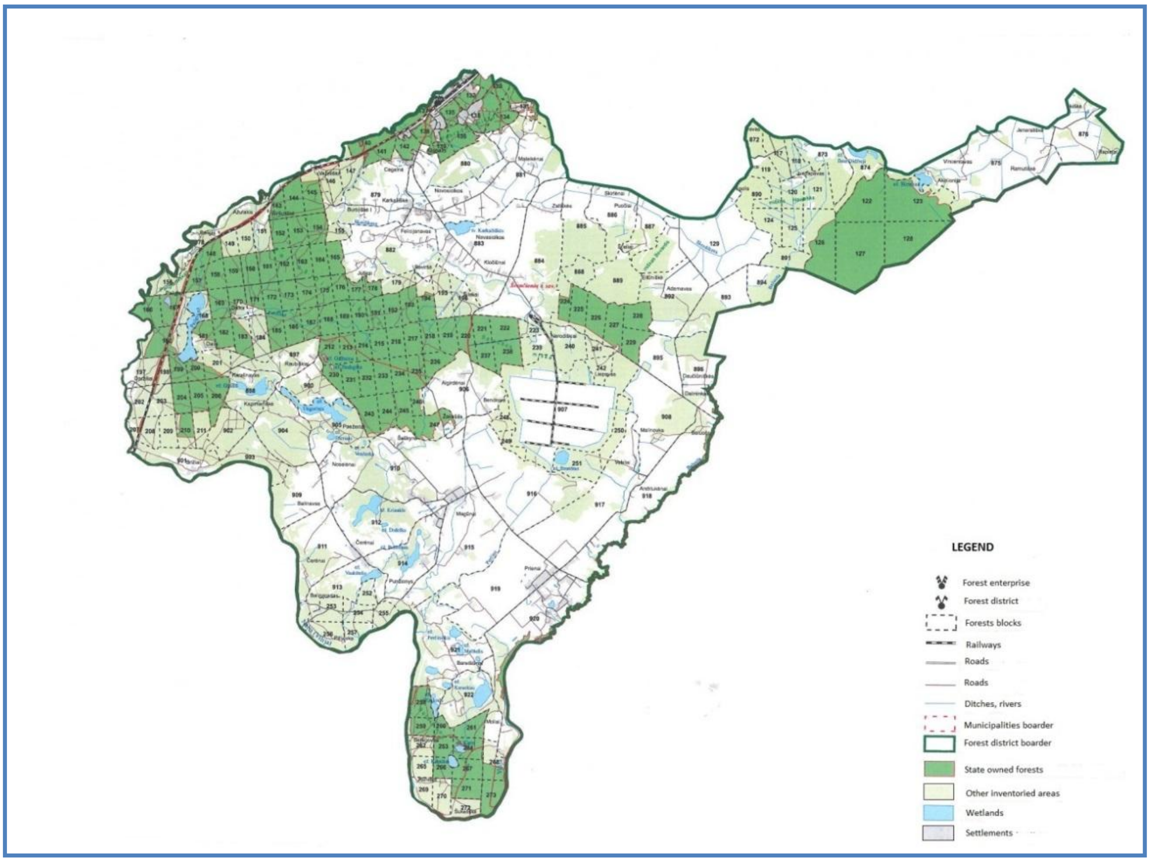

Figure 7-15. Scheme of the Forest District (S 1:10000)

National Forest Inventory

National Forest Inventory by sampling method as a comprehensive and continuous monitoring of all Lithuanian forests was established in 1998. It was launched by the State Forest Management and Inventory Institute under the Ministry of Agriculture and Forestry. Its activity is consolidated by Forest Law of the Republic of Lithuania (2001, 2011, 2012 ed.[132].) and it is conducted by the State Forest Service following the Regulations of National Forest Inventory, approved in 2004 and revised in 2012. Data presented by NFI is used while making forest policy decisions (forestry related laws, forestry programmes etc.), planning forestry activities (large scale forest management planning, country forestry planning etc.), planning forest industry investments and modelling forestry related scenarios (forest resources development etc.).

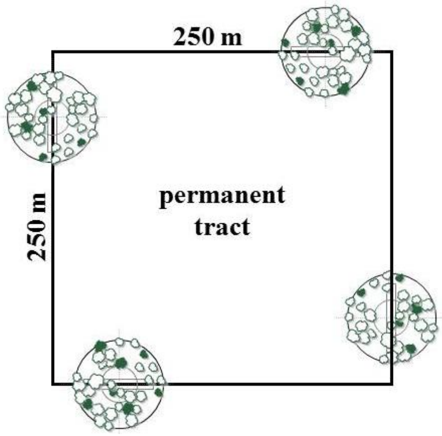

Figure 7-16. Tract of permanent sample plots

NFI is based on continuous, multistage sampling and GIS integrated technology and is organized in the same manner for all forests of Lithuania. The systematic grid (16325 permanent sample plots) of the NFI of Lithuania covers all land categories (Figure 7-16) including inland waters.

Sampling is conducted using a 4×4 km systematic grid with a random starting point. The systematic grid assures a uniform distribution of plots over the entire country and regular monitoring of conversion amongst land use categories. The sample units are arranged to square shape clusters and include four permanent, regularly measured plots (Figure 7-17).

Taking into account the number of homogeneous stands (strata), minimal growing stock volume and increment estimation accuracy, 5600 permanent sample plots were established on forest land over a 5-year period. Approximately 1120 permanent sample plots are re-measured each year. The NFI plots annually cover the entire country each year with the total number of plots measured over the 5-year inventory cycle reaching a sampling intensity of one sample plot per 400 ha.

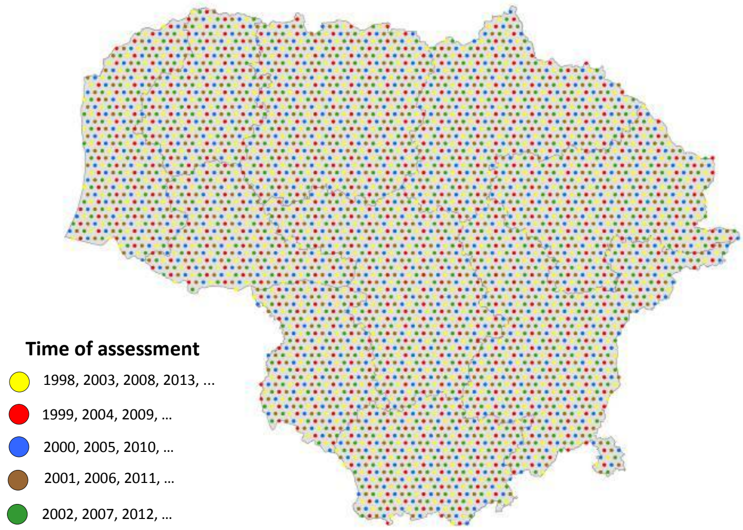

Figure 7-17. Distribution of NFI clusters of plots on Lithuanian territory

The aim of establishment of permanent sample plots is to reliably estimate (by direct measurements) growing stock volume, gross increment, mortality and fellings, to control the dynamics of forest areas in the country.

[132] *Forest Law of the Republic of Lithuania. 10.04.2010. Nr. IX-240, Žin., 2001, Nr. 35-1161 (2001 04 25).*

Following the order of the Minister of Environment[133] and renewed Regulations of National Forest Inventory[134] field measurements in all land use categories of Lithuania were started in 2012 in more than 16 thous. permanent sample plots. The main aim of non-forest land measurements is to (*a*) monitor land use changes, required by UNFCCC, and (*b*) to measure living trees outside the forest land.

Lithuanian State Forest Cadastre

The purpose of Lithuanian State Forest Cadastre (LSFC) is to collect, compile, process, systematize, store, use, update and provide data on Lithuanian forests. LSFC is a component of state registers' system. The structure of LSFC is based on natural-geographical principle. A forest tract is considered to be a unit of LSFC registration. LSFC is a database of forest tracts. It has been created employing the information of forest land compartments data base, originated from the stand-wise forest inventory data.
Primary tasks of LSFC:

1. Drawing up a technical draft of LSFC, including:
   - regulations on separation of registration units and on attribution of code numbers to forest tracts;
   - regulations on attaching and updating attributes of forest tracts;
   - formulation of technical requirements for software;
   - regulations on data provision to stake-holders and other cadastres.

2. Systematizing geographical data of forest tracts for entire country.

To work out the hierarchical system of forest tracts, the territory of Lithuania was subdivided into 6 regions, separated by the beds of the biggest rivers. Each region was divided into districts dominated by a forest tract bigger than 10 000 ha. Each forest tract smaller than 10 000 ha is subordinated to the district dominating tract and acquires a part of its code number. Such code number of a small forest tract identifies both its geographical location and hierarchical position. Records of an identified forest tract are combined with the database of forest land compartments. Each forest land compartment receives a forest tract code number besides its own number. Information on compartments serves as a basis for forest tract information summary.

An interior numbering of blocks occur in each forest tract separately. Such an approach will gradually result in a stable system of block number, independent neither of administrative division of forests nor of ownership category. LSFC database is due to be updated on a regular basis following the outcome of every next stand-wise inventory, the information on carried out silvicultural measures, on ownership, administrative boundaries and other changes, on newly planted or naturally regenerated forests provided by forest enterprises and other institutions.

LSFC data are integrated with the data of other cadastres and registers such as those of Real Estate, Protected Areas, Territorial Administrative Units, Cultural Values; as well as with other layers, namely the Code of Forest Seed Breeding Ingredients, training and experimental forests etc.

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[133] *Order of the Minister of Environment on Approval of Harmonised Principles for data collection and reporting on LULUCF. 12.01.2012. No. D1/27*
[134] *Regulation of National forest inventory by sampling method. 08.11.2004. Order No D1-570. Adopted by the Minister of Environment of the Republic of Lithuania on 08 November 2004.*

Organic and mineral soils

NFI provides data on forest land distribution by forest soils (Table 7-9). According to NFI[135] data, area of mineral soils amounts to 84,3% and area of organic soils – 15,7% of the total forest area. Drained organic forest soils constitute to 7,9% of the total forest land. This area consists of 2,6% infertile and 5,3% of fertile drained organic forest soils.

Table 7-9. Forest land area by mineral and organic soils 1990-2011, thous. ha

Year	Mineral soils	Organic soils			Total forest land
		Not drained	Drained	Total	
1990	1737,7	160,8	162,8	323,6	2061,4
1991	1743,8	161,3	163,4	324,8	2068,6
1992	1748,8	161,8	163,9	325,7	2074,6
1993	1753,2	162,2	164,3	326,5	2079,7
1994	1755,6	162,4	164,5	327,0	2082,5
1995	1757,6	162,6	164,7	327,3	2084,9
1996	1762,0	163,0	165,1	328,1	2090,1
1997	1765,0	163,3	165,4	328,7	2093,7
1998	1768,0	163,6	165,7	329,3	2097,3
1999	1770,4	163,8	165,9	329,7	2100,1
2000	1775,1	164,2	166,4	330,6	2105,7
2001	1777,8	164,5	166,6	331,1	2108,9
2002	1781,5	164,8	167,0	331,8	2113,3
2003	1786,2	165,3	167,4	332,7	2118,9
2004	1793,0	165,9	168,0	333,9	2126,9
2005	1799,7	166,5	168,7	335,2	2134,9
2006	1805,7	167,1	169,2	336,3	2142,1
2007	1812,8	167,7	169,9	337,6	2150,4
2008	1818,5	168,3	170,4	338,7	2157,2
2009	1820,9	168,5	170,6	339,1	2160,0
2010	1826,3	169,0	171,1	340,1	2166,4
2011	1832,0	169,5	171,7	341,2	2173,2

Soils are classified by using Forest soils classification prepared by M. Vaičys[136]. Prof. M. Vaičys studied forest soil genesis and collected abundant data on soil properties. New soil-forming processes in Lithuanian forest soils, such as lessivation and browning, were also ascertained. Later on, original methods of large-scale forest soil mapping were prepared. In the 1960–1970s, under the guidance of Prof. M. Vaičys, all forest soils in Lithuania were mapped and the national genetic classification of forest soils was prepared. An original classification of the humidity and trophicity of forest sites, based on soil-typological groups, was offered by Prof. M. Vaičys as well. While becoming a member of European Union, necessity of preparation of new Lithuanian Soils Classification, which would be harmonized with World Soil Map legend, has emerged (S 1:5000000, FAO – UNESCO, 1990). First version of such classification was presented in 1997 by M. Vaičys *et al*. Later it was developed, adjusted and finally approved in 1999. The new Lithuanian Soils Classification (LTDK-99) was quite recital, and was difficult to use for forest inventories which

[135] *Lithuanian National Forest Inventory 2003 – 2007. Forest resources and their dynamics*
[136] *M.Vaičys et al. 2006. Miško augaviečių tipai. [en. Forest soil types. 2006]*

are based on forest soil types, therefore it was harmonized with forest soil types used in forest inventory, forestry, forest related science etc. The final harmonized forest soil type classification is presented in Figure 7-18.

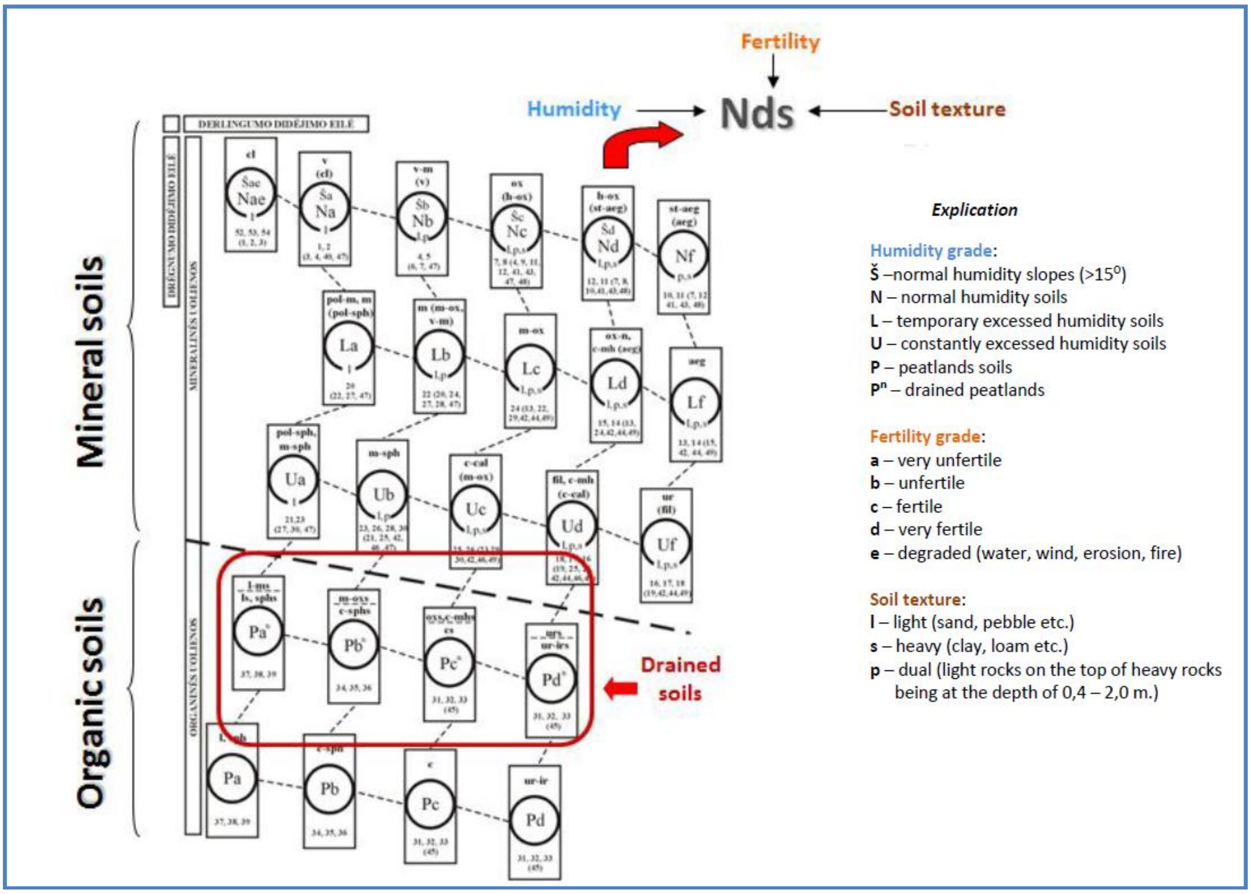

Figure 7-18. Classification of forest soil types

In this greenhouse gas inventory Lithuania defines organic soils and drained organic soils on forest land category as they are classified in the above mentioned soil classification system. Definition of organic soils in LTDK-99 is in line with the definition and requirements of IPCC 2003, hence organic soils are identified with peat and peaty soil layer equal to or being more than 30 cm of the total thickness. Drained organic soils are defined as organic soils identified with peat and peaty soil layer equal to or being more than 20 cm of the total thickness.

Living and dead trees volume in Forest land

Living trees volume (*growing stock volume*) was estimated in forest stand areas corresponding to *Study-1* "Forest Land changes in Lithuania during 1990-2011". For estimation of changes in growing stock volume commitment period was divided in two time series: 1990-2001 and 2002-2010.

Total growing stock volume in the period of 1990-2001 was estimated using the following data sources: forest land area determined during the *Study-1,* percentage of forests stands area from total forest land area and mean growing stock volume of stands (Table 7-10). Percentage of forest stands area from total forest land area varied from 96,5 to 97,0 depending on the assessment year. This percentage is presenting forest land area without dead stands, clear-cut areas, forest blanks, forest roads, forest block lines, technological and fire-break belts and other small areas related to forest facilities.

Using available data six time points were elected to identify mean growing stock volume in stands: 1988, 1992, 1995, 1997, 1999 and 2000. However, only since 2002 known accuracy growing stock volumes, based on NFI permanent sample plots information are available, therefore volumes for the unknown years from the period of 1988-2001 were modelled using available data in the named time points.

Mean growing stock volume per hectare in stands for 1988 and 1999 was used from the research[137]. Forest stand yield was estimated based on Standwise Forest Inventory (SFI) data and data on fellings during 1922-1999. To demonstrate reliability of SFI data during 1958-1999, forest stand yield balance model and data from SFI by sampling method in 1969 was applied. Based on earlier mentioned methods mean growing stock volume in 1988 resulted in 194 m^3/ha, in 1999 - 214 m^3/ha.

Data on mean growing stock volume per hectare for 1992 and 1995 was used from Lithuanian forest resources assessment[138]. Mean growing stock volume for 1997 was taken from Lithuanian forest statistics[139]. Data for the year 2000 presented from Lithuanian Statistical Yearbook of Forestry 2009[140]. Note that, taking into account underestimation of mean growing stock volume for 1992, 1995, 1997 and 2000, making the harmonization of this data with the data of the research[141] for 1988 and 1999 together with National forest inventory data for 2002, it was corrected by 13%.

Total growing stock volume for the period of 2002-2011 was estimated based on permanent NFI sample plots data. In 2002 Lithuanian NFI has finished establishment of permanent sample plots and started providing objective annual data on wood resources in Lithuanian forests (Chapter 7.2.1).

Table 7-10. Growing stock volume identified according to *Study-1*, Forest assessment data and other research results

Year	Mean volume identified, m^3/ha	Mean annual volume change, m^3/ha	Forest land area, thous. ha.	Percentage of forest stands area, %	Total growing stock volume, thous. m^3
1988	194,0	-	-	-	-
1989	196,4	2,3	-	-	-
1990	198,7	2,3	2061,4	97,0	397614,2

[137] *Kuliešis, A. 2000. Lietuvos miškų našumo apskaita, reguliavimas ir naudojimas. Mokslas ir miškininkystė XXI amžiaus išvakarėse., p 127-133 [en. Stand yield inventory, regulation and using in Lithuanian forests. In: Science and forestry on the eve of XXI century].*

[138] *Valstybinis miškotvarkos institutas. 1993 (1996) Lietuvos miško ištekliai. 1993 (1996). [en. Forest Inventory and Management Institute. Lithuanian Forest resources 1993 (1996)].*

[139] *Valstybinis miškotvarkos institutas.1998. Lietuvos miškų statistika. [en. Forest Inventory and Management Institute. Lithuanian Forest statistics.1998].*

[140] *Valstybinė miškų tarnyba. Lietuvos miškų ūkio statistika. 2009. [en. State Forest Service. Lithuanian Statistical Yearbook of Forestry. 2009].*

[141] *Kuliešis, A. 2000. Lietuvos miškų našumo apskaita, reguliavimas ir naudojimas. Mokslas ir miškininkystė XXI amžiaus išvakarėse., p 127-133 [en. Stand yield inventory, regulation and using in Lithuanian forests. In: Science and forestry on the eve of XXI century].*

Year	Mean volume identified, m^3/ha	Mean annual volume change, m^3/ha	Forest land area, thous. ha.	Percentage of forest stands area, %	Total growing stock volume, thous. m^3
1991	201,1	2,3	2068,6	97,0	403640,9
1992	203,4	2,3	2074,6	97,0	409540,9
1993	205,7	2,3	2079,7	97,0	415127,3
1994	207,9	2,3	2082,5	97,0	420253,1
1995	210,2	2,3	2084,9	96,5	423117,2
1996	209,1	-1,1	2090,1	96,5	421889,8
1997	207,9	-1,1	2093,7	97,0	422508,5
1998	211,0	3,0	2097,3	97,0	429503,3
1999	214,0	3,0	2100,1	97,0	436273,0
2000	218,1	4,1	2105,7	96,5	443412,2
2001	222,4	4,3	2108,9	96,5	452850,6
2002	226,7	4,3	-	-	-

Based on data presented above, total growing stock volume for the period of 1990-2011 was estimated (Table 7-11).

Table 7-11. Total growing stock volume estimated on growing stock volume analysis during 1988 – 2001 and NFI permanent sample plots data during 2002 – 2011

Year	Growing stock volume, thous. m^3
1990	397306,4
1991	403407,3
1992	409304,6
1993	414888,1
1994	420011,3
1995	422874,2
1996	421648,1
1997	422266,9
1998	429176,5
1999	435941,5
2000	443159,8
2001	452593,5
2002	454588,4
2003	461979,4
2004	465794,6
2005	467095,0
2006	469471,5
2007	470875,7
2008	476053,5
2009	484616,3
2010	494285,3
2011	503565,7

The figure below shows comparison between the total growing stock volumes declared in the earlier submission (04.11.2011) and estimated total growing stock volume, based on growing stock volume analysis during the period of 1988-2001 with NFI permanent sample plots data for 2002-2011.

Main differences of these two trends appear to be in the period of 1990-2000, especially in 1996-1999. On the earlier submission total growing stock volume estimations were based mainly on expert assumptions and the rough linear trend. As the one of result of the executed *Study-1,* data on total forest area was presented, which has made an impact on total growing stock volume data as well. Decrease in annual volume change in 1996-1997 (-1226 and 619 thous. m^3) is the result of spruce dieback, caused by bark beetle *Ips Typographus* what resulted in a huge damages on spruce stands[142]. Even though mean annual volume change for 1997 is negative (-1,1 m^3/ha) but the total annual volume change is positive due conversion of non-forest land to Forest land (0,8 thous. ha) and accumulated volume from this land use category (42 thous. m^3).

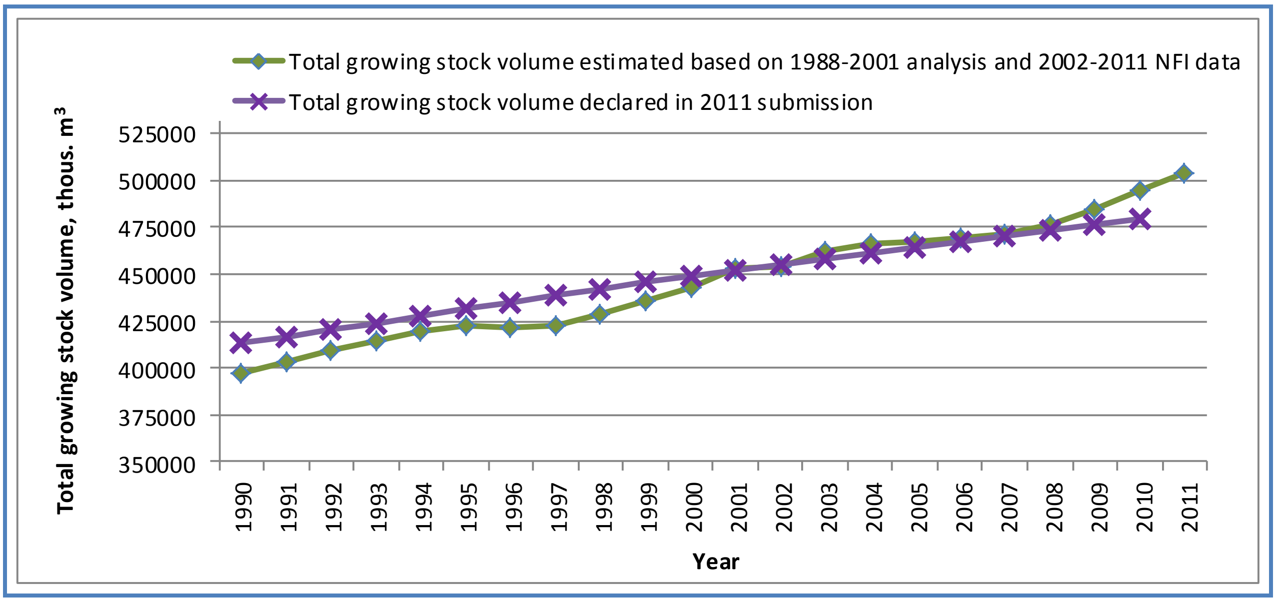

Figure 7-19. Comparison of total growing stock volume between estimated and submitted on 2011.11.04

In the Table 7-12, annual growing stock volume and growing stock volume changes by tree species are presented. The partition of total growing stock volume was made using NFI permanent sample plots data of tree species composition. For the period of 2002-2011 annual NFI data was used, and for the period 1990-2001 – due to the lack of statistical data, modelled using NFI data for 2002.

Note: Negative annual growing stock volume change shows decrease between two periods.

Table 7-12. Annual change of growing stock volume, thous. m^3

Year	Growing stock volume			Annual change of growing stock volume		
	Coniferous	Deciduous	Total	Coniferou s	Deciduous	Total
1990	224296,6	173009,8	397306,4	3444,2	2656,7	6100,9
1991	227740,9	175666,4	403407,3	3444,2	2656,7	6100,9

[142] *Kuliešis A., Kulbokas G. Dubravos miško medynų pokyčiai nepalankių gamtinių veiksnių poveikio laikotarpiu. Miškininkystė, 2008, Nr.2 (en. „Changes of Dubrava forest stands during the impact of adverse natural factors").*

Year	Growing stock volume			Annual change of growing stock volume		
	Coniferous	Deciduous	Total	Coniferou s	Deciduous	Total
1992	231070,1	178234,4	409304,6	3329,3	2568,0	5897,3
1993	234222,3	180665,8	414888,1	3152,2	2431,4	5583,6
1994	237114,5	182896,7	420011,3	2892,2	2230,9	5123,1
1995	238730,8	184143,4	422874,2	1616,3	1246,7	2863,0
1996	238038,6	183609,5	421648,1	-692,2	-533,9	-1226,1
1997	238387,9	183879,0	422266,9	349,3	269,4	618,8
1998	242288,7	186887,8	429176,5	3900,8	3008,8	6909,6
1999	246107,8	189833,7	435941,5	3819,1	2945,8	6765,0
2000	250182,9	192976,9	443159,8	4075,1	3143,3	7218,4
2001	255508,6	197084,9	452593,5	5325,7	4108,0	9433,7
2002	256634,8	197953,6	454588,4	1126,2	868,7	1994,9
2003	261513,4	200465,9	461979,4	4878,6	2512,4	7391,0
2004	263853,6	201941,0	465794,6	2340,1	1475,1	3815,2
2005	264417,7	202677,3	467095,0	564,1	736,3	1300,4
2006	266726,6	202744,9	469471,5	2308,9	67,5	2376,5
2007	269802,6	201073,1	470875,7	3076,0	-1671,8	1404,2
2008	273555,6	202497,9	476053,5	3753,0	1424,9	5177,8
2009	278365,9	206250,4	484616,3	4810,3	3752,5	8562,7
2010	285687,8	208597,5	494285,3	7321,9	2347,1	9669,0
2011	290992,9	212572,8	503565,7	5305,1	3975,2	9280,4

Volume of dead tree stems was assessed for two periods as well as growing stock volume. The total dead tree stems volume for the period of 1990-2001 was estimated using forest land area determined during the *Study-1,* percentage of forests stands area from the total forest land area and mean volume of dead tree stems in stands. Mean volume of dead tree stems was estimated taking into account data of spruce dieback in 1993-1996[143].

For 2002-2011 total standing and lying volume of dead tree stems was estimated using accurate data of NFI permanent sample plots. Broadleaves and coniferous were separated using NFI data of dead tree stems species composition.

The foliage and needles biomass for separate tree species was estimated as a percentage from the total stem volume, using models designed by V. Usolcev. Models were adapted to Lithuanian stands taking into account forest area by dominant tree species (Lithuanian Statistical Yearbook of Forestry, 2011). Computations result that needles takes 7% from the total stem volume and foliage share is 3% from the total stem volume. Estimated volumes of needles and foliage biomass were not included into total dead tree stems biomass (Table 7-13).

[143] *Kuliešis A., Kulbokas G. Dubravos miško medynų pokyčiai nepalankių gamtinių veiksnių poveikio laikotarpiu. Miškininkystė, 2008, Nr.2 (en. „Changes of Dubrava forest stands during the impact of adverse natural factors").*

Table 7-13. Total and mean dead tree stems volume changes during 1990-2011

Year	Total volume of dead tree stems, thous. m^3	Total volume of coniferous dead tree stems, thous. m^3	Total volume of deciduous dead tree stems, thous. m^3	Mean dead tree stems volume, m^3/ha
1990	10740,1	5139,9	5600,1	5,4
1991	10978,2	5358,5	5619,7	5,5
1992	11311,8	5675,9	5635,9	5,6
1993	11743,6	6093,5	5650,1	5,8
1994	12466,4	6808,8	5657,6	6,2
1995	13221,2	7586,2	5635,0	6,6
1996	13254,1	7605,1	5649,0	6,6
1997	12939,5	7251,5	5688,0	6,4
1998	12554,9	6857,1	5697,8	6,2
1999	12266,1	6560,7	5705,4	6,0
2000	12032,1	6341,0	5691,1	5,9
2001	12050,4	6350,6	5699,7	5,9
2002	12513,4	6594,7	5918,8	5,9
2003	12811,6	6566,9	6244,7	6,0
2004	13853,5	7070,4	6783,2	6,5
2005	15186,3	7374,2	7812,1	7,1
2006	16856,9	7770,3	9086,6	7,9
2007	18398,9	8423,6	9975,3	8,6
2008	20199,1	9124,2	11074,9	9,4
2009	21122,9	9408,8	11714,1	9,8
2010	21465,8	9622,3	11843,4	9,9
2011	22372,8	10002,0	12370,8	10,3

Volumes of standing and lying dead tree stems in forests were increasing since 1990. The peak was recorded in the period of 1994-1997 (Table 7-14). That is explained by spruce dieback, caused by the bark beetle *Ips Typographus*, when more than 13000 thous. m^3 of dead tree stems were accumulated in forests (Figure 7-20). Volume of dead tree stems was stabilized only after 1998.

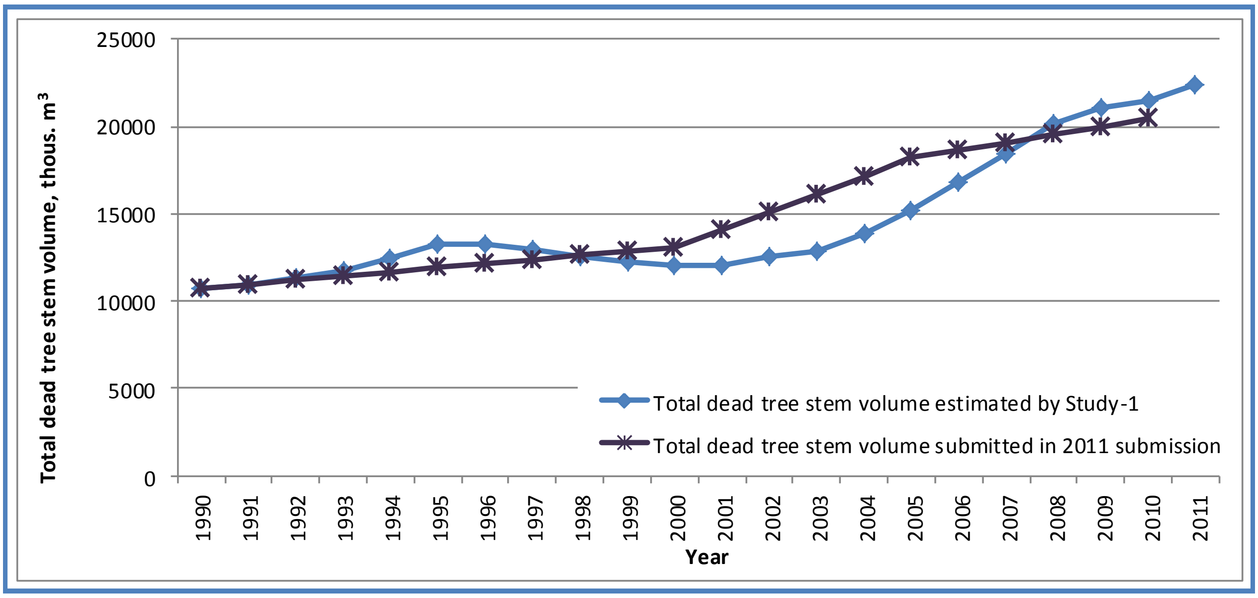

Figure 7-20. Comparison of total dead tree stems stock volume between estimated according to *Study-1* and earlier submitted data (2011.11.04)

Another steady increase of dead tree stems has started since 2001. Reasons for that are the following: storm damages in 2000-2005[144], low number of commercial thinnings, endorsed international environmental agreements committing to leave more deadwood in stands to maintain biodiversity (Natura 2000[145] etc.). In 2011 more than 10 m^3/ha of merchantable dead tree stems are accumulated in stands to decay, what is almost twice more comparing with 1990.

Table 7-14. Total dead tree stems volume and their changes during 1990-2011, thous. m^3

Year	Dead tree stems volume			Annual change of dead tree stems volume		
	Coniferous	Deciduous	Total	Coniferous	Deciduous	Total
1990	5139,9	5600,1	10740,1	218,6	19,5	238,1
1991	5358,5	5619,7	10978,2	218,6	19,5	238,1
1992	5675,9	5635,9	11311,8	317,4	16,3	333,6
1993	6093,5	5650,1	11743,6	417,7	14,1	431,8
1994	6808,8	5657,6	12466,4	715,2	7,6	722,8
1995	7586,2	5635,0	13221,2	777,5	-22,7	754,8
1996	7605,1	5649,0	13254,1	18,9	14,0	32,9
1997	7251,5	5688,0	12939,5	-353,6	39,0	-314,6
1998	6857,1	5697,8	12554,9	-394,4	9,8	-384,7
1999	6560,7	5705,4	12266,1	-296,4	7,6	-288,8
2000	6341,0	5691,1	12032,1	-219,6	-14,3	-233,9
2001	6350,6	5699,7	12050,4	9,6	8,6	18,3
2002	6594,7	5918,8	12513,4	244,0	219,0	463,1
2003	6566,9	6244,7	12811,6	-27,8	325,9	298,1
2004	7070,4	6783,2	13853,5	503,5	538,5	1042,0
2005	7374,2	7812,1	15186,3	303,9	1028,9	1332,8

[144] *Available from: http://www.msat.lt/lt/miskai/misku-bukle/vejo-pazeidimai-istorija-ir-prognoze/*
[145] *Available from: http://www.natura.org/sites.html*

Year	Dead tree stems volume			Annual change of dead tree stems volume		
	Coniferous	Deciduous	Total	Coniferous	Deciduous	Total
2006	7770,3	9086,6	16856,9	396,1	1274,5	1670,6
2007	8423,6	9975,3	18398,9	653,3	888,7	1542,0
2008	9124,2	11074,9	20199,1	700,6	1099,6	1800,2
2009	9408,8	11714,1	21122,9	284,6	639,2	923,8
2010	9622,3	11843,4	21465,8	213,5	129,4	342,9
2011	10002,0	12370,8	22372,8	379,7	527,4	907,1

Fellings

Over 1990-1995 felling rates in all Lithuanian forests (irrespective of their ownership) were unstable, but still slightly increasing and reached the peak in 1995 with the total of 9,43 mill. m^3 of living trees felled. After 1995 fellings were decreasing to 7,71 mill. m^3 of living trees felled in 1997 and then started to increase. The highest point over the whole accounting period was reached in 2003 (10,34 mill. m^3 of living trees felled) and then started slightly to decrease until 2011 (8,06 mill. m^3 of living trees felled). Changes in total forest fellings (living trees) for the period of 1990-2011 are presented in the Figure 7-21.

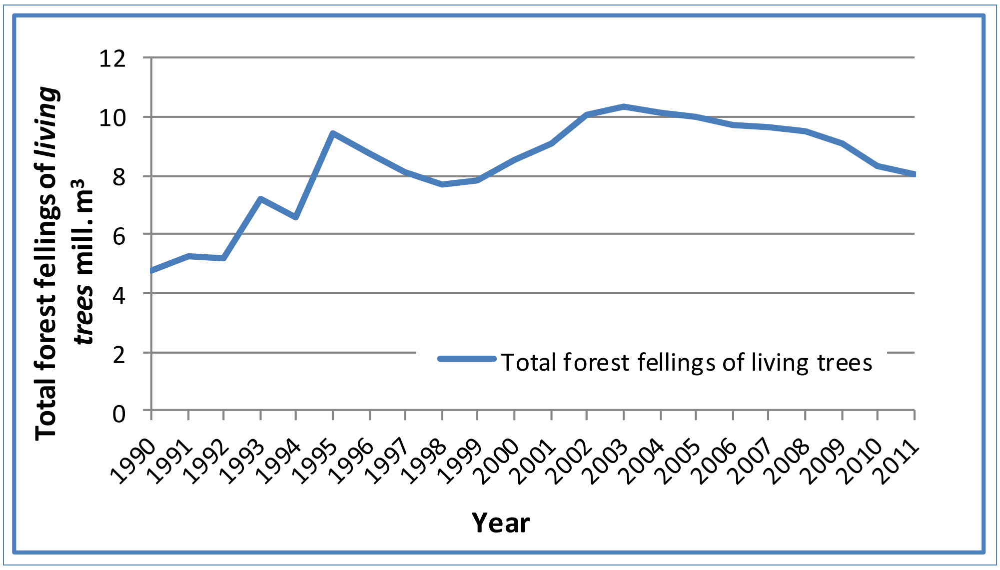

Figure 7-21. Total forest fellings (living trees) in all forests irrespectful of their ownership 1990-2011

Biomass burning

Data on areas affected by forest fires is provided by the Directorate General of State Forests. The Directorate General of State Forests under the Ministry of Environment performs the functions of state forest enterprises founder and coordinator of their activities as well as establisher of mandatory norms for state forest enterprises regarding reforestation, forest protection and management.

Lithuania is one of the few countries in Europe that has uniform system of state fire prevention measures, comprising monitoring, preventive and fire control measures that are established and maintained in forests irrespective of the forest ownership type. Every forest enterprise presents data on forest fires to the Directorate General of State Forests every year.

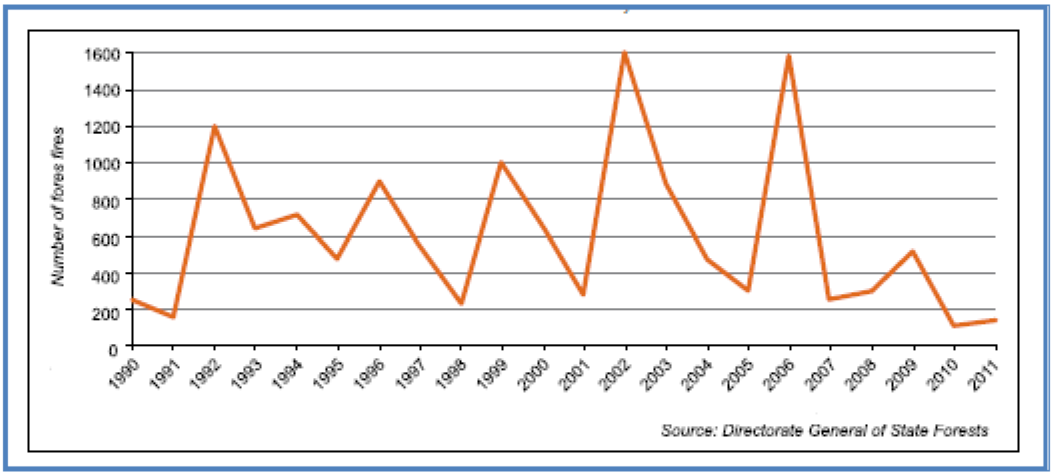

Figure 7-22. Number of forest fires in Lithuania

Forests in Lithuania refer to high natural fire potentiality. They are distributed into three fire potentiality classes: I – high potentiality (38% of the total forest area), II – medium potentiality (22% of the total forest area) and III – low potentiality (40% of the total forest area).

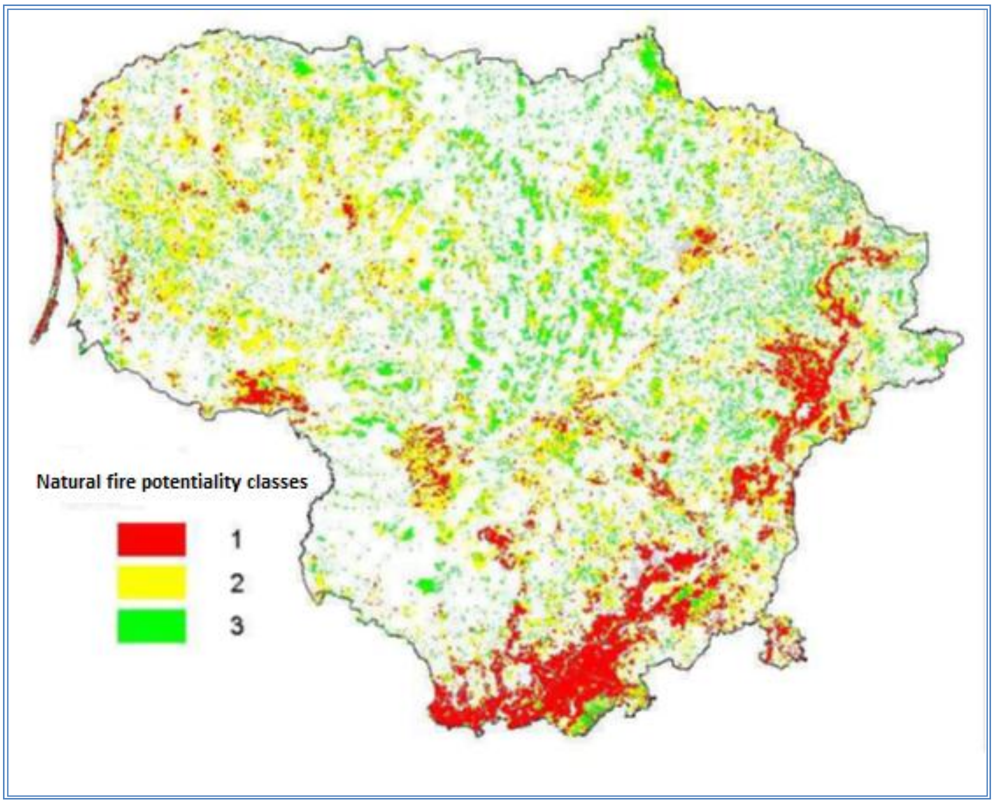

Figure 7-23. Lithuanian forests according to natural fire potentiality classes

Prescribed burning of forest biomass is not used in Lithuania.

Windbreaks and windfalls

Statistical Yearbook of Forestry provides data on windbreaks and windfalls. However, according to the data collection principles used by National Forest Inventory, volumes of windbreaks and windfalls are included in volumes of dead trees, or removals by sanitary or other fellings.

Therefore, to avoid double counting, windbreaks and windfalls were not included in calculations of carbon losses.

Forest fertilization

Fertilization of forest land is not applicable in Lithuania. There is no available data to confirm any fertilization of forest land occurring since 1990.

Fertilization and liming of forest land is possible using biofuel ashes, but there are only several studies presented in Lithuania, evaluating impact of ashes application on forest land, but the clear evidences of such application efficiency are still unknown[146].

Fertilization of forest land with other mineral fertilizers is still not economically efficient due to high prices of fertilizers and unclear benefit on forest growth in our climatic conditions.

7.2.2 Methodological Issues

7.2.2.1 Forest land remaining Forest land

The greenhouse gas inventory for Forest land remaining Forest land involves estimations of changes in carbon stock in five carbon pools (above-ground biomass, below-ground biomass, dead wood, litter and soil organic matter) as well as estimations of non-CO_2 gases from those pools. The algorithm for assessment of carbon stock changes in carbon pools is given in *IPCC 2003* eq. 3.2.1 (p. 3.23):

$$\Delta C = \Delta C_{LB} + \Delta C_{DOM} + \Delta C_{Soils} \quad (7.1)$$

where:
ΔC – annual change in carbon stock in total forest land, t C yr^{-1};
ΔC_{LB} – annual change in carbon stock in living biomass (includes above and below-ground biomass) in total forest land, t C yr^{-1};
ΔC_{DOM} – annual change in carbon stock in dead organic matter (includes dead wood and forest litter) in total forest land, t C yr^{-1};
ΔC_{Soils} – annual change in carbon stock in soils in total forest land, t C yr^{-1}.

Carbon stock changes in living biomass

Living biomass pool in this greenhouse gas inventory refers to above-ground biomass and below-ground biomass. The estimation of carbon stock changes in living biomass is consistent with the *Method 2* further described in the *IPCC 2003*, which is also called as the *stock change method.* Estimations of carbon stock changes by using this method requires biomass carbon stock inventories for a given forest area in two points in time. Biomass change is the difference between the biomass at *time*$_2$ and *time*$_1$, divided by the number of years between the inventories (*IPCC 2003* eq. 3.2.3, p. 3.24):

$$\Delta C_{LB} = (C_{t2} - C_{t1})/(t_2 - t_1) \text{ and } C = (\Delta AGB + \Delta BGB) \times CF \text{ (modified eq. 3.2.3)} \quad (7.2)$$

[146] *Ozolinčius R., Armolaitis K., Mikšys V., Varnagirytė-Kabašinskienė I. 2010. Recommendations for compensating wood ash fertilization (2nd revised edition).*

where:
ΔC_{LB} – annual change in carbon stock in living biomass (includes above- and belowground biomass) in total forest land. t C yr^{-1};
C_{t2} – total carbon in biomass calculated at time t_2, t C;
C_{t1} – total carbon in biomass calculated at time t_1, t C;
ΔAGB – above-ground biomass change, t d. m.;
ΔBGB – below-ground biomass change, t d. m.;
CF – carbon fraction of dry matter (default = 0,5), t C $(\text{tonne d.m.})^{-1}$.

Annual growing stock volume (GSV) change from 2003 for Forest land remaining forest land was estimated based on NFI data by the following steps:

1. Estimation of GSV based on data of re-measured permanent sample plots on the same forest area (for each assessment year separately);
2. First cycle of NFI, when the establishment of permanent sample plots has been completed, has been finished in 1998-2002. First re-measurement of these sample plots has started in 2003 and finished in 2007 (1998 sample plots re-measured in 2003, 1999 sample plots re-measured in 2004, 2000 sample plots re-measured in 2005 etc.). At the same time of re-measurement of old sample plots, new sample plots were measured as well (NFI in details in chapter 7.2.1).
3. Estimation of annual GSV increment, based on new established permanent plots data, on the lost before measuring, and new forest area (for each assessment year separately);
4. Estimation of annual GSV change in all forest area by the change of GSV on the same area (re-measured permanent sample plots data) plus GSV increment of new measured permanent sample plots;
5. Estimation of annual GSV change on land converted to forest land area by relationship between mean GSV and age of forest in permanent plots of land converted to forest land;
6. Estimation of annual GSV change in Forest land remaining Forest land area by difference of all forest annual GSV change (explained in step 3) and annual GSV change on land converted to forest land area.

The equations presenting calculations on growing stock volume change in Forest land remaining Forest land are shown below:

$$\Delta FF_t = ((V_{rem_{t2}} - V_{rem_{t1}}) + \Delta V_{new}) - \Delta F2 \qquad (7.3)$$

where:
ΔFF_t – growing stock volume change for Forest land remaining Forest land for the defined year, m^3;
$V_{rem_{t1}}$ – growing stock volume calculated at time t_1, m^3;
$V_{rem_{t2}}$ – growing stock volume calculated at time t_2, m^3;
ΔV_{new} – growing stock volume change of the new measured sample plots, m^3;
ΔF2 – growing stock volume change of new forest areas, m^3.

Above-ground biomass

Above ground biomass refers to all living biomass above the soil including stem, stump, bark, branches, seeds and foliage. Calculation of above-ground biomass is based on volume of living trees stems with bark, basic wood density and biomass expansion factor. Above-ground biomass is calculated by employing slightly modified eq. 3.2.3, (p. 3.24) of *IPCC 2003*:

$$\Delta AGB = (\Delta GS) \times WD \times BEF \qquad (7.4)$$

where:
ΔAGB – above-ground biomass change, t d.m.;
ΔGS – change of tree stems volume with bark, m^3;
WD – basic wood density, t d. m. m^{-3};
BEF – biomass expansion factor.

Basic wood density (*WD*) was estimated on the basis of data provided in Table 3A.1.9 of the *IPCC 2003*. Density values for coniferous and deciduous were calculated as weighted average values related to growing stock volume (Table 7-15).

Above ground biomass was calculated for broadleaves and coniferous separately. For the period of 2002-2011 data of NFI was used, and for the period of 1990-2001 mean value for the known time period was used.

Table 7-15. Total growing stock volume and average basic wood density values

Species	Total growing stock volume (mill m^3). Average 2002-2009	Basic wood density, tonnes d.m. m^{-3}	
		By species	Weighted average
Pine	190,6	0,42	
Spruce	762,4	0,40	
Total coniferous	**267,0**		**0,41**
Birch	83,2	0,51	
Aspen	34,0	0,35	
Black alder	41,2	0,45	
Grey alder	21,6	0,45	
Oak	11,2	0,58	
Ash	9,0	0,57	
Total deciduous	**200,1**		**0,47**
Overall total	**467,1**		**0,44**

Default values of biomass expansion factor (BEF) for conversion of tree stems volume with bark to above-ground tree biomass were estimated using national tables of merchantable wood volume (for branches) and leaves-needles biomass data by Usolcev (Усольцев, В. А. 2001; 2002; 2003[147]). Rate of BEF for coniferous was estimated to be 1,221 and 1,178 for deciduous. The rates of BEF

[147] *Усольцев В.А. 2001. Фитомасса лесов Северной Евразии. База данных и география. 707с., Якатеринбург.*
Усольцев В.А. 2002. Фитомасса лесов Северной Евразии. Нормативы и элементы географии. 762с. Якатеринбург.
Усольцев В.А. 2003. Фитомасса лесов Северной Евразии. Предельная продуктивность и география. 405 с., Якатеринбург.

estimated for Lithuania are very close to the rates presented in *IPCC 2003* in Table 3A.1.10, what shows the consistency between the chosen methods.

Below-ground biomass

Below ground biomass refers to all living biomass of live roots. Below-ground biomass is calculated by using modified eq. 3.2.3 (p. 3.24) of the IPCC 2003 which requires data for above-ground biomass and root-to-shoot ratio. Default values of root-to-shoot ratios R were estimated using data of Usolcev and Table 3A.1.8 of IPCC 2003: for coniferous – 0,26; for deciduous – 0,19:

$$\Delta BGB = \Delta AGB \times R \tag{7.5}$$

where:
ΔBGB – below-ground biomass change, t d. m.;
ΔAGB – above-ground biomass change, t d. m.;
R – root-to-shoot ratio, dimensionless.

Carbon fraction of dry matter

Default value of 0,5 tonne C (tonne d.m.)$^{-1}$ provided in the *IPCC 2003* was used for estimation of carbon fraction (CF) in dry biomass matter.

Change in carbon stock in dead organic matter

For the greenhouse gas inventory Lithuania defines dead organic matter (*DOM*) as it is described in *IPCC 2003*, which provides two types of dead organic matter pools: dead wood and litter.

Annual change in carbon stocks in dead organic matter in Forest Land remaining Forest Land is calculated following the summarising equation for calculation of changes in dead organic matter carbon pools which is equal to the sum of carbons stock in dead wood (measured available dead wood) and carbon stock in dead wood that is left on site after fellings (*BGB*). Dead wood that is left on site after fellings is assumed to be below-ground biomass which is roots. It is assumed that BGB decays in equal parts in 5 years. Modified equation 3.2.10 (p. 3.32) of *IPCC 2003* has been used to calculate carbon stock change in dead organic matter:

$$\Delta C_{DOM} = C_{DW} + C_{DW_H} \tag{7.6}$$

where:
ΔC_{DOM} – annual change in carbon stocks in dead organic matter, t C yr^{-1};
C_{DW} – change in carbon stocks in dead wood (*measured available dead stems*), t C yr^{-1};
C_{DW_H} – change in carbon stocks in dead wood (*BGB left on site after fellings*), t C yr^{-1}.

Annual change of biomass of dead trees stems is calculated by using stock change method and employing equation 3.2.12, p. 3.34 of *IPCC 2003*:

$$\Delta C_{FF_{DW}} = [A \times (B_{t2} - B_{t1}) / T] \times CF \tag{7.7}$$

where:
$\Delta C_{FF_{DW}}$ – annual change in carbon stocks in dead wood in forest land remaining forest land, t C yr-^{1};
A – area of managed forest land remaining forest land, ha;
B_{t1} – dead wood stock at time t_1 for managed forest land remaining forest land, t d.m. ha^{-1};
B_{t2} – dead wood stock at time t_2 (the second time) for managed forest land remaining forest land, t d.m. ha^{-1};

T (= $t_2 - t_1$) – time period between time of the second stock estimate and the first stock estimate, yr.;
CF – carbon fraction in dry biomass matter (default = 0,5), tonnes C (tonne d.m.)$^{-1}$.

$$\Delta C_{FF_{DW}} = \Delta B / T \times CF \quad (7.8)$$

where:
$\Delta C_{FF_{DW}}$ – annual change in carbon stocks in dead wood in forest land remaining forest land, t C yr-^{1};
ΔB – dead wood stock change for managed forest land remaining forest land, t d.m. ha^{-1};
T (= $t_2 - t_1$) – time period between time of the second stock estimate and the first stock estimate, yr.;
CF – carbon fraction in dry biomass matter (default = 0,5), tonnes C (tonne d.m.)$^{-1}$.

$$\Delta B = B_{t2} - B_{t1} \quad (7.9)$$

where:
ΔB – dead wood stock change for managed forest land remaining forest land, t d.m. ha^{-1};
B_{t1} – dead wood stock at time t_1 for managed forest land remaining forest land, t d.m. ha^{-1};
B_{t2} – dead wood stock at time t_2 (the second time) for managed forest land remaining forest land, t d.m. ha^{-1}.

$$Bt = AGB + BGB \quad (7.10)$$

where:
AGB – above-ground biomass, t d. m.;
BGB – below-ground biomass, t d. m.

$$AGB = V_{dw} \times WD \times BEF \quad (7.11)$$

where:
V_{dw} – available dead wood volume, m^{3};
WD – basic wood density, t d. m. m^{-3};
BEF – biomass expansion factor.

$$BGB = AGB \times R \quad (7.12)$$

where:
AGB – above-ground biomass, t d. m.;
R – root-to-shoot ratio, dimensionless.

Change in carbon stock in soil organic matter

Carbon stock change in drained organic forest soils was calculated using equation 3.2.15 (p. 3.42) of *IPCC 2003*:

$$\Delta C_{FOS} = A_{Drainage} \times EF_{Drainage} \quad (7.13)$$

where:
ΔC_{FOS} – CO_2 emissions from drained organic forest soils, t C yr^{-1};
$A_{Drainage}$ – area of drained organic forest soils, ha;
$EF_{Drainage}$ – emission factor for CO_2 from drained organic forest soils, t C ha^{-1} yr^{-1}.

Default value of emission factor for drained organic soils in managed forests provided in Table 3.2.3 of the *IPCC* 2003 (p. 3.42) was accepted in calculations. Default $EF_{Drainage}$ for temperate forests is 0,68 tonnes C ha^{-1} yr^{-1}.

Non-CO_2 emissions from drainage of forest soils

For estimation of non-CO2 emissions from drained forest soils country uses default Tier 1 method. In Tier 1 equation 3a.2.1 is applied with a simple disaggregation of drained forest soils into "nutrient rich" and "nutrient poor" areas and default emission factors are used.

$$N_2O\ emisions_{FF} = \Sigma(A_{FF_{organic\ IJK}} \times EF_{FF_{drainage,\ organic\ IJK}}) + A_{FF_{mineral}} \times EF_{FF\ drainage,\ mineral} \times 44/28 \times 10^{-6} \qquad (7.14)$$

where:
N_2O emisions $_{FF}$ – emission of N_2O in units of nitrogen, kg N;
$A_{FF_{organic}}$ – area of drained forest organic soils, ha;
$A_{FF_{mineral}}$ – area of drained forest mineral soils, ha;
$EF_{FF_{drainage,\ organic}}$ – emission factor for drained forest organic soils, kg N2O-N ha-1 yr-1;
$EF_{FF\ drainage,\ mineral}$ – emission factor for drained forest mineral soils, kg N2O-N ha-1 yr-1;
IJK – soil type, climate zone, intensity of drainage, etc. (depends on level of disaggregation).

NFI provides data on forest land distribution by forest soils (Table 7-9). According to NFI[148] data, area of mineral soils amounts to 84,3% and area of organic soils – 15,7% of the total forest area. Drained organic forest soils constitute to 7,9% of the total forest land. This area consists of 2,6% infertile and 5,3% of fertile drained organic forest soils. Area of lands converted to Forest land was also included into estimations.

Biomass Burning

Data on areas affected by forest fires on areas under the category Forest land remaining Forest land is provided by the Directorate General of State Forests. However, data on wildfires on lands converted to Forest land is not so accurate, therefore Lithuania, following recommendations made by ERT 2012, subdivides the forest area burned on the basis of the proportional contribution of each category to the total forest land area.

Carbon release from burnt biomass was calculated using equation 3.2.20 (p. 3.49) of *IPCC 2003*:

$$L_{fire} = A \times B \times C \times D \times 10^{-6} \qquad (7.15)$$

where:
L_{fire} – quantity of GHG released due to fire, t of GHG;
A – area burnt, ha;
B – mass of 'available' fuel, kg d.m. ha^{-1};
C – combustion efficiency (or fraction of biomass combusted), dimensionless;
D – emission factor, g (kg d.m.)$^{-1}$.

Values of biomass stock were taken from the Table 3A.1.13 of the *IPCC 2003* (Annex 3A.1, p. 3.185). Mean value for wildfire of temperate forest is 19,8 t per ha.

Average values of emission factor D for CO_2, N_2O and CH_4 gases were calculated based on the values presented by *Delmas et al*. and *Kauffmann et al*. in the Table 3A.1.16 of the *IPCC 2003* (Annex 3A.1, p. 3.185) and are equal to:

CO_2 – 1555,5 g (kg d.m.)$^{-1}$

[148] *Lithuanian National Forest Inventory 2003 – 2007. Forest resources and their dynamics*

N_2O – 8,05 g (kg d.m.)$^{-1}$
CH_4 – 0,11 (kg d.m.)$^{-1}$.

7.2.2.2 Land converted to Forest land

Land use area calculations of Land converted to Forest land are further described in chapter 7.2.1. The total area of land converted to Forest land area between 1990 and 2011 were computed by using sample plots data of National Forest Inventory.

The land-use categories from which areas have been converted to Forest land are the following: Croplands, Grasslands, Wetlands, Settlements and Other land.

Yearly land transition matrixes of conversions from one land use category to Forest land were created based on year of the conversion and the category converted. In the table below annual land transition matrix for conversion of Croplands to Forest land is presented in table below.

Table 7-16. Yearly land transition matrix for Croplands converted to Forest Land

Year of the conversion	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0	**399,4**	**399,4**	**798,8**	0,0	**798,8**	**399,4**	**798,8**	**798,8**	**2795,9**	**1597,7**	0,0	**399,4**	**1997,1**
2	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0	**399,4**	**399,4**	**798,8**	0,0	**798,8**	**399,4**	**798,8**	**798,8**	**2795,9**	**1597,7**	0,0	**399,4**
3	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0	**399,4**	**399,4**	**798,8**	0,0	**798,8**	**399,4**	**798,8**	**798,8**	**2795,9**	**1597,7**	0,0
4	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0	**399,4**	**399,4**	**798,8**	0,0	**798,8**	**399,4**	**798,8**	**798,8**	**2795,9**	**1597,7**
5	0,0	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0	**399,4**	**399,4**	**798,8**	0,0	**798,8**	**399,4**	**798,8**	**798,8**	**2795,9**
6	0,0	0,0	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0	**399,4**	**399,4**	**798,8**	0,0	**798,8**	**399,4**	**798,8**	**798,8**
7	0,0	0,0	0,0	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0	**399,4**	**399,4**	**798,8**	0,0	**798,8**	**399,4**	**798,8**
8	0,0	0,0	0,0	0,0	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0	**399,4**	**399,4**	**798,8**	0,0	**798,8**	**399,4**
9	0,0	0,0	0,0	0,0	0,0	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0	**399,4**	**399,4**	**798,8**	0,0	**798,8**
10	0,0	0,0	0,0	0,0	0,0	0,0	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0	**399,4**	**399,4**	**798,8**	0,0
11	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0	**399,4**	**399,4**	**798,8**
12	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0	**399,4**	**399,4**
13	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0	**399,4**
14	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**	0,0
15	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**	**798,8**
16	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0	**399,4**
17	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	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0	0,0
18	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	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**	0,0
19	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	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**	**1198,2**
20	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	**399,4**	0,0	0,0	0,0	**399,4**	**399,4**
	399,4	**798,8**	**1198,2**	**2396,5**	**2396,5**	**2396,5**	**2795,9**	**3594,7**	**3594,7**	**3994,1**	**4393,5**	**5192,4**	**5192,4**	**5991,2**	**6390,6**	**7189,4**	**7988,3**	**10384,7**	**11982,4**	**11982,4**	**12381,8**	**13979,4**

Carbon stock changes in living biomass

For the estimation of carbon stock changes in living biomass, growing stock volume of Lands converted to Forest land was estimated using data of NFI permanent sample plots on mean growing stock volume of non-forest Lands converted to Forest land according to the year of conversion (Figure 7-24). 2nd order polynomial trend was used to come up with mean growing stock volume and mean growing stock volume increment of lands converted to Forest land (Table 7-17).

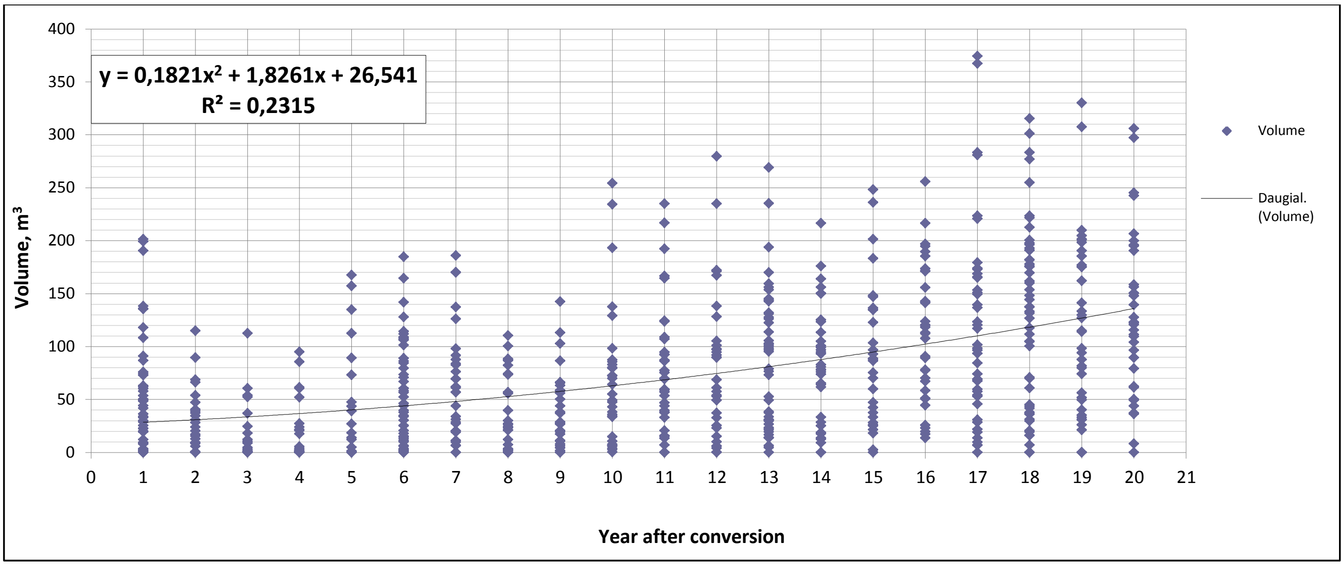

Figure 7-24. NFI data on growing stock volume of non-forest lands converted to forest land at the year of conversion to Forest land

Table 7-17. Mean GSV and GSV increment based on NFI data on lands converted to Forest land at the year of conversion

Year after conversion	Mean growing stock volume, m^3/ha	Growing stock volume increment, m^3/ha
1	28,5	2,0
2	30,9	2,4
3	33,7	2,7
4	36,8	3,1
5	40,2	3,5
6	44,1	3,8
7	48,2	4,2
8	52,8	4,6
9	57,7	4,9
10	63,0	5,3
11	68,7	5,7
12	74,7	6,0
13	81,1	6,4
14	87,8	6,7
15	94,9	7,1
16	102,4	7,5

Year after conversion	Mean growing stock volume, m^3/ha	Growing stock volume increment, m^3/ha
17	110,2	7,8
18	118,4	8,2
19	127,0	8,6
20	135,9	8,9

GSV change for land converted to Forest land was estimated by using equation presented below:

$$\Delta V = \sum [A_i (V_{t_2} - V_{t_1}))$$ (7.16)

where:
ΔV – GSV change on land converted to Forest land, m3;
Ai – area according to land use category, ha;
V t1 – GSV at time t1, m3;
V t2 – GSV at time t2, m3.

Annual change in carbon stocks in living biomass in land converted to Forest land was calculated by using equation 3.2.25 (p. 3.53) of the IPCC 2003:

$$\Delta C_{LFLB} = \Delta C_{LFGROWTH} + \Delta C_{LFCONVERSION} - \Delta C_{LFLOSS}$$ (7.17)

where:
$\Delta C_{LF_{LB}}$ – annual change in carbon stocks in living biomass in land converted to forest land, tonnes C yr^{-1};
$\Delta C_{LF_{GROWTH}}$ – annual increase in carbon stocks in living biomass due to growth in land converted to forest land, tonnes C yr^{-1};
$\Delta C_{LF_{CONVERSION}}$ – annual change in carbon stocks in living biomass due to actual conversion to forest land, tonnes C yr^{-1};
$\Delta C_{LF_{LOSS}}$ – annual decrease in carbon stocks in living biomass due to losses from harvesting, fuel wood gathering and disturbances in land converted to forest land, tonnes C yr^{-1}.

Annual change in carbon stocks in living biomass due to actual conversion to forest land was calculated employing equation 3.2.26 (p. 3.53) of the *IPCC 2003*:

$$\Delta C_{LF_{CONVERSION}} = \sum_i [B_{AFTER_i} - B_{BEFORE_i}] \times \Delta A_{TO\_FOREST_i} \times CF$$ (7.18)

where:
$\Delta C_{LF_{CONVERSION}}$ – change in carbon stocks in living biomass in land annually converted to forest land, tonnes C yr^{-1};
B_{BEFORE_i} – biomass stocks on land type *i* immediately before conversion, tonnes d.m. ha^{-1};
B_{AFTER_i} – biomass stocks that are on land immediately after conversion of land type *i*, tonnes d.m. ha^{-1} (in other words, the initial biomass stock after artificial or natural regeneration);
$\Delta A_{TO\_FOREST_i}$ – area of land-use *i* annually converted to forest land, ha yr^{-1};
CF – carbon fraction of dry matter (default = 0.5), tonnes C (tonnes d.m.)-1;
I – represent different types of land converted to forest.

B_{BEFORE} value was modelled by using Figure 7-24.

Above-ground biomass

Above ground biomass refers to all living biomass above the soil including stem, stump, bark, branches, seeds and foliage. Calculation of above-ground biomass is based on volume of living trees stems with bark, basic wood density and biomass expansion factor. Above-ground biomass is calculated by employing slightly modified eq. 3.2.3, (p. 3.24) of *IPCC 2003*:

$$\Delta AGB = (\Delta GS) \times WD \times BEF \quad (7.19)$$

where:
ΔAGB – above-ground biomass change, t d.m.;
ΔGS – change of tree stems volume with bark, m^3;
WD – basic wood density, t d. m. m^{-3};
BEF – biomass expansion factor.

Basic wood density (*WD*) was estimated on the basis of data provided in Table 3A.1.9 of the *IPCC 2003*. Density values for coniferous and deciduous were calculated as weighted average values related to growing stock volume (Table 7-18).

Above ground biomass was calculated for broadleaves and coniferous separately. For the period of 2002-2011 data of NFI was used, and for the period of 1990-2001 mean value for the known time period was used.

Table 7-18. Total growing stock volume and average basic wood density values

Species	Total growing stock volume (mill m^3). Average 2002-2009	Basic wood density, tonnes d.m. m^{-3}	
		By species	Weighted average
Pine	190,6	0,42	
Spruce	762,4	0,40	
Total coniferous	**267,0**		**0,41**
Birch	83,2	0,51	
Aspen	34,0	0,35	
Black alder	41,2	0,45	
Grey alder	21,6	0,45	
Oak	11,2	0,58	
Ash	9,0	0,57	
Total deciduous	**200,1**		**0,47**
Overall total	**467,1**		**0,44**

Default values of biomass expansion factor (BEF) for conversion of tree stems volume with bark to above-ground tree biomass were estimated using national tables of merchantable wood volume (for branches) and leaves-needles biomass data by Usolcev (Усольцев, В. А. 2001; 2002; 2003[149]). Rate of BEF for coniferous was estimated to be 1,221 and 1,178 for deciduous. The rates of BEF

[149] *Усольцев В.А. 2001. Фитомасса лесов Северной Евразии.База данных и география. 707с., Якатеринбург.*
Усольцев В.А. 2002. Фитомасса лесов Северной Евразии. Нормативы и элементы географии. 762с. Якатеринбург.

estimated for Lithuania are very close to the rates presented in *IPCC 2003* in Table 3A.1.10, what showing the consistency between the chosen methods.

Below-ground biomass

Below ground biomass refers to all living biomass of live roots. Below-ground biomass is calculated by using modified eq. 3.2.3 (p. 3.24) of the *IPCC 2003* which requires data for above-ground biomass and root-to-shoot ratio. Default values of root-to-shoot ratios R were estimated using data of Usolcev and Table 3.A.1.8 of *IPCC 2003*: for coniferous – 0,26, for deciduous – 0,19.

$$\Delta BGB = \Delta AGB \times R \qquad (7.20)$$

where:
ΔBGB – below-ground biomass change, t d. m.;
ΔAGB – above-ground biomass change, t d. m.;
R – root-to-shoot ratio, dimensionless.

Carbon fraction of dry matter

Default value of 0,5 tonne C (tonne d.m.)$^{-1}$ provided in the *IPCC 2003* was used for estimation of carbon fraction (CF) in dry biomass matter.

Change in carbon stock in dead organic matter

It was assumed that carbon stock in litter in land converted to Forest land accumulates in 20 years period and then it remains stable. The average value of carbon stock in litter is 24 t per ha per 20 years. This value was accepted for Forest land, using values for cold temperate dry and moist region from Table 3.2.1 of *IPCC* 2003. Average value accumulated in litter in land converted to Forest land is equal to 1,2 t/ha (24 t/ha / 20 years). Change in carbon stock in litter in land converted to Forest land was calculated using area from annual land use conversion to forest land matrix.

For Land converted to Forest Land it was assumed that there is no dead organic matter at the moment of conversion. After conversion, dead organic matter starts to accumulate and reaches steady state after 20 years, at the end of conversion period.

Change in carbon stock in soil organic matter

NFI provides data on forest land distribution by forest soils (Table 7-9). According to NFI[150] data, area of mineral soils amounts to 84,3% and area of organic soils – 15,7% of the total forest area. Drained organic forest soils constitute to 7,9% of the total forest land. Due to the lack of accurate data on drained organic soils in land converted to Forest land, it was assumed that the same proportion of drained organic soils as it is accepted for Forest land remaining Forest land category refers also to lands converted to Forest land.

Carbon stock change in drained organic forest soils was calculated using equation 3.2.15 (p. 3.42) of *IPCC 2003*:

$$\Delta C_{FOS} = A_{Drainage} \times EF_{Drainage} \qquad (7.21)$$

[150] *Lithuanian National Forest Inventory 2003 – 2007. Forest resources and their dynamics*

where:
ΔC_{FOS} – CO_2 emissions from drained organic forest soils, t C yr^{-1};
$A_{Drainage}$ – area of drained organic forest soils, ha;
$EF_{Drainage}$ – emission factor for CO_2 from drained organic forest soils, t C ha^{-1} yr^{-1}.

Default value of emission factor for drained organic soils in managed forests provided in Table 3.2.3 of the *IPCC* 2003 (p. 3.42) was accepted in calculations. Default $EF_{Drainage}$ for temperate forests is 0,68 tonnes C ha^{-1} yr^{-1}.

Biomass Burning

Data on areas affected by forest fires on areas under the category Forest land remaining Forest land is provided by the Directorate General of State Forests. However, data on wildfires on lands converted to Forest land is not so accurate, therefore Lithuania, following recommendations made by ERT 2012, subdivides the forest area burned on the basis of the proportional contribution of each category to the total forest land area.

Carbon release from burnt biomass on lands converted to Forest land was calculated using the same methodology as it was used for Forest land remaining Forest land and employing equation 3.2.20 (p. 3.49) of *IPCC 2003*:

$$L_{fire} = A \times B \times C \times D \times 10^{-6} \quad (7.22)$$

where:
L_{fire} – quantity of GHG released due to fire, t of GHG;
A – area burnt, ha;
B – mass of 'available' fuel, kg d.m. ha^{-1};
C – combustion efficiency (or fraction of biomass combusted), dimensionless;
D – emission factor, g $(kg\ d.m.)^{-1}$.

Values of biomass stock were taken from the Table 3A.1.16 of the *IPCC 2003* (Annex 3A.1, p. 3.185). Mean value for biomass consumption used for wildfires of temperate forest is 19,8 t per ha.

Emission factor *D* is calculated as average of two values (1531 and 1580 g/kg) of CO_2 dry matter combusted, provided in Table 3A.1.16 of the *IPCC 2003* (Annex 3A.1, p. 3.185). The emission ratios of CH_4 (0,012) and N_2O (0,007) are taken from Table 3A.1.15 of the *IPCC 2003* (Annex 3A.1, p. 3.185).

Non-CO_2 emissions from drainage of forest soils

Non-CO_2 emissions from drainage of lands converted to forest land were included into calculations of non-CO_2 emissions of Forest land remaining Forest land.

7.2.3 Quantitative overview of carbon emissions/removals from the sector

The area of total forest land area, Forest Land remaining Forest Land, and area of Land converted to Forest Land are provided in the table **Klaida! Nerastas nuorodos šaltinis.**below.

Table 7-19. Forest land area changes in 1990-2011, thous. ha

Year	Forest land	Forest land remaining Forest land	Land converted to Forest land					
			Cropland	*Grassland*	*Wetlands*	*Settlements*	*Other land*	Total land converted to Forest land
1990	2061,4	1959,5	0,4	66,3	34,0	NO	1,2	101,9
1991	2068,6	1961,9	0,8	68,7	35,5	0,4	1,2	106,6
1992	2074,6	1964,3	1,2	71,1	35,9	0,4	1,6	110,2
1993	2079,7	1969,1	2,4	71,5	34,7	0,4	1,6	110,6
1994	2082,5	1972,7	2,4	70,7	34,4	0,8	1,6	109,8
1995	2084,9	1975,9	2,4	69,9	34,4	0,8	1,6	109,0
1996	2090,1	1980,3	2,8	69,5	35,1	0,8	1,6	109,8
1997	2093,7	1983,9	3,6	69,1	34,7	0,8	1,6	109,8
1998	2097,3	1989,1	3,6	69,5	32,4	0,8	2,0	108,2
1999	2100,1	1993,1	4,0	68,7	31,6	0,8	2,0	107,0
2000	2105,7	2002,3	4,4	64,7	31,2	0,8	2,4	103,4
2001	2108,9	2006,7	5,2	64,7	29,2	0,8	2,4	102,2
2002	2113,3	2012,2	5,2	65,5	27,2	0,8	2,4	101,1
2003	2118,9	2018,2	6,0	65,1	26,4	1,2	2,0	100,7
2004	2126,9	2021,4	6,4	68,7	27,2	1,2	2,0	105,4
2005	2134,9	2025,4	7,2	71,9	26,8	1,2	2,4	109,4
2006	2142,1	2030,6	8,0	73,5	26,4	1,2	2,4	111,4
2007	2150,4	2036,2	10,4	72,3	27,6	1,2	2,8	114,2
2008	2157,2	2041,0	12,0	73,9	26,4	1,2	2,8	116,2
2009	2160,0	2047,8	12,0	72,7	23,6	1,2	2,8	112,2
2010	2166,4	2058,2	12,4	72,3	20,4	1,2	2,0	108,2
2011	2173,2	2065,4	14,0	73,1	18,0	0,8	2,0	107,8

Carbon stock change in living biomass

Area and growing stock volume in Forest Land remaining Forest Land was increasing annually since 1990 to 2011 except 1996 when total growing stock volume resulted in losses comparing to previous years due to spruce dieback (Table 7-20). Annual change in area converted to Forest land was ranging from 0 ha change between the period 1996-1997 to the highest decrease of 4,0 thous. ha between the periods 2008-2009 and 2009-2010. The changes of growing stock volume are also related to area changes in Land converted to Forest Land.

Table 7-20. Annual change in growing stock volume in Forest Land remaining Forest Land and Land converted to Forest Land categories

Year	Forest land remaining forest land			Land converted to forest land (≤ 20 years stands)			Total, thous. m^3
	Coniferous thous. m^3	Deciduous, thous. m^3	Total, thous. m^3	Coniferous thous. m^3	Deciduous, thous. m^3	Total, thous. m^3	
1990	223337,4	167462,0	390799,5	959,2	5547,7	6506,9	397306,4

Year	Forest land remaining forest land			Land converted to forest land (≤ 20 years stands)			Total, thous. m^3
	Coniferous thous. m^3	Deciduous, thous. m^3	Total, thous. m^3	Coniferous thous. m^3	Deciduous, thous. m^3	Total, thous. m^3	
1991	226722,9	169779,0	396501,9	1017,9	5887,4	6905,4	403407,3
1992	229993,9	172010,0	402004,0	1076,2	6224,4	7300,6	409304,6
1993	233138,1	174395,1	407533,2	1084,2	6270,8	7355,0	414888,1
1994	236012,7	176524,1	412536,7	1101,8	6372,7	7474,5	420011,3
1995	237596,2	177581,5	415177,7	1134,6	6562,0	7696,6	422874,2
1996	236883,0	176925,9	413808,8	1155,6	6683,6	7839,3	421648,1
1997	237199,5	177005,5	414204,9	1188,4	6873,5	8061,9	422266,9
1998	241099,6	180010,4	421110,0	1189,1	6877,4	8066,5	429176,5
1999	244902,8	182864,6	427767,5	1205,0	6969,0	8174,0	435941,5
2000	249053,9	186447,3	435501,3	1129,0	6529,6	7658,6	443159,8
2001	254368,5	190490,8	444859,3	1140,1	6594,1	7734,2	452593,5
2002	255503,7	191411,8	446915,5	1131,1	6541,8	7672,9	454588,4
2003	260282,4	194162,2	454444,5	1231,1	6303,8	7534,9	461979,4
2004	262755,9	195178,2	457934,1	1097,7	6762,8	7860,5	465794,6
2005	263191,3	195811,7	459003,0	1226,4	6865,6	8092,0	467095,0
2006	265424,3	195951,1	461375,4	1302,3	6793,7	8096,0	469471,5
2007	268526,9	194178,4	462705,3	1275,8	6894,6	8170,4	470875,7
2008	272096,0	195636,0	467731,9	1459,7	6862,0	8321,6	476053,5
2009	277059,6	199519,3	476578,9	1306,3	6731,1	8037,4	484616,3
2010	284695,7	202232,2	486927,9	992,1	6365,3	7357,4	494285,3
2011	290293,9	206163,3	496457,2	699,0	6409,5	7108,5	503565,7

The total living biomass was fluctuating in Forest land remaining Forest Land from -788,4 thous. t d.m. up to 6164,8 thous. t d.m. during the period of 1990-2011. Living biomass losses of 788,4 thous. t d.m. were inventoried in 1996. The mean value of annual carbon stock change is about 1707 Gg. The largest living biomass decrease for Land converted to Forest land was observed in 1999-2003 and 2008-2009. This is related to decrease in area of Lands converted to Forest Land category. The carbon stock change values are varying between 165,0 and 202,9 Gg per year (Table 7-21).

Table 7-21. Annual carbon stock change due to living biomass change in Forest Land (emissions negative sign, removals positive sign)

Year	Forest land remaining forest land				Land converted to forest land (≤ 20 years stands)				Total Carbon stock change, Gg
	Above-ground biomass stock change, t d.m.	Below-ground biomass stock change, t d.m.	Total living biomass stock change, t d.m.	Carbon stock change, Gg	Above-ground biomass stock change, t d.m.	Below-ground biomass stock change, t d.m.	Total living biomass stock change, t d.m.	Carbon stock change, Gg	
1990	3195098,3	727763,1	3922861,5	1831,0	275130,8	54878,7	330009,4	165,0	1996,0
1991	3195098,3	727763,1	3922861,5	1831,0	291103,8	58064,7	349168,5	174,5	2005,5
1992	3088476,9	703477,4	3791954,3	1766,6	306716,1	61178,8	367894,9	183,9	1950,5
1993	2924183,0	666055,4	3590238,4	1777,3	310012,4	61836,3	371848,6	185,9	1963,2
1994	2683031,3	611127,1	3294158,4	1607,9	315250,6	62881,1	378131,7	189,0	1796,9

Year	Forest land remaining forest land				Land converted to forest land (≤ 20 years stands)				Total Carbon stock change, Gg
	Above-ground biomass stock change, t d.m.	Below-ground biomass stock change, t d.m.	Total living biomass stock change, t d.m.	Carbon stock change, Gg	Above-ground biomass stock change, t d.m.	Below-ground biomass stock change, t d.m.	Total living biomass stock change, t d.m.	Carbon stock change, Gg	
1995	1499368,3	341518,4	1840886,8	847,8	323506,1	64527,8	388033,9	193,9	1041,7
1996	-642131,6	-146261,5	-788393,1	-440,9	328590,0	65541,8	394131,9	196,9	-244,4
1997	324054,2	73811,4	397865,6	126,0	336133,1	67046,4	403179,6	201,5	327,5
1998	3618642,1	824235,8	4442877,9	2220,0	335572,9	66934,7	402507,6	201,1	2421,1
1999	3542884,9	806980,2	4349865,1	2139,7	338308,9	67480,4	405789,3	202,7	2342,5
2000	3780341,9	861066,9	4641408,8	2489,4	319123,5	63653,6	382777,1	191,2	2680,6
2001	4940519,8	1125326,3	6065846,1	3008,2	320906,7	64009,3	384916,0	192,3	3200,4
2002	1044745,3	237966,7	1282712,0	661,4	317687,6	63367,2	381054,8	190,3	851,8
2003	3833284,6	899284,5	4732569,1	1867,3	311445,7	62446,6	373892,3	186,7	2054,0
2004	1988200,7	459763,0	2447963,7	748,5	323144,5	64292,3	387436,7	193,5	941,9
2005	690037,9	150874,8	840912,7	186,3	330639,2	66039,8	396679,1	198,0	384,4
2006	1193266,5	307631,8	1500898,3	548,1	330464,7	66205,5	396670,2	198,0	746,1
2007	614292,9	224507,5	838800,4	199,5	333599,1	66730,8	400329,9	199,8	399,3
2008	2667664,6	638370,8	3306035,4	1776,8	338799,8	68197,6	406997,3	203,1	1979,9
2009	4485663,5	1020840,5	5506504,1	2800,3	301820,1	60499,6	362319,8	180,7	2981,0
2010	4964905,4	1199911,3	6164816,8	2736,3	306965,9	60977,7	367943,6	183,6	2919,9
2011	4856738,3	1108686,6	5965424,8	2642,4	300513,7	58985,7	359499,4	179,6	2822,0

Carbon stock change in dead organic matter

Dead wood is inventoried for Forest Land remaining Forest Land. Dead wood pool also includes below-ground biomass which has left on site during the forest fellings. Above-ground biomass of dead wood which is available during forest fellings is assumed to be removed.

Table 7-22 provides values of stock change in biomass and carbon stock change in dead wood. The data represent tendency of annual accumulation of dead wood in forest land since 1990 to 2011.

Table 7-22. Annual carbon stock change in Forest Land remaining Forest Land due to change in dead organic matter

Year	Dead wood				Dead wood from forest fellings		Total carbon stock change in dead organic matter, Gg
	Above-ground biomass stock change, t d. m.	Below-ground biomass stock change, t d. m.	Total biomass stock change, t d. m.	Carbon stock change, Gg	Below-ground biomass stock change, t d. m	Carbon stock change, Gg	
1990	113525,0	28777,6	142302,6	71,2	114516,7	57,3	128,4
1991	113525,0	28777,6	142302,6	71,2	50101,0	25,1	96,2
1992	158305,2	40543,6	198848,8	99,4	38888,0	19,4	118,9
1993	204386,4	52606,8	256993,1	128,5	270068,5	135,0	263,5
1994	341035,7	88381,9	429417,5	214,7	134557,1	67,3	282,0
1995	354004,1	92899,4	446903,5	223,5	432061,9	216,0	439,5
1996	16484,2	3755,0	20239,2	10,1	238099,3	119,0	129,2
1997	-145492,0	-39304,8	-184796,8	-92,4	83978,9	42,0	-50,4
1998	-180532,4	-47308,0	-227840,4	-113,9	-37217,9	-18,6	-132,5
1999	-135537,3	-35527,1	-171064,4	-85,5	-36740,8	-18,4	-103,9
2000	-111199,6	-28370,9	-139570,5	-69,8	17416,1	8,7	-61,1

Year	Dead wood				Dead wood from forest fellings		Total carbon stock change in dead organic matter, Gg
	Above-ground biomass stock change, t d. m.	Below-ground biomass stock change, t d. m.	Total biomass stock change, t d. m.	Carbon stock change, Gg	Below-ground biomass stock change, t d. m	Carbon stock change, Gg	
2001	9202,7	2065,9	11268,5	5,6	109745,1	54,9	60,5
2002	233351,6	52384,4	285736,1	142,9	219013,1	109,5	252,4
2003	158856,5	29166,7	188023,2	94,0	202707,3	101,4	195,4
2004	516464,4	114731,5	631195,8	315,6	111342,2	55,7	371,3
2005	698652,3	142763,9	841416,2	420,7	39812,7	19,9	440,6
2006	875186,9	179347,8	1054534,7	527,3	-22998,2	-11,5	515,8
2007	788122,3	171287,4	959409,7	479,7	-45155,5	-22,6	457,1
2008	928580,1	199631,3	1128211,4	564,1	-51402,5	-25,7	538,4
2009	491324,7	102736,1	594060,8	297,0	-84649,8	-42,3	254,7
2010	169483,7	39244,0	208727,7	104,4	-145745,6	-72,9	31,5
2011	464179,8	100715,2	564895,0	282,4	-142532,4	-71,3	211,2

Carbon stock change in soil

Carbon stock in dead organic matter has been increasing due to expansion of mineral soils in Forest Land remaining Forest Land and Land converted to Forest Land categories. Data on organic soils is presented by NFI, which is assessing soil type during inventory process by using Forest soils classification methodology prepared by prof. M. Vaičys. For more detailed information see chapter 7.2.1.

Table 7-23. Annual carbon stock change in Forest land remaining Forest land and land converted to Forest land from drained organic soils

Year	Forest land remaining Forest land		Land converted to Forest land												Total area of drained organic soils, thous. ha	Total CO_2 emissions, Gg
			Area of drained organic soils , thous. ha						CO_2 emissions, Gg							
	Area of drained organic soils , thous. ha	CO_2 emissions, Gg	*Cropland*	*Grassland*	*Wetlands*	*Settlements*	*Other land*	***Total***	*Cropland*	*Grassland*	*Wetlands*	*Settlements*	*Other land*	***Total***		
1990	154,8	-105,3	0,03	5,2	2,7	0,00	0,09	8,05	0,0	-3,6	-1,8	0,0	-0,8	-6,2	162,8	-111,5
1991	155,0	-105,4	0,06	5,4	2,8	0,03	0,09	8,39	0,0	-3,7	-1,9	-0,3	-0,8	-6,7	163,4	-112,1
1992	155,2	-105,5	0,09	5,6	2,8	0,03	0,13	8,68	-0,1	-3,8	-1,9	-0,3	-1,1	-7,2	163,9	-112,7
1993	155,6	-105,8	0,19	5,6	2,7	0,03	0,13	8,71	-0,1	-3,8	-1,9	-0,3	-1,1	-7,2	164,3	-113,0
1994	155,8	-106,0	0,19	5,6	2,7	0,06	0,13	8,61	-0,1	-3,8	-1,8	-0,5	-1,1	-7,4	164,5	-113,4
1995	156,1	-106,1	0,19	5,5	2,7	0,06	0,13	8,55	-0,1	-3,8	-1,8	-0,5	-1,1	-7,4	164,7	-113,5
1996	156,4	-106,4	0,22	5,5	2,8	0,06	0,13	8,61	-0,2	-3,7	-1,9	-0,5	-1,1	-7,4	165,1	-113,8
1997	156,7	-106,6	0,28	5,5	2,7	0,06	0,13	8,61	-0,2	-3,7	-1,9	-0,5	-1,1	-7,4	165,4	-114,0
1998	157,1	-106,9	0,28	5,5	2,6	0,06	0,16	8,49	-0,2	-3,7	-1,7	-0,5	-1,4	-7,6	165,7	-114,4
1999	157,5	-107,1	0,32	5,4	2,5	0,06	0,16	8,39	-0,2	-3,7	-1,7	-0,5	-1,4	-7,5	165,9	-114,6
2000	158,2	-107,6	0,35	5,1	2,5	0,06	0,19	8,11	-0,2	-3,5	-1,7	-0,5	-1,6	-7,6	166,4	-115,1
2001	158,5	-107,8	0,41	5,1	2,3	0,06	0,19	8,01	-0,3	-3,5	-1,6	-0,5	-1,6	-7,5	166,6	-115,3
2002	159,0	-108,1	0,41	5,2	2,1	0,06	0,19	7,92	-0,3	-3,5	-1,5	-0,5	-1,6	-7,4	167,0	-115,5
2003	159,4	-108,4	0,47	5,1	2,1	0,09	0,16	7,86	-0,3	-3,5	-1,4	-0,8	-1,4	-7,4	167,4	-115,8
2004	159,7	-108,6	0,50	5,4	2,1	0,09	0,16	8,24	-0,3	-3,7	-1,5	-0,8	-1,4	-7,7	168,0	-116,3
2005	160,0	-108,8	0,57	5,7	2,1	0,09	0,19	8,55	-0,4	-3,9	-1,4	-0,8	-1,6	-8,1	168,7	-116,9
2006	160,4	-109,1	0,63	5,8	2,1	0,09	0,19	8,71	-0,4	-3,9	-1,4	-0,8	-1,6	-8,2	169,2	-117,3
2007	160,9	-109,4	0,82	5,7	2,2	0,09	0,22	8,93	-0,6	-3,9	-1,5	-0,8	-1,9	-8,6	169,9	-118,0
2008	161,2	-109,6	0,95	5,8	2,1	0,09	0,22	9,09	-0,6	-4,0	-1,4	-0,8	-1,9	-8,7	170,4	-118,4
2009	161,8	-110,0	0,95	5,7	1,9	0,09	0,22	8,77	-0,6	-3,9	-1,3	-0,8	-1,9	-8,5	170,6	-118,5
2010	162,6	-110,6	0,98	5,7	1,6	0,09	0,16	8,46	-0,7	-3,9	-1,1	-0,8	-1,4	-7,8	171,1	-118,4
2011	163,2	-111,0	1,10	5,8	1,4	0,06	0,16	8,46	-0,8	-3,9	-1,0	-0,5	-1,4	-7,5	171,7	-118,5

Biomass burning

The default mean burned biomass values per hectare were used. Carbon emissions are related with burned area (Table 7-24). The largest carbon emissions were observed in 1992 (29,9 GgCO_2) and in 2006 (36,9 GgCO_2). This is the result of repetitive draughts (1992, 1994, 2002, 2006)[151] and irresponsible human behaviour with fire in over-dried forests. Forest fires resulted in nearly 1 million EUR losses for State forests in 2002 – 2006. 97% of all forest fires in Lithuania are caused by direct human activities (transportation, littering etc.) and only 1% is caused by natural circumstances e.g. thunder.

Table 7-24. Annual carbon stock change due to biomass burning

Year	Area burned, ha	Burned biomass, t d.m.	CO_2 emissions, Gg
1990	134,0	2653,2	4,1
1991	64,0	1267,2	2,0
1992	971,0	19225,8	29,9
1993	355,0	7029,0	10,9
1994	355,0	7029,0	10,9
1995	355,0	7029,0	10,9
1996	355,0	7029,0	10,9
1997	355,0	7029,0	10,9
1998	54,0	1069,2	1,7
1999	342,9	6789,8	10,6
2000	327,1	6476,0	10,1
2001	111,1	2200,6	3,4
2002	746,4	14778,9	23,0
2003	436,2	8636,2	13,4
2004	253,2	5013,4	7,8
2005	50,8	1006,6	1,6
2006	1199,3	23746,1	36,9
2007	38,0	752,4	1,2
2008	112,4	2225,5	3,5
2009	315,3	6242,9	9,7
2010	21,5	425,7	0,7
2011	292,8	5797,4	9,0

7.2.4 Uncertainty assessment

Lithuanian reporting system is mostly based on sampling method therefore national methodology was employed while estimating overall uncertainty.

Information obtained during NFI is based on the data of especially small size. The total number of allocated permanent plots in Lithuanian forests during the NFI of 1998 – 2007 comprised only slightly more than 264 ha. Information derived from this part of forests and trees is generalized to represent more than 2,1 mill. ha of Lithuanian forests. One sample tree (in permanent plots) represents 8000 trees. Several indices are important characterizing statistical information, namely, data accuracy and validity. Data accuracy depends on the variation of parameters of the measured

[151] *Lithuanian Hydrometeorological Service (available from: www.meteo.lt)*

object, sampling volume and measurement accuracy. Measurement accuracy may be increased by applying advanced measuring devices, more precise (often even more time saving) instrumental measurement methods and decreasing the influence of subjective "human" factor. Data validity is determined by the stability of the chosen sampling design (main parameters of which are: size of sample plots, clustering, location etc.) to assess the analysed object, as well as by methods and standards applied to estimate (measure) different parameters, elimination of any possible parameter estimation biases in the inventory system, etc. However, the obtained accurate data not necessarily guarantee the validity of the information on the analysed object. In other words, the use of highly precise up-to-date devices may not ensure sufficient data validity if they are collected, for instance, in subjectively selected sampling areas.

Lithuanian NFI system is developed so that the desired accuracy of results is in line with the maximum validity of information. Initial desired accuracy of NFI results is determined already in the first stage of NFI planning – prior to inventory, when the necessary sampling intensity is defined, measurement methods and tools are selected.

A two-stage sampling was tested for NFI sample plots, while estimating area distribution. In the first stage sample plots were allocated and assessed in the map of a satellite image. In the second stage the plots were allocated and assessed on the ground. According to a large extent first-stage sampling, forest land area may be assessed very accurately, i.e. with 0,15% precision. It would correspond to 3000 ha forest area error in the whole country. However, forest land identified in a satellite image map failed to comply with the reality. According to ground NFI estimation even in 9,8% of cases, i.e. so many times forest land was not detected in nature. And on the contrary, by ground method additionally 6,6% of plots on forest land were identified, which were not recognized in the satellite image. Thus, the assessment of forest land according to satellite images is of a comparatively low accuracy and in this phase it was eliminated.

Total forest land area according to yearly measurements of plots or according to the data of plots measured over a certain number of years is estimated by using the following equations:

$$Q_m = Q \times p_m \textit{ or } Q_m = K_m \times q_R;\ Q_m = \frac{q_m \times q_R}{500} \tag{7.23}$$

where:
Q – total area of Lithuanian territory (6 530 000 ha);
Q_m – forest land area, ha;
p_m – part of forest land area.
Part of forest land area is calculated using the following equation:

$$p_m = \frac{Km}{K} \tag{7.24}$$

where:
K_m – sum of plots or their parts on forest land, ascertained during inventory;
K – total number of plots in Lithuania.
Number of sample plots is estimated:

$$K = \frac{Q}{q_R} \tag{7.25}$$

where:
Q – total area of Lithuanian territory;
q_R - area, represented by one sample plot (399,41 ha).

The error of forest land assessment is estimated:

$$P_{Q_m} = \sqrt{\frac{1-p_m}{(K-1)p_m}} \times 100 \qquad (7.26)$$

where:
p_m – part of forest land area;.
K – total number of plots in Lithuania.

Estimation accuracy of different stand parameters depends on the variation of estimated parameter (expressed by variation coefficient $V_{\%}$) in the analysed set. The most actual is growing stock volume variation in sample plots of stand communities covering a large diversity of natural conditions. This parameter in Lithuania has not been studied yet. The first reliable data on growing stock volume variation in sample plots of entire stand communities were obtained after the first five – year period of NFI in 1998 – 2002. Having re-measured permanent sample plots in 2003 – 2007, these data were supplemented with the new information both on the growing stock volume and on the variation of gross volume increment, volume change, the volume of felled and dead trees. Variation of growing stock volume in sample plots, depending on site conditions and stand parameters, were analysed in 500 m^2 size permanent and temporary sample plots allocated in stands. The dependence of growing stock volume variation coefficient on dominant tree species, stand age, stocking level, site humidity and fertility and on site index, expressed by tree height at maturity, has been determined.

Overall uncertainties were estimated by using Tier 1 method further described in *IPCC 2003*, which is also known as simple error propagation method.

To estimate uncertainty of a product of several quantities eq. 5.2.1 (p. 5.10) of *IPCC 2003* was used:

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \cdots\ U_n^2} \qquad (7.27)$$

where:
U_{total} – percentage uncertainty in the product of the quantities (half the 95% confidence interval divided by the total and expressed as a percentage);
U_i – percentage uncertainties associated with each of the quantities, *i=1,..n.*

For estimation of overall uncertainty, the following equation of *IPCC 2003* was used (eq. 5.2.2; p.5.11):

$$U_E = \frac{\sqrt{(U_E \times E_1)^2 + (U_2 \times E_2)^2 + \ldots.(U_n \times E_n)^2}}{|\ E_1 + E_2 + \cdots E_n|} \qquad (7.28)$$

where:
U_E – percentage uncertainty of the sum;
U_i – percentage uncertainty associated with source/sink *I*;
E_i – emission/removal estimate for source/sink *i*.

The growing stock volume per 1 ha of all Lithuanian forests, based on permanent and temporary sample plots, was estimated with 0,9% accuracy. The lowest standard error (1,3%) was estimated for pine stands (dominant tree species in Lithuania) and the highest (5,1%) for ash and oak stands (lowest prevalence). To be consistent with *IPCC 2003* uncertainties should be reported as a confidence interval giving the range within which the underlying value of an uncertain quantity is through to lie for a specific probability. 95% confidence interval is used by Lithuania in uncertainty estimations.

For Forest Land remaining Forest Land it was assumed that uncertainty of area is 2,3%. Uncertainties of emission factor were estimated using *Tier 1* error propagation method described in *IPCC 2003* (eq. 5.2.2). For Forest Land remaining Forest land uncertainty of emission factor was assumed to be about 31,1%.

For Land converted to Forest Land it was assumed that uncertainty of area is 12,2%. Uncertainty of emission factor was assumed to be about 38,4%.

References for the uncertainties of values that were used in calculations are provided below:

Biomass:
1) D (wood density) – *IPCC 2003* Chapter 3 p. 3.31;
2) BEF – *IPCC 2003* Chapter 3 p. 3.31;
3) R (below ground biomass) – *IPCC 2003* Chapter 3 p. 3.31;
4) CF (carbon fraction) – *IPCC 2003* Chapter 5 p. 5.17

Dead wood:
1) D (wood density) – *IPCC 2003* Chapter 3 p. 3.31;
2) BEF – *IPCC 2003* Chapter 3 p. 3.31;
3) R (below ground biomass) – *IPCC 2003* Chapter 3 p. 3.31;
4) CF (carbon fraction) – *IPCC 2003* Chapter 5 p. 5.17

Litter:
1) Carbon in litter – *IPCC 2003* Chapter 3, p. 3.38

Organic soils (CO_2): EF (drainage) – *IPCC 2003* Chapter 3 p. 3.79 and p. 3.118
Organic soils (N_2O): EF_{ff} (drainage) – *IPCC 2003* Chapter 3, Appendix 3a.2, p 3.275, Table 3a.2.1

Forest fires: Coefficients – *IPCC 2003* Chapter 3, p 3.50

Table 7-25. Assessment uncertainty values

Indicator	Land Use Category	Unit	Uncertainty, %
Growing stock volume	Forest Land remaining Forest land	m^3	2,6
	Land converted to Forest Land	m^3	12,8
Area	Forest Land remaining Forest land	ha	2,3
	Land converted to Forest Land	ha	12,2
Emission factor	Forest Land remaining Forest land	$GgCO_2$	31,1
	Land converted to Forest Land	$GgCO_2$	38,4

7.2.5 Source-specific QA/QC and verification

National Forest Inventory Department of the Lithuanian State Forest Service is responsible for reporting of greenhouse gas emissions and removals from LULUCF sector. The main duties of NFI Dept. regarding greenhouse gas accounting are:

- Collection of activity data and emission factors used to calculate emissions and removals;
- Selection of methods for calculation of emissions and removals;
- Emission and removals estimates;
- Uncertainty assessment;
- Checking and archiving of input data, prepared estimates and used materials;
- Preparation of Common Reporting Format (CRF) tables and NIR parts for LULUCF & KP LULUCF;
- Implementation of QA/QC plan and specific QA/QC procedures;
- Providing of the final estimates (CRF tables and NIR part) for the EPA;
- Evaluating requirements for new data, based on internal and external reviews.

National Forest Inventory Dept. is managed by 16 well educated, experienced employees who are periodically trained and examined, participates in international workshops etc. 6 persons are responsible for collection of data on forest land and 4 persons on non-forest land, 2 employees are responsible for LULUCF & KP LULUCF data analysis, provides methodological guidance and prepares GHG reports.

Quality assurance and Quality control for data collection, data processing issues, preparation of reporting tables achieved by State Forest Service, elaborated control routines of executed LULUCF activities are ensured with the help of procedures established by Environmental Protection Agency. Every GHG emissions and removals submission is presented to scientific-advisory board, where chosen methods, activity data, emission factors and other parameters are discussed and approved.

The following procedures were carried out to ensure QC/QA procedures described in *IPCC 2003*:

- **periodical trainings** of field crews and individual training of new staff;
- **data consistency and completeness control** – carried out during measurements by field crews while entering data, and during processing of data after field works;
- **independent internal check assessments** – carried out on 5% of measured sample plots by NFI Control team;
- **independent external check assessments and judgments** of data processing procedures and algorithms used in the course of NFI, elaborated models, uncertainties etc. – carried out by third parties;
- **cross checking of statistics** gathered from permanent and temporary sample plots, comparison of NFI and SFI results;
- **domestic and external expert analysis and reviews;**
- **data archiving** (maintenance and storage) in several forms and copies in order to recover lost or corrupted data etc.

Applied QA/QC system ensures accuracy of reported information and it is in agreement with the QA/QC system requirements described in *IPCC 2003*.

7.2.6 Source-specific recalculations

Following ERT 2012 recommendations uncertainty values were re-estimated.

Yearly land transition matrixes of conversions from one land use category to Forest land were created, based on year of the conversion and the category converted.

For estimations of carbon stock changes in living biomass in lands converted to forest land, growing stock volume of lands converted was estimated using data of NFI permanent sample plots on mean growing stock volume at the year of conversion.

The total difference between emission/removals from Forest land of this submission and submission of 2012 is presented in Table 7-26.

Table 7-26. Reported in previous submission and recalculated emission/removals from Forest land during the period 1990-2010

Year	Previous submission, GgCO_2 eq.	This submission, GgCO_2 eq.	Absolut difference, GgCO_2 eq.	Relative difference, %
1990	-7207,5	-7819,5	612,0	8,5
1991	-7206,7	-7757,3	550,6	7,6
1992	-7119,3	-7622,6	503,3	7,1
1993	-7206,2	-8219,2	1013,0	14,1
1994	-6733,2	-7672,3	939,1	13,9
1995	-4098,1	-5476,5	1378,4	33,6
1996	1437,5	372,8	1064,7	-74,1
1997	-360,2	-1063,4	703,2	195,2
1998	-7943,0	-8437,6	494,6	6,2
1999	-7601,2	-8239,6	638,4	8,4
2000	-8545,2	-9617,5	1072,3	12,5
2001	-11221,9	-11970,0	748,1	6,7
2002	-2847,2	-4036,0	1188,8	41,8
2003	-9122,0	-8243,5	-878,5	-9,6
2004	-5654,0	-4836,2	-817,8	-14,5
2005	-3030,0	-3065,6	35,6	1,2
2006	-4707,6	-4639,5	-68,1	-1,4
2007	-3421,8	-3196,5	-225,3	-6,6
2008	-8243,0	-9295,3	1052,3	12,8
2009	-11316,1	-11868,2	552,1	4,9
2010	-12303,6	-10854,5	-1449,1	-11,8

7.2.7 Source specific planned improvements

Following the recommendations of ERT 2012, Lithuania plans to revise methodology used for estimation of country-specific mass values of available fuel for wildfires, including dead wood and litter.

7.3 Cropland (CRF 5.B)

The area of cropland comprises of the area under arable crops as well as orchards and berry plantations. According to national definitions - arable land is continuously managed or temporary unmanaged land, used and suitable to use for cultivation of agricultural crops, also fallows, inspects, plastic cover greenhouses, strawberry and raspberry plantations, areas for production of flowers and decorative plants. Arable land set at rest for one or several years (<5 years) before being cultivated again as part of an annual crop-pasture rotation is still included under cropland. Orchards and berry plantations are areas planted with fruit trees and fruit bushes (apple-trees, pear-trees, plum-trees, cherry-trees, currants, gooseberry, quince and others). Under this category only those orchards and berry plantations are included that are planted on other than household purpose land and mainly used for commercial purposes. Orchards and berry plantations planted in small size household areas and only used for householders' meanings are included under *Settlements* category. All croplands are managed land.

7.3.1 Source category description

Two source categories are accounted under this category: emissions from Cropland remaining Cropland and emissions from Land converted to Cropland. Estimated carbon stocks are presented in the table below.

Table 7-27. Estimated carbon stocks under Cropland land use category

Land Use Category	Carbon stock change in living biomass	Carbon stock change in dead organic matter	Carbon stock change in soils	
			Mineral soils	Organic soils
Cropland remaining Cropland	√	NO	NO*	√
Land converted to Cropland	√	NO	√	√

**Assumed to be close to zero, therefore reported as NO*

Information on data sources used for calculations are presented in Table 7-28.

Table 7-28. Information on data sources used for estimation of cropland land area

Sources used	Source data used
Soviet kolkhoz'es land use plans	1990
Orthophoto maps	NLF: 1995-1998; 2005, 2009, 2010
Land areas and croplands declarations database	2010-2011

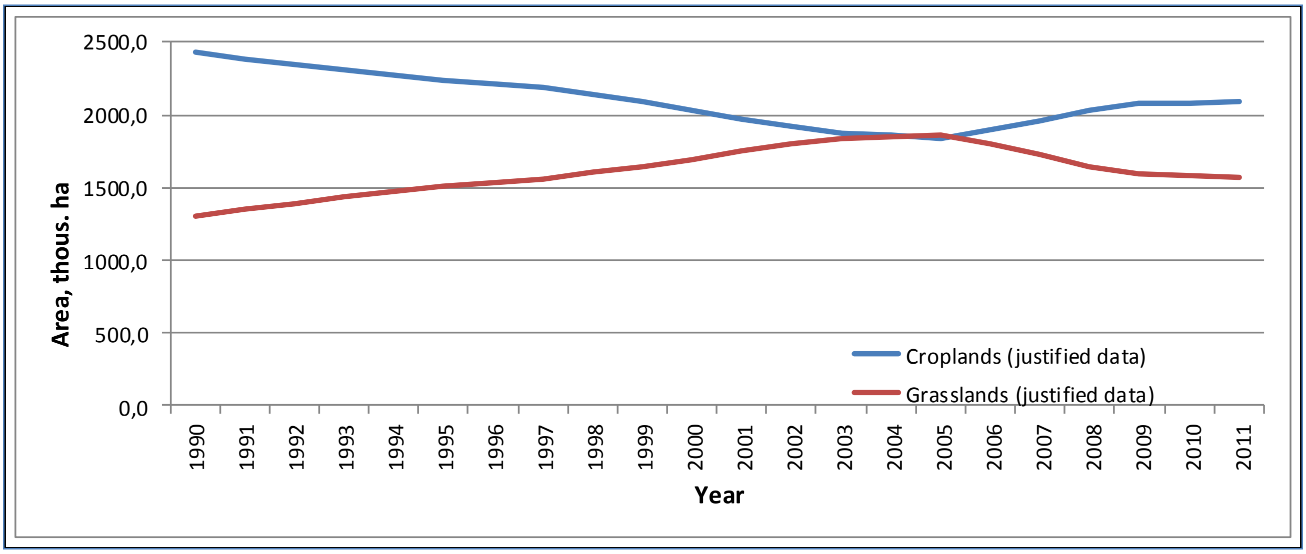

Figure 7-25. Comparison between estimated cropland and grassland area based on study and evened data

By seeking methodological correctitude and trying to avoid high range data jumps, data adjustment has been made based on reference points (1990, 1995, 2005, 2009) which had topographical data (Figure 7-25).

7.3.2 Methodological issues

7.3.2.1 Cropland remaining cropland

Emissions and removals reported from Cropland remaining Cropland (CC) include two subcategories of CO_2 emissions/removals:

- changes in carbon stocks in living biomass;
- changes in carbon stocks in soils.

The following equation was used for calculation of carbon stock changes (*IPCC 2003,* eq. 3.3.1, p. 3.70):

$$\Delta Ccc = \Delta Ccc_{LB} + \Delta Ccc_{Soils} \qquad (7.29)$$

where:
ΔCcc – annual change in carbon stocks in cropland remaining cropland, tonnes C yr^{-1};
ΔCcc_{LB} – annual change in carbon stocks in living biomass, tonnes C yr^{-1};
ΔCcc_{Soils} – annual change in carbon stocks in soils, tonnes C yr^{-1}.

To convert tonnes C to Gg CO_2, value is being multiplied by 44/12 and by 10^{-3}.

Change in carbon stocks in living biomass

The change in living biomass was only estimated for perennial woody crops. Statistics Lithuania reports total area of orchards and berry plantations in Lithuania being 45 thous. ha in 1990 to 29,2 thous. ha in 2011. Major part of total horticultural area reported in the agricultural statistics is covering private gardens and small land plots at the summer houses containing fruit trees which, according to the *IPCC 2003*, must be reported in Settlements (Chapter 7.6). Therefore, Lithuania reports only perennial woody biomass accumulated in commercial orchards. Since 1999 statistical data on areas of commercial orchards in Lithuania obtained from annual statistical reports of the State enterprise Agricultural Information and Rural Business Centre[152]. Area of commercial orchards in 1990 obtained from scientific publication of Venskutonis[153]. Data on area of commercial orchards during the period 1990-1998 was obtained using data interpolation.

Tier 1 method was chosen for calculations according to available activity data. Default factors were applied to nationally derived estimates of land areas. Default growth (2,1 tonnes C ha^{-1} yr^{-1}) and loss rates (63 tonnes C ha^{-1}) of aboveground woody biomass were employed from Table 3.3.2 of the *IPCC 2003* (p. 3.71).

For calculation of living biomass in perennial woody crops on cropland the following equation was used (*IPCC 2003,* eq. 3.2.2, p. 3.24):

$$\Delta Ccc_{LB} = (\Delta Ccc_G - \Delta Ccc_L) \qquad (7.30)$$

where:
ΔCcc_{LB} – annual change in carbon stocks in living biomass (includes aboveground biomass) in cropland remaining cropland, tonnes C yr^{-1};
ΔCcc_G – annual increase in carbon stocks due to biomass growth, tonnes C yr^{-1};
ΔCcc_L – annual decrease in carbon stocks due to aboveground biomass loss, tonnes C yr^{-1}.

Using default harvest cycles in cropping containing perennial species indicated in Table 3.2.2 of *IPCC 2003*, 30 years harvest/maturity cycle matrix was prepared. Area was distributed equally in age classes since 1990. ΔCcc_L – was calculated considering decrease in area according to age classes and was assumed that all aboveground biomass is lost at the age of 30.

The sources of uncertainty when using *Tier 1* method include the degree of accuracy in land area estimates and default carbon accumulation and loss rates. Established values of uncertainties are provided in Table 7-30.

Change in carbon stocks in soils

CO_2 emissions or removals from soils include these carbon stocks: mineral soils, CO_2 emissions from organic soils (i.e. peat soils) and emissions of CO_2 from liming of agricultural soils. According to *IPCC 2003*, carbon stocks are measured to a default depth of 30 cm and do not include C in surface residue (i.e. dead organic matter) or changes in inorganic carbon (i.e. carbonate minerals).

The change in organic carbon stocks in soils has been estimated using the following equation (*IPCC 2003*, eq. 3.3.2, p. 3.74):

$$\Delta Ccc_{Soils} = \Delta C_{CCMineral} - \Delta C_{CCOrganic} - \Delta C_{CCLime} \qquad (7.31)$$

where:
$\Delta C_{CCSoils}$ – annual change in carbon stocks in soils in cropland remaining cropland, tonnes C yr^{-1};
$\Delta C_{CCMineral}$ – annual change in carbon stocks in mineral soils, tonnes C yr^{-1};
$\Delta C_{CCOrganic}$ – annual carbon emissions from cultivated organic soils (estimated as net annual flux), tonnes C yr^{-1};
ΔC_{CCLime} – annual C emissions from agricultural lime application, tonnes C yr^{-1}.

[152] *Available from: http://www.vic.lt/*
[153] *Venskutonis,Vladas. Sodininkystė. Vilnius 1999 [en. Horticulture]*

Mineral soils

According to the report of available soil data in Lithuania[154] HAC soils (*Albeluvisols*, *Luvisols*, *Cambisols*) occupy 70% of cropland area, sandy soils (*Arenosols*) – 12%, spodic soils (*Podzols*) – 11%, wetland soils (*Gleysols*) – 5,3%.

Default reference soil organic carbon stocks (SOC_{REF}) in tones C per ha for 30 cm layer corresponding to cold temperate moist climate region were taken from *IPCC 2003* Table 3.3.3 (p. 3.76). Reference carbon content of HAC soils reported as 95 tonnes C per ha, sandy soils have 71 tonnes C per ha, spodic soils have 115 tonnes C per ha and wetland soils have 87 tonnes C per ha.

Carbon stock change in mineral soils was calculated using the following equation (*IPCC 2003,* eq. 3.3.3, p. 3.75):

$$\Delta C_{CCMineral} = [(SOC_0 - SOC_{(0-T)}) \times A] / T \quad (7.32)$$

$$SOC = SOC_{REF} \times F_{LU} \times F_{MG} \times F_I \quad (7.33)$$

where:
SOC – soil organic carbon stock, tonnes C ha^{-1};
SOC_{REF} – the reference carbon stock, tonnes C ha^{-1};
T – inventory time period, years (default is 20 year);
A – land area of each parcel, ha;
F_{LU} – stock change factor for land use or land-use change type, dimensionless;
F_{MG} – stock change factor for management regime, dimensionless;
F_I – stock change factor for input of organic matter, dimensionless.

Relative stock change factors (F_{LU}, F_{MG}, and F_I) for different management activities on cropland were taken from *IPCC 2003* Table 3.3.4 (p. 3.77).

Croplands in Lithuania represent area that has been continuously managed over 20 years, to predominantly annual crops. GPG revised F_{LU} factor for temperate wet climatic conditions is 0,71, error range ±12%. Conservation reserves having different F_{LU} factor started to be accounted by National Land Service since 2002. Though, such areas increased by ~15% since 2002, still remains negligible (<1 thous. ha) and therefore not included into calculations.

Main tillage practice is full tillage, described as substantial soil disturbance with full inversion and frequent tillage operations and little part of the surface covered by residues at planting time. GPG revised F_{MG} factor for temperate wet climatic conditions is 1,0, error NA. Area under reduced tillage has been growing in the period 1999-2004 (Šiuliauskas, Liakas. 2005)[155]. Statistics for such land accounting is not available, therefore not included into calculations.

Croplands in Lithuania mainly have medium residue return when all crop residues are returned to the field, either removal of residues compensated by organic matter supplements from green manure or other manures. Corresponding *IPCC 2003* revised F_I factor for such input in temperate wet climatic conditions is 1,0 (error NA).

[154] *Buivydaite, V.V. 2005. Soil Survey and Available Soil Data in Lithuania. ESB-RR9, p.211-223*
[155] *Šiuliauskas A.,Liakas V. Beplūgė žemdirbystė Lietuvos ūkiuose / Žemės ūkis. 2005. Nr. 2. –P.4-5. [en. Ploughless agriculture in Lithuanian farms]*

Organic soils

Using data presented by National Forest Inventory permanent sample plots measured in 2012, referring to 0,7% of organic soils from the total croplands area, it was assumed that this value is equally correct to croplands remaining croplands and to lands converted to croplands.

Tier 1 approach was used in order to calculate carbon stock change in organic soils (*IPCC 2003,* eq. 3.3.5, p. 3.79). Default emission factors (*IPCC 2003* Table 3.3.5, p. 3.79) were used along with area estimates for cultivated organic soils in cold temperate climate region present in Lithuania (*IPCC 2003,* eq. 3.3.5, p. 3.79). Default emission factor for cold temperate regions – 1 tonne C ha^{-1} yr^{-1}.

$$\Delta C_{CC_{Organic}} = \sum_c (A \times EF)_c \qquad (7.34)$$

where:
$\Delta C_{CC_{Organic}}$ – CO_2 emissions from cultivated organic soils in croplands remaining croplands, tonnes C yr^{-1};
A – land area of organic soils in climate type *c*, ha;
EF – emission factor for climate type *c*, (Table 3.3.5), tonnes C ha^{-1} yr^{-1}.

Liming

Naturally acid soils cover ~41% of agricultural land in Lithuania. Following the introduction of large-scale agricultural technologies (1965-1990) the extent of acid soils was successfully reduced to 19% nationwide (Eidukeviciene *et al.* 2010)[156]. It was succeeded due to intensive long-term liming, with applications of dust limestone to 160.000-200.000 ha per year from 1976, with average application rate of 4,5 t ha^{-1} $CaCO_3$ (Knasys, 1985)[157]. Main liming agent was dust limestone produced by AB „Akmenės cementas".

However, as a result of political and economical changes in Lithuania since 1991 and the repeal of state support, the extent of liming decreased, falling from 14.400 to 4.000 ha per year between 1993 and 1996. Since 1997 liming of acid soils has virtually ceased, except on large farms using various liming agents, but reliable statistical data on liming of such agricultural land in Lithuania is not available. The overview of annual application rates and annual C emissions are presented in Table 7-29. Drastic reduction in liming was also confirmed by two dolomite quarries which are the main suppliers of dolomite based liming agents in Lithuania, both companies are not producing dolomite for soil liming for the last 10 years. AS "Naujasis kalcitas" being subsidiary company of AB „Akmenės cementas" which nowadays produces limestone based soil liming agents, reports 4000-6000 tonnes annual limestone sales in recent years. Eventhough liming has decreased dramatically novadays comparing to 1990 but the long-term effect of previous large scale liming is still visible allowing producing reasonable yields on acidified areas even today. This is also supported by farming practice growing acidity tolerant plants.

[156] *Eidukeviciene, M., Volungevicius, J., Marcinkonis, S., Tripolskaja, L., Karcauskiene, D., Fullen, M. A., and Booth, C. A. (2010) Interdisciplinary analysis of soil acidification hazard and its legacy effects in Lithuania. Nat. Hazards Earth Syst. Sci., 10, 1477-1485, doi:10.5194/nhess-10-1477-2010.*

[157] *Knašys V. (1985). Dirvožemių kalkinimas. Vilnius: Mokslas. 262 p. [en. Soil liming]*

Table 7-29. Annual amount of limestone and dolomite used for liming in 1990-2011, tonnes

Reporting year			**± change 1990-2011**
1990	1996	2011	
Annual application in tones of $CaCO_3$			
900000	18000	6000	-894000
Annual C emissions from agricultural lime application. tonnes C yr^{-1}			
108000	2160	720	-107280

The *Tier 1* method was used to estimate CO_2 emissions from liming of cropland. The following equation was used for calculation of annual C emissions from agricultural lime application (*IPCC 2003* eq. 3.3.6, p. 3.42):

$$\Delta C_{CCLime} = M_{Limestone} \times EF_{Limestone} \quad (7.35)$$

where:
ΔC_{CCLime} – annual C emissions from agricultural lime application, tonnes C yr^{-1};
$M_{Limestone}$ – annual amount of calcium limestone or dolomite, tonnes yr^{-1};
$EF_{Limestone}$ – emission factor, tonnes C (tonne limestone or dolomite)$^{-1}$.

Overall emission factor of 0,12 has been used to estimate CO_2 emissions, without differentiating between variable compositions of lime material. Tonnes of C converted to $GgCO_2$ by multiplying conversion factor by 44/12 and 10^{-3}.

Annual CO_2 emissions in recent years founded to be ~150 times lower comparing with 1990. CO_2 emission in 2011 from agricultural lime application were 2,64 $GgCO_2$.

7.3.2.2 Land converted to Cropland

Regarding information obtained from NFI, during the last decades there have been no conversions of Forest land to Cropland. CO_2 and N_2O emissions and removals are reported from Land converted to Cropland (LC) using *Tier 1* method.

The following equation was used for calculation of total change in carbon stocks in Land converted to Cropland (*IPCC 2003* eq. 3.3.7, p. 3.83):

$$\Delta C_{LC} = \Delta C_{LCLB} + \Delta C_{LCSoils} \quad (7.36)$$

where:
ΔC_{LC} - total change in carbon stocks in land converted to cropland, tonnes C yr^{-1};
ΔC_{LCLB} - change in carbon stocks in living biomass in land converted to cropland, tonnes C yr^{-1};
$\Delta C_{LCSoils}$ - change in carbon stocks in soil in land converted to cropland, tonnes C yr^{-1};
To convert tonnes C to Gg CO_2, value multiplied by 44/12 and by 10^{-3}.

Change in carbon stock in living biomass

Tier 1 was used to estimate annual change in carbon stocks in living biomass on Land converted to Cropland. The default assumption for *Tier 1* is that all carbon in biomass is lost to the atmosphere through decay processes either on- or off-site. As such, *Tier 1* calculations do not differentiate immediate emissions from burning and other conversion activities. The following equation was used for calculation (*IPCC 2003* eq. 3.3.8, p. 3.85)

$$\Delta C_{LCLB} = A_{Conversion} \times (L_{Conversion} + \Delta C_{Growth}) \quad (7.37)$$

$$L_{Conversion} = C_{After} - C_{Before} \quad (7.38)$$

where:
ΔC_{LCLB} - annual change in carbon stocks in living biomass in land converted to cropland, tonnes C yr^{-1};
$A_{Conversion}$ - annual area of land converted to cropland, ha yr^{-1};
$L_{Conversion}$ - carbon stock change per area for that type of conversion when land is converted to cropland, tonnes C ha^{-1};
ΔC_{Growth} - changes in carbon stocks from one year of cropland growth, tonnes C ha^{-1};
C_{After} - carbon stocks in biomass immediately after conversion to cropland, tonnes C ha^{-1};
C_{Before} - carbon stocks in biomass immediately before conversion to cropland, tonnes C ha^{-1}.

It is assumed that for conversions from grasslands to croplands all biomass is cleared when preparing a site for cropland use, thus, no data available for conversions from other land uses to croplands. The default for C_{After} is 0 tonnes C ha^{-1}. Default 2,4 tonnes d.m. ha^{-1} estimate for C_{Before} has been used (Table 3.4.2 of *IPCC 2003*). It was also assumed that changes in carbon stocks from one year of cropland growth are equal to zero, because considering cropland management practice, biomass stock from one year is marginal. Default 5,0 tonnes C ha^{-1} carbon stock in biomass present on Land converted to Cropland (ΔC_{Growth}) has been used (Table 3.3.8 of *IPCC 2003*).

Change in carbon stock in soils

Tier 1 was used to estimate annual change in carbon stocks in soils on Land converted to Cropland. For calculation the following equation was used (*IPCC 2003* eq. 3.3.12, p. 3.89):

$$\Delta C_{LCSoils} = \Delta C_{LCMineral} - \Delta C_{LCOrganic} - \Delta C_{LCLiming} \quad (7.39)$$

where:
$\Delta C_{LCSoils}$ – annual change in carbon stocks in soils in land converted to cropland, tonnes C yr^{-1};
$\Delta C_{LCMineral}$ – change in carbon stocks in mineral soils in land converted to cropland, tonnes C yr^{-1};
$\Delta C_{LCOrganic}$ – annual C emissions from cultivated organic soils converted to cropland (estimated as netannual flux), tonnes C yr^{-1};
$\Delta_{CLCLiming}$ – annual C emissions from agricultural lime application on land converted to cropland, tonnes C yr^{-1}.

Calculation of carbon stocks in mineral soils on Lands converted to Cropland were based on same methodological approaches as for Cropland remaining Cropland described in more details in chapter 7.3.2.1.

Tier 1 approach was used in order to calculate carbon stock change in organic soils. Default 1 tonne C ha^{-1} yr^{-1} emission factor (Table 3.3.5 of *IPCC 2003*, p. 3.79) was used along with area estimates for Wetlands converted to Cropland in cold temperate climate region which is common for Lithuania (*IPCC 2003* eq. 3.3.5, 3.79). Area of organic soils was assumed to be 0,7% to all conversions to Croplands.

All carbon emission from lime application reported in Cropland remaining Cropland category, therefore CO_2 emissions from liming reported to be zero in Land converted to Cropland.

7.3.3 Non-CO_2 greenhouse gas emissions

Emissions of non-CO_2 greenhouse gases resulting from fires in Cropland categories were estimated employing the following equation: (*IPCC 2006* eq. 2.27, p. 2.42):

$$L_{fire} = A \times M_b \times C_f \times G_{ef} \times 10^{-3} \quad (7.40)$$

where:
L_{fire} – amount of greenhouse gas emissions from fire, tonnes of each GHG e.g., CH_4, N_2O, etc.;
A – area burnt, ha;
M_b – mass of fuel available for combustion, tonnes ha^{-1}. This includes biomass, ground litter and dead wood. When *Tier 1* methods are used then litter and dead wood pools are assumed zero, except where there is a land-use change;
C_f – combustion factor, dimensionless (Table 2.6, *IPCC 2006*);
G_{ef} – emission factor, g kg^{-1} dry matter burnt (Table 2.5, *IPCC 2006*).

Note: Where data for M_B and C_f was not available, a default value for the amount of fuel actually burnt (the product of M_B and C_f) was used (Table 2.4, IPCC 2006).

Conversion of GHG emissions to CO_2 Gg has been made by multiplying certain amount of gases in tonnes by:
- For CH_4 multiplied by 16/12/1000.
- For CO multiplied by 28/12/1000.
- For N_2O multiplied by 44/28/1000.
- For NO multiplied by 46/14/1000.

Agriculture section already addresses the following non-CO_2 emission sources:
- N_2O emissions from application of mineral and organic fertilizers, organic residues and biological nitrogen fixation and N_2O emissions from cultivation of organic soils reported as part of the Chapter 6 - Agriculture (CRF sector 4).

7.3.4 Uncertainty assessment

The activity data were obtained from The National Land Service (NLS) and State enterprise Agricultural Information and Rural Business Centre (AIRBC). The emission factors were employed from *IPCC 2003*. The uncertainty rates in the activity data and the emission factors used in the estimates are reported in Table 7-30.

Table 7-30. Estimated values of uncertainties for Cropland

Input	Uncertainties, %	References
Activity data		
Cropland area	±2,2	*Study 2*
Emission factors		
G (biomass accumulation)	±75	*IPCC 2003*, p. 3.71
L (biomass loss)	±75	*IPCC 2003*, p. 3.71
SOC_{REF}	±95	*IPCC 2003*, p. 3.76
F_{LU} F_{MG} F_I	NA	*IPCC 2003*, p. 3.77
EF (organic soils)	±90	*IPCC 2003*, p. 3.79

7.3.5 Source-specific QA/QC and verification

The QC/QA includes the QC activities described in the *IPCC 2003*. Activity data and emission values are compared with emission values of other countries. If errors were found they were corrected.

7.3.6 Source-specific recalculations

Carbon stock changes for conversions from other land uses to croplands were estimated in this submission, particularly carbon stock changes in organic soils on lands converted to croplands were estimated in this submission. Also re-estimations of carbon stock changes in organic and mineral soils in Croplands remaining croplands were performed using data presented by NFI.

The total difference between emission/removals from Cropland of this submission and submission of 2012 is presented in Table 7-31.

Table 7-31. Reported in previous submission and recalculated emission/removals from Cropland during the period 1990-2010

Year	Previous submission, $GgCO_2$ eq.	This submission, $GgCO_2$ eq.	Absolut difference, $GgCO_2$ eq.	Relative difference, %
1990	354,8	5772,1	-5417,3	1526,9
1991	136,0	5211,8	-5075,8	3732,2
1992	140,1	5042,9	-4902,8	3499,5
1993	78,3	4855,2	-4776,9	6100,8
1994	141,5	4682,0	-4540,5	3208,8
1995	138,8	4494,0	-4355,2	3137,8
1996	136,0	4326,4	-4190,4	3081,2
1997	128,9	4211,9	-4083,0	3167,6
1998	132,8	4052,2	-3919,4	2951,4
1999	136,7	3891,0	-3754,3	2746,4
2000	171,6	3619,6	-3448,0	2009,3
2001	16,3	3199,6	-3183,3	19529,4
2002	192,9	3046,2	-2853,3	1479,2
2003	3,8	2661,1	-2657,3	69928,9
2004	-3,5	2575,6	-2579,1	-73688,6
2005	-3,9	2449,9	-2453,8	-62917,9
2006	-463,3	3147,1	-3610,4	-779,3
2007	-645,7	3346,4	-3992,1	-618,3
2008	-616,7	3792,3	-4409,0	-714,9
2009	-564,8	3953,3	-4518,1	-799,9
2010	-30,3	3669,4	-3699,7	-12210,2

7.3.7 Source-specific planned improvements

Following ERT 2012 recommendations inconsistencies in biomass, dead wood and litter stock changes estimates as well as carbon stock-change factors and assumptions made to ensure comparability between land use changes associated with land use conversions from croplands to grasslands and vice versa will be revised. Uncertainty assessment of emissions from cropland will be improved.

7.4 Grassland (CRF 5.C)

7.4.1 Source category description

According to national definition – grassland includes meadows and natural pastures planted with perennial grasses or naturally developed, on a regular basis used for moving and grazing. Grasslands cultivated for less than 5 years, in order to increase ground vegetation, still remain grasslands. All grasslands are managed land. Only emissions from organic soils have been estimated under category Grassland remaining Grassland, assuming that there is no carbon stock change in living biomass and no liming of natural grasslands and pastures was applied during the last decades. Estimated carbon stocks are presented in the table below.

Table 7-32. Estimated carbon stocks under Grassland land use category

Land Use Category	Carbon stock change in living biomass	Carbon stock change in dead organic matter	Carbon stock change in soils	
			Mineral soils	Organic soils
Grassland remaining Grassland	NO	NO	NO*	√
Land converted to Grassland	√	NO	√	√

**Assumed to be close to zero, therefore reported as NO*

Two source categories are accounted under this category: emissions from Grassland remaining Grassland and emissions from Land converted to Grassland.

7.4.2 Methodological issues

7.4.2.1 Grassland remaining Grassland

Emissions and removals reported from Grassland remaining Grassland (GG) include two subcategories of CO_2 emissions/removals:

- changes in carbon stocks in living biomass;
- changes in carbon stocks in soils.

The total annual carbon stock change in GG category was estimated as the sum of annual estimates of carbon stock changes in each carbon pool – living biomass and soils – as shown in equation below (*IPCC 2003* eq. 3.4.1, p. 3.105):

$$\Delta C_{GG} = \Delta C_{GGLB} + \Delta C_{GGSoils} \qquad (7.41)$$

where:
ΔC_{GG} – annual change in carbon stocks in Grassland remaining Grassland, tonnes C yr^{-1};
ΔC_{GGLB} – annual change in carbon stocks in living biomass in Grassland remaining Grassland, tonnes C yr^{-1};
$\Delta C_{GGSoils}$ – annual change in carbon stocks in soils in Grassland remaining Grassland, tonnes C yr^{-1}.

To convert tonnes C to Gg CO_2 values are multiplied by 44/12 and by 10^{-3}.

Change in carbon stocks in living biomass

Grassland management practices in Lithuania mainly are static. Default *Tier 1* method was used assuming that there is no carbon stocks change in living biomass. Because *Tier 1* method does not assume any change in grassland biomass, it is not relevant to develop activity data and uncertainty estimates for *Tier 1*.

Change in carbon stocks in soils

Carbon stock changes (CO_2 emissions or removals) for mineral and organic soils (i.e. peat soils) are considered. Liming was not applied for natural grasslands and pastures during the last decades. Carbon emission from grassland lime application in the early 90's was reported together with cropland lime application in subcategory 5.B.1, therefore CO_2 emissions from liming reported to be zero in grasslands to avoid double counting and reported as NO.

For carbon stock changes in mineral soils, the *IPCC 2003* define soil carbon stocks as organic carbon incorporated into mineral soil horizons to a depth of 30 cm and do not include C in surface residue (i.e. dead organic matter) or changes in inorganic carbon (i.e. carbonate minerals).

The change in organic carbon stocks in soils has been estimated using the following equation (*IPCC 2003* eq. 3.4.7, p. 3.111):

$$\Delta C_{GGSoils} = \Delta C_{GGMineral} - \Delta C_{GGOrganic} - \Delta C_{GGLiming} \qquad (7.42)$$

where:
$\Delta C_{GGSoils}$ – annual change in carbon stocks in soils in grassland remaining grassland, tonnes C yr^{-1};
$\Delta C_{GGMineral}$ – annual change in carbon stocks in mineral soils in grassland remaining grassland, tonnes C yr^{-1};
$\Delta C_{GGOrganic}$ – annual change in carbon stocks in organic soils in grassland remaining grassland (estimated as net annual flux), tonnes C yr^{-1};
$\Delta C_{GGLiming}$ – annual C emissions from lime application to grassland, tonnes C yr^{-1}.

Mineral Soils

Area of organic and mineral soils was determined by using data of NFI permanent sample plots measured in 2012, according to which area of organic soils constitute to 10,5% and area of mineral soils 89,5%

Annual rates of emissions by source or removals by sinks were calculated as the difference in stocks (over time) divided by the inventory time period. The default time period is 20 years. Carbon stock change in mineral soils was calculated using the following equation (*IPCC 2003* eq. 3.4.8, p. 3.112):

$$\Delta C_{GGMineral} = [(SOC_0 - SOC_{(0-T)}) \times A] / T \qquad (7.43)$$

$$SOC = SOC_{REF} \times F_{LU} \times F_{MG} \times F_I \qquad (7.44)$$

where:
$\Delta C_{GGMineral}$ – annual change in carbon stocks in mineral soils, tonnes C yr^{-1};
SOC_0 – soil organic carbon stock in the inventory year, tonnes C ha^{-1};
$SOC_{(0-T)}$ – soil organic carbon stock T years prior to the inventory, tonnes C ha^{-1};
T – inventory time period, years (default is 20 years);
A – land area of each parcel, ha;

SOC_{REF} – the reference carbon stock, tonnes C ha^{-1} (Table 3.4.4 of *IPCC 2003*);
F_{LU} – stock change factor for land use or land-use change type, dimensionless (Table 3.4.5 of *IPCC 2003*);
F_{MG} – stock change factor for management regime, dimensionless (Table 3.4.5 of *IPCC 2003*);
F_I – stock change factor for input of organic matter, dimensionless (Table 3.4.5 of *IPCC 2003*).

Default reference soil organic carbon stocks (SOC_{REF}) were taken from *IPCC 2003* Table 3.4.4 (p. 3.117). For cold temperate moist climate region, HAC soils with 95 tonnes C per ha for 30 cm layer, sandy soils - 71 tonnes C per ha for 30 cm layer, spodic soils - 115 tonnes C per ha for 30 cm layer and wetland soils - 87 tonnes C per ha for 30 cm layer. The average value obtained from the values given above was calculated as 93,88 tonnes C per ha for 30 cm layer.

Relative stock change factors (F_{LU}, F_{MG} and F_I) for grassland management were taken from *IPCC 2003* Table 3.4.5 (p. 3.118).

All grasslands (excluding those on organic soils) are assigned a base or (land use) F_{LU} factor of 1 (error NA).

It was assumed that carbon inputs and losses in mineral soil balance in Grassland remaining Grassland category is equal one to another and therefore net changes are close to zero (reported as NO). Carbon inputs and losses from mineral soil are calculated for Land converted to Grassland category only.

Grasslands in Lithuania mainly represents non-degraded and sustainably managed grasslands, but without significant management improvements during the last decades. Corresponding *IPCC 2003* revised default F_{MG} factor in all climatic conditions is 1,0 (error NA).

Nominal level input (applied only to improved grassland) used. Corresponding *IPCC 2003* revised F_I factor for improved grassland where no additional management inputs is 1,0 (error NA).

As grassland management activities in Lithuania are not changing, it was assumed that annual carbon stock changes in mineral soils for Grassland remaining Grassland are close to zero.

Organic soils

The activity data was determined by using data of NFI permanent sample plots measured in 2012, according to which area of organic soils constitute to 10,5% and area of mineral soils 89,5% of the total land area.

Tier 1 is used to estimate annual C emissions. Area of grassland organic soils under cold temperate regime was multiplied by the default emission factor using the fallowing equation (*IPCC 2003* eq. 3.4.10, p. 3.114):

$$\Delta C_{GGOrganic} = \Sigma_c \, (A \times EF)_c \qquad (7.45)$$

where:
$\Delta C_{GGOrganic}$ – CO_2 emissions from cultivated organic soils in grassland remaining grassland, tonnes C yr^{-1};
A – land area of organic soils in climate type *c*, ha;
EF – emission factor for climate type *c*, tonnes C ha^{-1} yr^{-1}.

Emission factor (EF) of 0,25 tonnes C ha^{-1} yr^{-1} for a cold temperate regime has been used for calculations (*IPCC 2003* Table 3.4.6 p. 3.118). Tonnes C converted to Gg CO_2 by the multiplying conversion factor 44/12 and 10^{-3}.

7.4.2.2 Land Converted to Grassland

Regarding information obtained from *Study-1* and *Study-2* during the last decades there have been no conversions of Forest land to Grasslands. Emissions and removals from Land converted to Grassland (LG) reported using *Tier 1* method including two subcategories of CO_2 emissions/removals:

- changes in carbon stocks in living biomass;
- changes in carbon stocks in soils.

The following equation was used for calculation of total change in carbon stocks in Land converted to Grassland (*IPCC 2003* eq. 3.4.12, p. 3.120):

$$\Delta C_{LG} = \Delta C_{LGLB} + \Delta C_{LGSoils} \qquad (7.46)$$

where:
Δ_{CLG} – total change in carbon stocks in land converted to grassland, tonnes C yr^{-1};
ΔC_{LGLB} – change in carbon stocks in living biomass in land converted to grassland, tonnes C yr^{-1};
$\Delta C_{LGSoils}$ – change in carbon stocks in soils in land converted to grassland, tonnes C yr^{-1}.

To convert tonnes C to Gg CO_2, values are multiplied by 44/12 and by 10^{-3}.

Change in carbon stock in living biomass

Tier 1 is used to estimate annual carbon stocks change in living biomass from Land converted to Grassland. The default assumption for *Tier 1* is that all carbon in biomass is lost to the atmosphere through decay processes either on- or off-site. As such, *Tier 1* calculations do not differentiate immediate emissions from burning and other conversion activities. Equation used for calculation (*IPCC 2003* eq. 3.4.13, p. 3.122):

$$\Delta C_{LGLB} = A_{Conversion} \times (L_{Conversion} + \Delta C_{Growth}) \qquad (7.47)$$

$$L_{Conversion} = C_{After} - C_{Before} \qquad (7.48)$$

where:
ΔC_{LGLB} – annual change in carbon stocks in living biomass in land converted to grassland, tonnes C yr^{-1};
$A_{Conversion}$ – annual area of land converted to grassland from some initial use, ha yr^{-1};
$L_{Conversion}$ – carbon stock change per area for that type of conversion when land is converted to grassland, tonnes C ha^{-1};
ΔC_{Growth} – carbon stocks from one year of growth of grassland vegetation after conversion, tonnes C ha^{-1};
C_{After} – carbon stocks in biomass immediately after conversion to grassland, tonnes C ha^{-1};
C_{Before} – carbon stocks in biomass immediately before conversion to grassland, tonnes C ha^{-1}.

It is assumed that all biomass is cleared when preparing a site for grassland use, thus, the default value C_{After} is 0 tonnes C ha^{-1}. Default estimate of 10,0 tonnes d.m. ha^{-1} for C_{Before} has been used (Table 3.4.8 of *IPCC 2003*). Default value of 13,6 tonnes d.m. ha^{-1} carbon stock in biomass after one year (ΔC_{Growth}) for cold temperate wet climate zone has been used (Table 3.4.9 of *IPCC 2003*).

Change in carbon stock in soils

Tier 1 method is used to estimate annual carbon stocks change in soils for Land converted to Grassland. The following equation was used for calculation (*IPCC 2003* eq. 3.4.17, p. 3.126):

$$\Delta C_{LGSoils} = \Delta C_{LGMineral} - \Delta C_{LGOrganic} - \Delta C_{LGLime} \quad (7.49)$$

where:
$\Delta C_{LGSoils}$ – annual change in stocks in soils in Land converted to Grassland, tonnes C yr^{-1};
$\Delta C_{LGMineral}$ – change in carbon stocks in mineral soils in Land converted to Grassland, tonnes C yr^{-1};
$\Delta C_{LGOrganic}$ – annual C emissions from organic soils converted to Grassland (estimated as net annual flux), tonnes C yr^{-1};
ΔC_{LGLime} – annual C emissions from agricultural lime application on Land converted to Grassland, tonnes C yr^{-1}.

Calculation of carbon stocks in mineral soils in Land converted to Grassland is based on the same methodological approaches as for Grassland remaining Grassland detailed in section 7.4.2.1.

Annual rates of emissions by source or removals sinks in croplands converted to grasslands were calculated as the difference in stocks (over time) divided by the inventory time period. The default time period is 20 years. Carbon stock change in mineral soils was calculated using the following equation (*IPCC 2003* eq. 3.4.8, p. 3.112):

$$\Delta C_{GGMineral} = [(SOC_0 - SOC_{(0-T)}) \times A] / T \quad (7.50)$$

$$SOC = SOC_{REF} \times F_{LU} \times F_{MG} \times F_I \quad (7.51)$$

where:
$\Delta C_{GGMineral}$ – annual change in carbon stocks in mineral soils, tonnes C yr^{-1};
SOC_0 – soil organic carbon stock in the inventory year, tonnes C ha^{-1};
$SOC_{(0-T)}$ – soil organic carbon stock T years prior to the inventory, tonnes C ha^{-1};
T – inventory time period, years (default is 20 years);
A – land area of each parcel, ha;
SOC_{REF} – the reference carbon stock, tonnes C ha^{-1} (Table 3.4.4 of *IPCC 2003*);
F_{LU} – stock change factor for land use or land-use change type, dimensionless (Table 3.4.5 of *IPCC 2003*);
F_{MG} – stock change factor for management regime, dimensionless (Table 3.4.5 of *IPCC 2003*);
F_I – stock change factor for input of organic matter, dimensionless (Table 3.4.5 of *IPCC 2003*).

Default reference soil organic carbon stocks (SOC_{REF}) were taken from *IPCC 2003* Table 3.4.4 (p. 3.117). For cold temperate moist climate region, HAC soils with 95 tonnes C per ha for 30 cm layer, sandy soils - 71 tonnes C per ha for 30 cm layer, spodic soils - 115 tonnes C per ha for 30 cm layer and wetland soils - 87 tonnes C per ha for 30 cm layer. The average value obtained from the values given above was calculated as 93,88 tonnes C per ha for 30 cm layer.

Tier 1 approach was used in order to calculate carbon stock change in organic soils. Default emission factor of 0,25 tonnes C yr^{-1} (Table 3.4.6, p. 3.118) was used along with area estimates for Wetlands converted to Grasslands in cold temperate climate region present in Lithuania (Equation 3.4.10). Area of organic soils was determined using data of NFI 2012 (10,5%) and was distributed to all conversions to grasslands.

All carbon emissions from lime application reported in Cropland remaining Cropland category, therefore CO_2 emissions from liming assumed to be zero in Land converted to Grassland and reported as NO.

7.4.3 Non-CO_2 greenhouse gas emissions

Non-CO_2 greenhouse gas emissions resulting from fire in Grassland category were calculated employing the same methodology used for calculation of non-CO_2 GHG emissions in Cropland category (Section 7.3.3)
The following non-CO_2 greenhouse gas emissions already reported in the Agriculture section:

- N_2O emissions from application of mineral and organic fertilizers, organic residues and biological nitrogen fixation in managed grassland;
- CH_4 emissions from grazing livestock.

7.4.4 Uncertainty assessment

The activity data was obtained from The National Land Service (NLS) and national Nature Heritage Fund (NHF). The emission factors were employed from *IPCC 2003*. The uncertainty rates in the activity data and the emission factors used in the estimates are reported in Table 7-33.

Table 7-33. Estimated values of uncertainties for Grassland

Input	**Uncertainties, %**	**References**
Activity data		
Grassland area	±1,2	*Study 2*
Emission factors		
SOC_{REF}	±95	*IPCC 2003*, p 3.117
F_{LU} F_{MG} F_I	NA	*IPCC 2003*, p 3.118
EF (organic soils)	±90	*IPCC 2003*, p 3.118

7.4.5 Source-specific QA/QC and verification

The QC/QA includes the QC activities described in the *IPCC 2000*. Activity data and emission values are compared with emission values of other countries. If errors were found they were corrected.

7.4.6 Source-specific recalculation

Carbon stock changes for conversions from other land uses to grasslands were estimated in this submission. Carbon stock changes in organic and mineral soils were re-estimated using data presented by NFI.

The total difference between emission/removals from Grassland of this submission and submission of 2012 is presented in Table 7-34.

Table 7-34. Reported in previous submission and recalculated emission/removals from Grassland during the period 1990-2010

Year	**Previous submission, $GgCO_2$ eq.**	**This submission, $GgCO_2$ eq.**	**Absolut difference, $GgCO_2$ eq.**	**Relative difference, %**
1990	461,5	-2362,4	2823,9	-611,9
1991	15,9	-2531,3	2547,2	-16020,1

1992	28,4	-2699,4	2727,8	-9604,9
1993	200,4	-2837,7	3038,1	-1516,0
1994	58,4	-3057,7	3116,1	-5335,8
1995	71,6	-3151,0	3222,6	-4500,8
1996	48,6	-2997,8	3046,4	-6268,3
1997	67,2	-3307,4	3374,6	-5021,7
1998	71,3	-3751,0	3822,3	-5360,9
1999	90,4	-4017,9	4108,3	-4544,6
2000	118,8	-4333,6	4452,4	-3747,8
2001	195,5	-4565,8	4761,3	-2435,4
2002	123,5	-4678,1	4801,6	-3887,9
2003	146,4	-4699,2	4845,6	-3309,8
2004	155,7	-4690,9	4846,6	-3112,8
2005	167,3	-4687,9	4855,2	-2902,1
2006	657,9	-4370,4	5028,3	-764,3
2007	612,6	-4067,7	4680,3	-764,0
2008	586,5	-3734,5	4321,0	-736,7
2009	565,1	-3441,6	4006,7	-709,0
2010	535,5	-3308,6	3844,1	-717,9

7.4.7 Source-specific planned improvements

Following the ERT 2012 recommendations inconsistencies in biomass, dead wood and litter stock changes estimates as well as carbon-stock-change factors and assumptions made to ensure comparability between land use changes associated with land use conversions from grasslands to croplands and vice versa will be revised. Uncertainty assessment of emissions from grassland will be improved.

7.5 Wetland (CRF 5.D)

Wetlands include peat extraction areas and peatlands which do not fulfil the definition of other categories. Water bodies and swamps (bogs) are also included under this category. Peat extraction areas are considered as managed land.

Data on wetland area were taken from the *Study-2*. The area includes two categories reported in the statistics – water bodies and swamps (bogs). Figure 7-26 shows comparison between data used for greenhouse gas estimations (*Study-1* and *Study-2*) and data provided by Lithuanian Inland Water Register. The difference between these two data sources is marginal. CO_2 emissions associated with peat extraction were evaluated.

Extracted peat is mostly used for production of organic fertilizers or fuel. Extent of such production is available from Statistics Lithuania[158].

In 2011 inland waters (lakes, rivers etc.) constituted to 196,0 (*Study-2* data) thous. ha, what is 57% of the total wetlands area. During the *Study-2* there was no differentiation for wetlands into managed and unmanaged categories. Only natural rivers, lakes, ponds and peat lands were estimated.

[158] Available from*: http://www.stat.gov.lt*

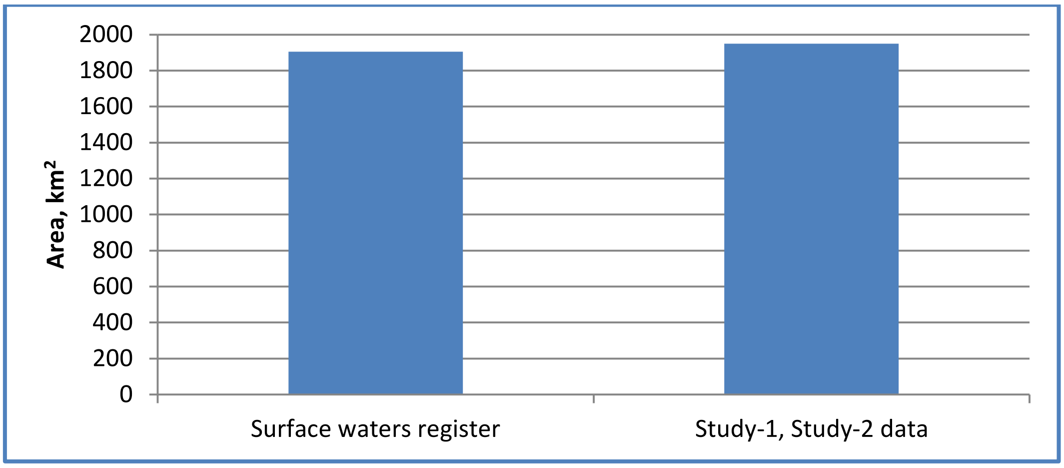

Figure 7-26. Comparison of data used for greenhous gas estimations (*Study-1* and *Study-2*) and data presented by Lithuanian Surface Waters Register

7.5.1 Source category description

Inland waters are distributed into two separate groups of managed and unmanned wetlands. Unmanaged wetlands are all surface waters (Lakes, riverbeds, lakelets, ponds etc.) and unmanaged peatlands. Managed wetlands are considered as peat extraction areas, which are monitored by Lithuanian Geological Service.

Table 7-35. Distribution of inland waters, thous. ha

Year	Inland waters		
	Unmanaged wetlands		Managed wetlands
	Surface waters	Peat lands	Peat lands
1990	240,4	143,1	18,0
1991	240,4	134,3	18,0
1992	240,4	127,9	18,0
1993	240,8	127,9	15,7
1994	240,8	120,2	18,7
1995	240,8	115,8	18,6
1996	240,8	112,9	18,5
1997	240,8	116,1	16,6
1998	240,8	115,1	16,8
1999	240,8	113,5	16,8
2000	240,4	108,3	17,6
2001	240,4	107,6	17,7
2002	240,4	113,5	14,4
2003	240,4	115,5	12,6
2004	240,0	111,7	13,3
2005	240,0	108,3	13,8
2006	239,6	104,5	14,3
2007	239,6	102,1	14,0
2008	239,2	101,6	14,0
2009	239,2	101,5	14,0
2010	239,2	99,8	14,0
2011	240,0	100,2	13,8

Surface waters are distributed by several groups, which are presented in the figure below.

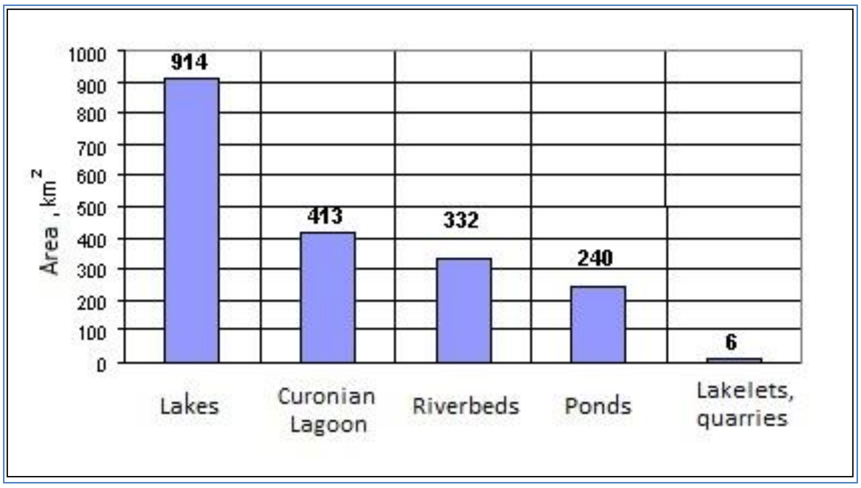

Figure 7-27. Surface waters area

Peat extraction areas are recorded by the Lithuanian Geological Service since 1992. Extraction area was fairly stable from 1992 to 2001 fluctuating in approximately 12% range (

Figure 7-28). Since 2002 extraction area has been reducing by approximately 20%. It was assumed that peat extraction area in 1990 and 1991 was the same as in 1992. In 2011 peat extraction area comprised to 13 778 ha.

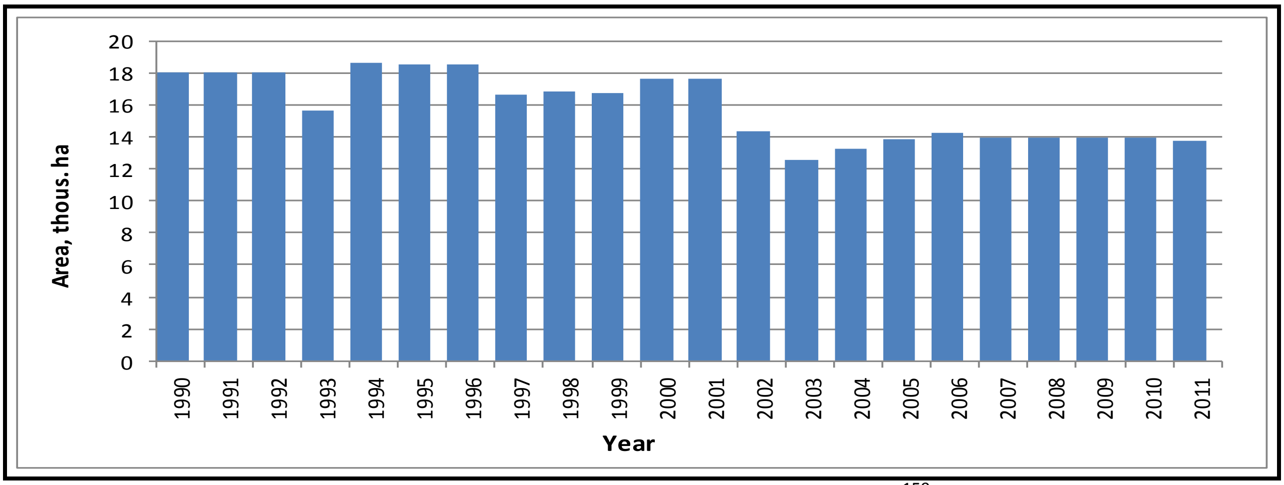

Figure 7-28. Changes of peat extraction areas[159]

7.5.2 Methodological Issues

The method provided in *IPCC 2003* addresses emissions from vegetation removal from land prepared for peat extraction and changes in soil organic matter due to oxidation of peat in the aerobic layer on the land during the extraction. As the total peat extraction area is slightly decreasing, it was assumed that emissions from removal of vegetation for peat extraction are negligible and was not taken into account. CO_2 emissions due to oxidation of peat were calculated using modified Equation 3a.3.6 of the Appendix 3a.3 of the *IPCC 2003*.

$$\Delta C_{drainage} = A_{Nrich} \times EF_{Nrich} \quad (7.52)$$

[159] *Lithuanian Geological Survey. [available on-line: www.lgt.lt]*

where:
$\Delta C_{drainage}$ – annual change in carbon stocks in soils due to drainage of organic soils converted to peat extraction, tonnes C yr^{-1}
A_{Nrich} – area of nutrient rich organic soils converted to peat extraction, ha
EF_{Nrich} – emission factor for changes in carbon stocks in nutrient rich organic soils converted to peatextraction, tonnes C ha^{-1} yr^{-1}.

As data on areas of nutrient rich and nutrient poor organic soils were not available, emission factor for carbon stocks change for soils that were converted to peat extraction was applied the one that is designed for nutrient rich peat land (Table 3.5.2 of *IPCC 2003*).

7.5.3 Uncertainty assessment

CO_2 emissions from wetlands were evaluated as a result of forest land conversion to wetlands. Converted areas are relatively very small and based on expert judgment it was assumed that uncertainty of activity data is about 80%. Emission factor uncertainty was assumed to be about 20%.

7.5.4 Source-specific QA/QC and verification

Quality control procedures named in *IPCC 2003* were established.

7.5.5 Source-specific recalculation

Carbon stock changes in soil during the conversion from Other land to Wetlands were eliminated from calculations, because it was assumed that land areas under Other land category do not contain organic soil layer.

For conversion of Forest land to Wetlands it was assumed that all aboveground and belowground biomass was removed entirely at the time of conversion.

The total difference between emission/removals from Wetland of this submission and submission of 2012 is presented in Table 7-36.

Table 7-36. Reported in previous submission and recalculated emission/removals from Wetland during the period 1990-2010

Year	Previous submission, $GgCO_2$ eq.	This submission, $GgCO_2$ eq.	Absolut difference, $GgCO_2$ eq.	Relative difference, %
1990	72,7	72,7	0	0
1991	72,7	72,7	0	0
1992	72,7	72,7	0	0
1993	142,7	63,3	79,4	-55,6
1994	75,3	75,3	0	0
1995	74,9	74,9	0	0
1996	74,7	74,7	0	0
1997	67,1	67,1	0	0
1998	68,0	68,0	0	0
1999	67,7	211,1	-143,4	211,8
2000	71,1	71,1	0	0

2001	84,8	71,4	13,4	-15,8
2002	58,2	58,2	0	0
2003	50,8	194,3	-143,5	282,5
2004	53,6	197,4	-143,8	268,3
2005	55,8	55,8	0	0
2006	57,6	57,6	0	0
2007	66,6	56,5	10,1	-15,2
2008	62,8	56,1	6,7	-10,7
2009	56,5	126,7	-70,2	124,2
2010	56,5	56,5	0	0

7.5.6 Source specific planned improvements

Additional studies and information research are planned in order to improve reporting of areas and greenhouse gas emissions/removals under this land use category.

7.6 Settlements (CRF 5.E)

7.6.1 Source category description

All urban territories, power lines, traffic lines and roads as well as orchards and berry plantations planted in small size household areas and only used for householders' needs are included under this category. According to national definition - urban territories are squares, playgrounds, stadiums, airports, yards, grave lands and buildings. Roads are land areas with engineering structure for transportation and traffic. In rural regions, areas with no special road cover used for mechanical and non-mechanical transport traffic and bridleways for animals were also included.

7.6.2 Methodological issues

7.6.2.1 Settlements remaining Settlements

General method was used to estimate changes in biomass carbon stocks as a result of tree growth, subtracting losses in biomass carbon stocks due to pruning and mortality. While growing conditions in parks and gardens usually are good, the growth and health condition of older trees are assumed to progressively deteriorate with time because of the harshness of urban conditions (e.g. relatively low radiation levels, air pollution). Therefore, estimation method assumes, that the accumulation of carbon in biomass slows down with the age and thus for trees older than 20 years increase in biomass carbon is assumed to offset losses from pruning and mortality. This is conservatively accounted for by setting $\Delta B_{SSG} = \Delta B_{SSL}$ (*IPCC 2003*, p. 3.298). Carbon stock changes in Settlements remaining Settlements assumed to be close to zero in Lithuania and reported as NO.

7.6.2.2 Land converted to Settlements

All land conversions to Settlements except conversion of Forest land accounted as Settlements remaining Settlements. For calculation of carbon stock changes caused by conversion of Forest land, Croplands and Grasslands to Settlements, it was assumed that all above ground forest biomass as well as dead wood and surface soil (litter) organic matter was removed entirely as a result of conversion.

7.6.3 Uncertainty assessment

CO_2 emissions from settlements were evaluated as a result of Forest land conversion to Settlements. Converted areas are relatively very small and based on expert judgment it was assumed that uncertainty of activity data is about 80%. Emission factor uncertainty was assumed to be about 20%.

7.6.4 Source-specific QA/QC and verification

Quality control procedures named in *IPCC 2003* were established when calculating emissions from Settlements category.

7.6.5 Source-specific recalculations

Carbon stock changes due to loss of living biomass from conversions of Croplands and Grasslands to Settlements were calculated.

For conversion of Forest land to Settlements carbon stock change it was assumed that all aboveground and belowground biomass was lost at the time of conversion.

The total difference between emission/removals from Settlements of this submission and submission of 2012 is presented in Table 7-37.

Table 7-37. Reported in previous submission and recalculated emission/removals from Settlements during the period 1990-2010

Year	Previous submission, $GgCO_2$ eq.	This submission, $GgCO_2$ eq.	Absolut difference, $GgCO_2$ eq.	Relative difference, %
1990	NE,NO	NE,NO		
1991	NE,NO	749,1		
1992	NE,NO	774,1		
1993	5660,0	354,6	5305,4	-93,7
1994	NE,NO	1313,9		
1995	NE,NO	524,6		
1996	NE,NO	NE,NO		
1997	NE,NO	249,5		
1998	NE,NO	249,5		
1999	NE,NO	394,5		
2000	604,4	959,0	-354,6	58,7
2001	2837,4	249,5	2587,9	-91,2
2002	NE,NO	209,9		
2003	NE,NO	144,7		
2004	NE,NO	104,8		
2005	NE,NO	458,8		
2006	144,5	723,9	-579,4	401,0
2007	1408,2	289,7	1118,5	-79,4
2008	394,5	394,5	0	0
2009	145,5	394,5	-249,0	171,1
2010	NE,NO	NE,NO		

7.6.6 Source-specific planned improvements

Additional studies and information research are planned in order to improve reporting of areas that are under NA, NO notation keys.

7.7 Other land (CRF 5.F)

7.7.1 Source category description

This category is included for overall land area consistency checking. All land not classified as Forest land, Croplands, Grasslands, Wetlands and Settlements were defined as Other land and reported together as a separate category in the CRF Reporter. For reporting activities, subcategories of national statistics were reduced significantly – swamps reported under Wetland category. Trees and bushes plantations in urban areas reported under Settlements category. Disturbed land and unmanaged land accounted under Other land category.

7.7.2 Methodological issues

7.7.2.1 Other Land Remaining Other Land

Carbon stocks changes and non-CO_2 emissions and removals are not considered for this category as it is not required by *IPCC 2003* guidelines.

7.7.2.2 Land converted to Other Land

Emissions and removals from Land converted to Other Land (OL) reported using *Tier 1* method and include two subcategories of CO_2 emissions/removals:

- changes in carbon stocks in living biomass;
- changes in carbon stocks in soils.

For calculation of total change in carbon stocks in Land converted to Other Land the following equation was used (*IPCC 2003* eq. 3.7.1, p. 3.145):

$$\Delta C_{LO} = \Delta C_{LOLB} + \Delta C_{LOSoils} \quad (7.53)$$

where:
ΔC_{LO} – annual change in carbon stocks in land converted to Other Land, tonnes C yr^{-1};
ΔC_{LOLB} – annual change in carbon stocks in living biomass in land converted to Other land, tonnes C yr^{-1};
$\Delta C_{LOSoils}$ – annual change in carbon stocks in soils in land converted to Other Land, tonnes C yr^{-1}.

To convert tonnes C to Gg CO_2, value multiplied by 44/12 and by 10^{-3}.

Change in carbon stocks in living biomass

Tier 1 method was used to estimate annual change in carbon stocks in living biomass on Lands converted to Other Land. The default assumption for *Tier 1* is that all carbon in biomass is lost to the atmosphere through decay processes either on- or off-site. The following equation was used for calculation (*IPCC 2003* eq. 3.7.2, p. 3.146):

$$\Delta C_{LOLB} = A_{Conversion} \times (B_{After} – B_{Before}) \times CF \quad (7.54)$$

where:
ΔC_{LOLB} – annual change in carbon stocks in living biomass in land converted to Other Land, tonnes C yr^{-1};
$A_{Conversion}$ – area of land converted annually to Other Land from some initial land uses, ha yr^{-1};
B_{After} – amount of living biomass immediately after conversion to Other Land, tonnes d.m. ha^{-1};
B_{Before} – amount of living biomass immediately before conversion to Other Land, tonnes d.m. ha^{-1};CF – carbon fraction of dry matter (default = 0,5), tonnes C (tonnes d.m.)$^{-1}$.

It is assumed that the entire biomass is removed in the year of conversion, thus, the default values for B_{After} is 0 tonnes C ha^{-1}. Default estimate of 10,0 tonnes d.m. ha^{-1} for B_{Before} has been used (Table 3.4.8 of *IPCC 2003*) for conversions from Cropland, default 2,4 tonnes d.m. ha^{-1} estimate for B_{Before} has been used (Table 3.4.2 of *IPCC 2003*) for conversions from Grassland.

The default assumption is that carbon stock after conversion is zero and reported as NO.

Change in carbons stock in soils

Soil carbon stocks after conversion are assumed to be zero for Other Land such as bare or degraded soils or deserts. It is also assumed that the changes in carbon stocks in organic soils are not relevant in this section.

7.7.3 Uncertainty assessment

Default uncertainty level of 75% of the estimated CO_2 emissions or removals has been assumed based on expert judgment.

7.7.4 Source-specific QA/QC and verification

Quality control procedures named in *IPCC 2003* were established when calculating emissions from Other Land category.

7.7.5 Source-specific recalculation

Carbon stock change in soil during the conversion from Other land to Wetlands were eliminated from calculations, because it was assumed that land areas under Other land category do not contain organic soil layer.

For conversions of forest land to other land it was assumed that all aboveground and belowground biomass is lost at the time of conversion.

The total difference between emission/removals from Other land of this submission and submission of 2012 is presented in Table 7-38.

Table 7-38. Reported in previous submission and recalculated emission/removals from Other land during the period 1990-2010

Year	Previous submission, $GgCO_2$ eq.	This submission, $GgCO_2$ eq.	Absolut difference, $GgCO_2$ eq.	Relative difference, %
1990	NE,NO	NE,NO		
1991	NE,NO	NE,NO		
1992	NE,NO	209,9		
1993	629,5	209,9	419,6	-66,7
1994	143,5	248,4	-104,9	73,1

1995	NE,NO	104,8		
1996	NE,NO	NE,NO		
1997	NE,NO	NE,NO		
1998	NE,NO	104,8		
1999	NE,NO	NE,NO		
2000	NE,NO	NE,NO		
2001	383,4	243,9	139,5	-36,4
2002	NE,NO	NE,NO		
2003	NE,NO	139,1		
2004	NE,NO	NE,NO		
2005	NE,NO	NE,NO		
2006	144,5	283,6	-139,1	96,3
2007	278,5	NE,NO		
2008	278,5	278,5	0	0
2009	NE,NO	139,1		
2010	NE,NO	NE,NO		

7.7.6 Source-specific planned improvements

Additional studies and information research are planned in order to improve reporting of areas that are under defined notation keys.

8 WASTE (CRF 6)

8.1 Overview of Waste Sector

This chapter covers the CRF source category 6 Waste, including: 6.A Solid Waste Disposal on Land, 6.B Wastewater Handling and 6.C Waste Incineration.

In Lithuania greenhouse gases emissions (GHG) from Waste Sector originate from the following sources:

- solid waste disposal on land including sewage sludge (CRF 6.A);
- wastewater handling (industrial and domestic/commercial wastewater)(CRF 6.B);
- human sewage(CRF 6.B.2.2);
- waste incineration (CRF 6.C).

Only one emission source from Waste Sector is identified as a key category, by level and trend, without LULUCF in 2010 (Table 8-1).

Table 8-1. Key category from Waste in 2011 by Level and Trend excluding LULUCF

IPCC source categoty	Gas	Identification criteria	Approach used
6.A Solid Waste Disposal on Land	CH_4	Level	Tier 1 / Tier 2
		Trend	Tier 1 / Tier 2
6.B Waste-water handling	CH_4	Level	Tier 2
		Trend	Tier 2
6.B Waste-water handling	N_2O	Level	Tier 2
		Trend	Tier 2

GHG emissions from Waste Sector are summarised in Table 8-2.

Table 8-2. Summary of GHG emissions from Waste Sector, Gg CO_2 eq.

Year	Solid waste disposal	Sewage sludge	Waste-water handling	Humane sewage	Waste incineration	Total
1990	827	37.5	174	80	4.5	1,123
1991	847	38.3	174	80	4.5	1,144
1992	865	38.9	173	80	1.3	1,158
1993	878	41.7	172	80	3.8	1,176
1994	885	40.0	170	80	1.2	1,176
1995	885	40.8	169	79	4.3	1,179
1996	888	45.1	168	79	1.4	1,181
1997	891	48.5	167	79	1.4	1,187
1998	891	52.1	166	78	1.5	1,189
1999	890	56.1	162	78	0.7	1,187
2000	896	58.3	157	77	1.9	1,191
2001	926	59.7	152	77	2.5	1,216
2002	937	58.0	147	77	2.3	1,221
2003	948	56.4	138	77	6.3	1,225
2004	934	52.0	131	76	3.2	1,197

2005	918	49.6	124	76	5.9	1,173
2006	905	46.1	112	75	5.5	1,144
2007	893	42.4	110	75	0.8	1,121
2008	880	39.6	118	75	0.7	1,113
2009	868	35.1	111	75	0.7	1,090
2010	853	31.0	103	74	2.0	1,063
2011	781	26.9	102	73	7.3	990

During the period 1990-2003 total GHG emission from Waste Sector increased by 9,1 % but during 2003-2011 it decreased by 19,1 %. The average GHG emission for period 1990-2011 was 1157 Gg CO_2 eq.

Solid waste disposal on land including disposal of sewage sludge is the largest GHG emission source from Waste Sector. It contributed around 81,6% of the total GHG emission from Waste Sector in 2011. Fluctuations of GHG emissions caused by solid waste disposal on land were not significant. Certain increase of emissions was observed from 2001 to 2004 and was caused mainly by disposal of large amounts of organic sugar production waste. In later years the producers managed to hand this waste over to farmers for use in agriculture and GHG emissions declined. Positive effect on GHG emissions from solid waste disposal had extraction of landfill gas from several closed landfills started in 2008.

Variations of GHG emissions from solid waste disposal on land during the period 1990 to 2011 are shown in Figure 8-1.

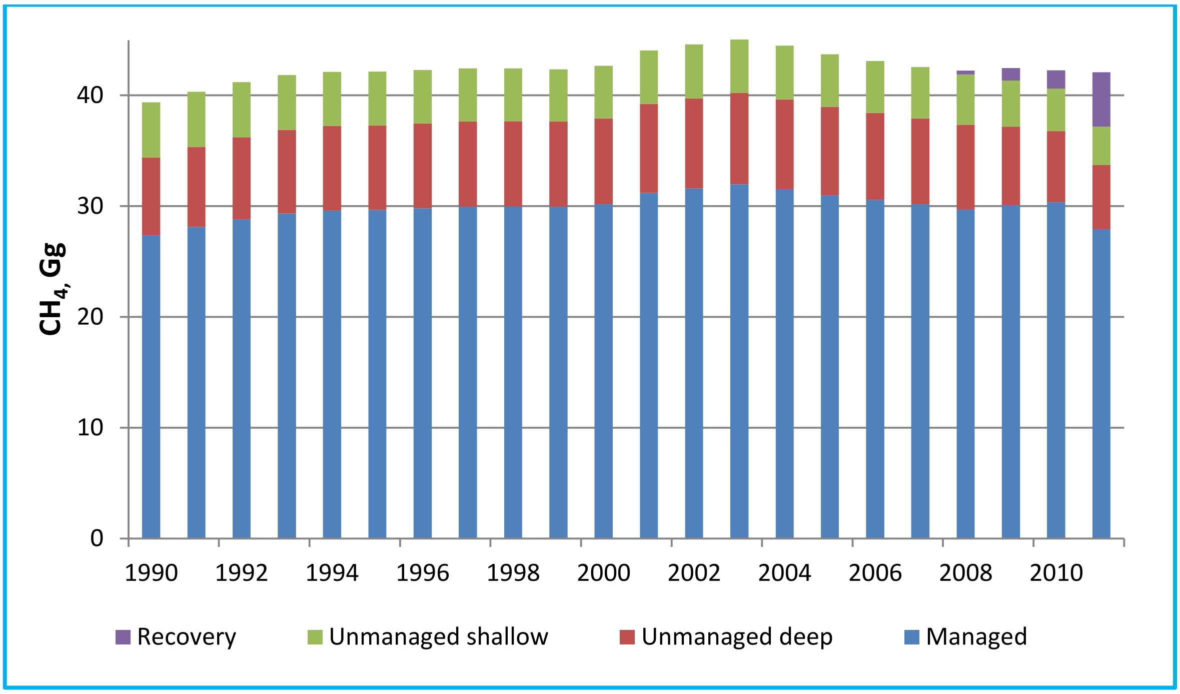

Figure 8-1. Variations of GHG emissions in Waste Sector (1990-2011)

Wastewater handling contributed around 17,7 % of GHG emissions from Waste Sector in 2011. Wastewater in Lithuania is treated with aerobic treatment system with minimum CH_4 generation.

However, significant part of population still does not have connection to public sewerage systems and emissions from sewage collected in septic caused significant emissions.

Humane sewage is responsible on average for 6,7 % of the total GHG emission from Waste Sector, fluctuating from 6,3 % in 2001 to 7,4 % in 2011.

Waste incineration is used in Lithuania on a very small scale contributing during the period 1990-2010 on average only 0,25 % of the total waste GHG emission.

8.2 Solid waste disposal on land (CRF 6.A)

8.2.1 Overview of waste management in Lithuania

Waste generation and disposal

The total amount of waste generated annually in Lithuania is about 5 million tonnes (Table 8-3). Major part of waste is generated in industrial sector of which about 100 thousand. tons - hazardous waste. Annual municipal waste generation is a bit more than 1 million tonnes.

Amount of waste generated by industry and other economic activities has increased from 2 to 4 million tons from 2000 to 2010. Waste generation during this period grew more slowly than production. About half of generated waste is still disposed of in landfills.

In early 1990s there were about 1000 landfills and dumps in Lithuania. In late 1990s waste management strategies were developed foreseeing development of waste management infrastructure including construction of new regional landfills complying with EU requirements, closure of existing landfills and dumps and provision of necessary equipment required for safe and efficient operation of waste management facilities.

The first new landfill complying with the requirements of the EU Landfill directive (1999/31/EC) was put into operation in 2007. Construction of remaining 10 regional landfill covering the whole area of Lithuania was completed during 2008-2009. In 2010 all wastes were disposed of in new regional landfills.

Old landfills and dumps were closed immediately when landfills were made available. Currently all old landfills not complying with the EU requirements are closed.

Landfill gas collection with energy recovery is planned at major old landfills. Recovery of landfill gas started at 2 landfills in 2008. In 2010 landfill gas recovery equipment was installed at 5 old closed landfills (Kaunas, Utena, Klaipėda, Marijampolė and Vilnius)

In order to encourage waste recovery and recycling and minimize disposal in landfills, regional waste management systems were equipped with appropriate waste management facilities including bulky waste collection sites, green waste composting sites etc.

Table 8-3. Waste collection and treatment in 2010 and 2011, thou. tonne

Statistical waste category		Collected	Treatment methods*							
			D1, D5	D2, D4, D6	Export	R1	D10	R2-R9	R10, R11	D8, D9, D14,R12,S5
2010										
01	Chemical compound wastes	8.6	0.6	0.0	2.3	0.0	0.1	1.4	0.0	4.0
02	Chemical preparation wastes	8.1	0.0	6.0	0.5	0.3	0.2	0.0	0.0	0.6
03	Other chemical wastes	2,104.2	2,044.2	8.5	0.9	0.0	0.5	32.8	0.0	15.0
05	Health care and biological wastes	1.6	0.4	0.0	0.0	0.0	0.7	0.4	0.0	0.2
06	Metallic wastes	595.5	0.0	0.0	563.1	0.0	0.0	13.7	0.0	1.1
07	Non-metallic wastes	520.9	7.5	0.0	51.3	108.2	0.0	337.7	0.4	0.0
08	Discarded equipment	57.7	0.0	0.0	7.0	0.0	0.0	14.4	0.0	35.4
09	Animal and vegetal wastes	343.8	8.0	61.4	4.1	2.3	0.0	216.1	90.3	2.2
10	Mixed ordinary wastes	1,136.0	1,097.8	3.3	11.6	0.0	0.0	19.4	0.0	0.1
11	Common sludges	61.5	1.0	1.0	1.2	0.0	0.0	11.9	15.5	0.0
12	Mineral wastes	483.6	118.8	12.3	0.2	0.0	0.0	249.1	59.2	7.3
	Total	5,321.6	3,278.4	92.5	642.1	110.8	1.5	897.0	165.4	65.9
2011										
01	Chemical compound wastes	9.3	0.1	0.0	1.8	0.0	0.7	1.9	0.0	5.0
02	Chemical preparation wastes	1.2	0.1	0.0	0.2	0.0	1.5	0.0	0.0	0.4
03	Other chemical wastes	55.3	0.5	3.0	4.5	0.0	0.9	53.5	0.0	16.8
05	Health care and biological wastes	1.2	0.2	0.0	0.4	0.0	0.4	0.0	0.0	0.1
06	Metallic wastes	686.6	0.0	0.0	661.6	0.0	0.0	11.8	0.0	0.1
07	Non-metallic wastes	449.6	9.7	0.0	60.9	101.1	0.3	273.2	4.6	0.3
08	Discarded equipment	66.3	0.0	0.0	8.7	0.0	0.2	14.2	0.0	42.8
09	Animal and vegetal wastes	267.8	11.0	0.5	2.1	1.7	0.0	201.2	53.9	0.3
10	Mixed ordinary wastes	3,238.2	3,162.0	6.6	23.5	0.2	0.0	40.6	0.8	3.7
11	Common sludges	54.5	1.3	0.5	0.5	0.0	0.0	10.6	15.9	0.0
12	Mineral wastes	619.6	106.0	28.8	1.1	0.0	0.4	333.2	67.4	8.3
	Total	5,449.6	3,290.8	39.4	765.4	103.0	4.4	940.2	142.6	77.8

*List of treatment operations is provided in Table 8-4 below

Source: Lithuanian EPA

According to information provided by the municipalities in the beginning of 2010, waste collection services were provided to 91% of population. Differences between provision of services in cities, towns and rural areas are decreasing. In 2010 waste collection services were provided to 96% of population in towns and cities with population exceeding 1000 inhabitants and to 66% of population in small towns and villages with population less than 200 inhabitants.

Disposal of green waste in municipal landfills is prohibited, thirteen green waste composting facilities were in operation in 2010.

Table 8-4. List of waste treatment operations

Waste disposal operations	
D 1	Deposit into or on to land (e.g. landfill, etc.)
D 2	Land treatment (e.g. biodegradation of liquid or sludgy discards in soils, etc.)
D 3	Deep injection (e.g. injection of pumpable discards into wells, salt domes or naturally occurring repositories, etc.)
D 4	Surface impoundment (e.g. placement of liquid or sludgy discards into pits, ponds or lagoons, etc.)
D 5	Specially engineered landfill (e.g. placement into lined discrete cells which are capped and isolated from one another and the environment, etc.)
D 6	Release into a water body except seas/oceans
D 7	Release to seas/oceans including sea-bed insertion
D 8	Biological treatment not specified elsewhere in this Annex which results in final compounds or mixtures which are discarded by means of any of the operations numbered D 1 to D 12
D 9	Physico-chemical treatment not specified elsewhere in this Annex which results in final compounds or mixtures which are discarded by means of any of the operations numbered D 1 to D 12 (e.g. evaporation, drying, calcination, etc.)
D 10	Incineration on land
D 11	Incineration at sea
D 12	Permanent storage (e.g. emplacement of containers in a mine, etc.)
D 13	Blending or mixing prior to submission to any of the operations numbered D 1 to D 12
D 14	Repackaging prior to submission to any of the operations numbered D 1 to D 13
D 15	Storage pending any of the operations numbered D 1 to D 14 (excluding temporary storage, pending collection, on the site where the waste is produced)
Waste recovery operations	
R 1	Use principally as a fuel or other means to generate energy
R 2	Solvent reclamation/regeneration
R 3	Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes)
R 4	Recycling/reclamation of metals and metal compounds
R 5	Recycling/reclamation of other inorganic materials
R 6	Regeneration of acids or bases

R 7	Recovery of components used for pollution abatement
R 8	Recovery of components from catalysts
R 9	Oil re-refining or other reuses of oil
R 10	Land treatment resulting in benefit to agriculture or ecological improvement
R 11	Use of waste obtained from any of the operations numbered R 1 to R 10
R 12	Exchange of waste for submission to any of the operations numbered R 1 to R 11
R 13	Storage of waste pending any of the operations numbered R 1 to R 12 (excluding temporary storage, pending collection, on the site where the waste is produced)

Source: Lithuanian EPA

From more than 260 thou. tonne of packaging materials placed on the market in Lithuania each year, about 30% is paper and cardboard packaging (Table 8-5). Glass and plastic packaging each comprise about 20% of generated packaging waste.

On average, about 60% of packaging waste is recovered and recycled. More than 70% of paper and cardboard and glass packaging and about two thirds of metal packaging is recycled.

Table 8-5. Generation and recovery of packaging waste

Packaging material	**Placed on the market**	**Recovered**	
	tonne	**tonne**	**%**
2009			
Glass	60,431	45,875	75.9
Plastic	53,606	19,458	36.3
Paper, cardboard	81,811	60,295	73.7
Metal	11,023	6,946	63.0
Composite	767	199	26.0
Wood	45,715	19,621	42.9
Other	7,252	0	0.0
Total	260,606	152,394	58.5
2010			
Glass	61,238	40,989	66.9
Plastic	56,522	21,689	38.4
Paper, cardboard	82,360	68,763	83.5
Metal	11,632	8,039	69.1
Composite	825	181	21.9
Wood	53,780	24,955	46.4
Other	6,121	0	0.0
Total	272,478	164,616	60.4

Source: Lithuanian EPA

From about 15 to 22 thou. tonne of oils placed on the Lithuanian market about one forth is recovered (Table 8-6).

Table 8-6. Collection and recovery of spent oils (tonne)

Year	Placed on the market	Collected spent oils	Recovered/recycled
2008	22,020	5,742	5,620
2009	16,854	4,607	3,988
2010	15,266	3,971	3,822

Source: Lithuanian EPA

Car batteries comprise more than 98% of the total amount of collected batteries and accumulators (Table 8-7).

Amendments to the Waste Management Law passed by the Seimas in 2012 place stricter requirements on producers and importers of batteries and accumulators as well as other equipment (electric and electronic equipment, oils, etc.) in order to improve collection, reuse, recovery and recycling of waste for which producer responsibility is established.

Oil producers and importers are obliged to ensure that oil waste equivalent to 30% of oils placed on the market is recycled from 2008 and at least 50% from 2012.

Table 8-7. Collection and treatment of batteries and accumulators

Waste category		Collection	Export	Recycling	Other treatment
2009					
16 06 01	Lead batteries	10,210.1	1,920.2	6,337.6	2,067.7
16 06 02	Ni-Cd batteries	2.3		2.0	0.4
17 06 03	Mercury-containing batteries	0.0			
18 06 04	alkaline batteries (except 16 06 03)				
19 06 05	Other batteries and accumulators	162.3		114.1	38.0
20 01 33	Batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries	2.7			11.1
20 01 34	Batteries and accumulators other than those mentioned in 20 01 33	30.1	27.5	11.51	
	Total	10,407.4	1,947.7	6,465.2	2,117.29
2010					
16 06 01	Lead batteries	15,498.9	3,023.2	11,615.4	
16 06 02	Ni-Cd batteries	3.9		1.4	
17 06 03	Mercury-containing batteries	0.0			
18 06 04	alkaline batteries (except 16	7.6		7.1	

	06 03)				
19 06 05	Other batteries and accumulators	188.5		191.4	
20 01 33	Batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries	12.3		3.5	
20 01 34	Batteries and accumulators other than those mentioned in 20 01 33	13.6	1.0	0.13	0.23
	Total	15,724.7	3,024.2	11,818.9	0.23

Source: Lithuanian EPA

Available data on generation and treatment of waste electrical and electronic equipment (WEEE) are provided in Table 8-8.

Approximately 17% of EEE placed on the market is collected as waste. Most of collected waste is treated in Lithuania, however certain part of wastes, such as waste containing ozone depleting substances, is exported for treatment in other, mainly EU, countries.

Waste reporting

There was no recording or reporting of waste generation or disposal in Lithuania during the Soviet Rule.

After declaration of independence in 1990 Environmental Protection Department was established which initialized collection of statistical data on waste generation and management. Installations generating or handling waste were obliged to record waste generation, recovery and disposal activities from 1991. The first reports covering waste management activities in 1991 were submitted to the Environmental Protection Department in 1992.

Waste generation, treatment and disposal were recorded and reported according to the waste classification categories shown in Table 8-9 and waste disposal and recovery operations listed in Table 8-10.

The Environmental Protection Department was reorganized to the Ministry of Environmental Protection in 1994 which was became the Ministry of Environment in 1998. The Minster of Environment approved new version of the Waste management regulation in 1999 (Order of the Minister of Environment No. 217 from July 14, 1999) including modifications of recording and reporting procedures.

Waste management regulation 1999 transposed basic requirements of the EU Waste framework directive (75/442/EEC) including list of wastes and list of hazardous wastes but established national version of waste disposal and recovery operations (Table 8-11).

Table 8-8. Generation and treatment of WEEE

EEE category		EEE placed on the market		Collection		Treatment		Recovery
		total	for households	from households	other than households	in Lithuania	abroad	
2010								
1	Large household appliances	14,102.3	14,026.8	5,045.4	9.5	3,524.9	724.4	748.9
2	Small household appliances	2,135.6	2,134.1	579.1	0.2	413.6		174.3
3	IT and telecommunications equipment	2,842.9	2,490.8	1,111.2	35.7	1,027.6		205.1
4	Consumer equipment	1,714.9	1,709.7	776.4	14.9	668.9		292.5
5	Lighting equipment, except fluorescent lamps	484.6	251.8	121.7	1.0	116.7		7.7
5a	Fluorescent lamps	460.0	388.6	151.4	6.7	73.1	96.4	
6	Electrical and electronic tools	1,463.6	1,452.0	571.9	1.5	304.9		242.3
7	Toys, leisure and sports equipment	307.5	304.6	113.6		77.1		45.6
8	Medical devices	156.5	115.4	72.8	3.0	37.5		44.3
9	Monitoring and control instruments	285.1	230.5	284.7	12.2	101.5	138.7	76.9
10	Automatic dispensers	44.6	37.6		14.7	12.7		5.3
	Total	23,997.6	23,141.9	8,828.2	99.5	6,358.3	959.5	1,843.0
2011								
1	Large household appliances	14,118.4	14,060.1	6,513.2	17.6	3,533.1	387.7	2,622.6
2	Small household appliances	2,191.0	2,189.5	624.6	0.0	322.6	0.0	299.8
3	IT and telecommunications equipment	3,011.4	2,677.5	1,521.2	16.1	577.2	20.7	870.3
4	Consumer equipment	2,267.0	2,262.0	1,188.3	12.5	402.4	128.4	635.7
5	Lighting equipment, except fluorescent lamps	529.8	311.1	172.4	19.3	148.2	0.0	31.9

5a	Fluorescent lamps	426.1	410.2	206.1	5.9	92.6	146.5	0.0
6	Electrical and electronic tools	1,879.0	1,857.4	852.1	6.7	506.1	0.0	333.5
7	Toys, leisure and sports equipment	327.7	325.9	134.4	11.8	45.3	0.0	58.5
8	Medical devices	213.1	167.1	84.8	4.3	27.7	9.2	53.6
9	Monitoring and control instruments	434.3	279.0	148.0	265.0	70.4	175.1	84.0
10	Automatic dispensers	39.5	36.4	0.0	32.4	21.1	0.0	1.8
	Total	25,437.2	24,576.2	11,445.1	391.7	5,746.7	867.6	4,991.8

Source: Lithuanian EPA

Table 8-9. Waste classification 1990

A. Non-hazardous waste	
A.01	Manure and animal faeces
A.02	animal-tissue waste
A.03	Green waste
A.04	Forest waste
A.05	wastes from mineral excavation
A.06	Gravel, stones
A.07	Food waste
A.08	Textile waste
A.09	Natural fibre waste
A.10	Synthetic fibre waste
A.11	Wood waste
A.12	Paper and cardboard waste
A.13	Plastic and polymer waste
A.14	Rubber waste
A.15	Glass waste
A.16	Ferrous metal waste
A.17	Non-ferrous metal waste
A.18	end-of-life vehicles, household appliances
A.19	Construction material waste
A.20	Natural leather waste
A.21	Natural fur waste
A.22	Mixed municipal waste
A.23	Other waste
B. Hazardous waste	
B.01	Sanitary wastes of medicine services
B.02	Pharmaceutical wastes (unfit medicine, narcotics, veterinary remedies)
B.03	Wood preservatives wastes (wood antiseptics with heavy metals)
B.04	Biocides and phytopharmaceutical wastes (unfit pesticides, insecticides and etc.
B.05	Organic solvent wastes
B.06	Halogenated organic substances, excluding solvents
B.07	Wastes contaminated with cyanides
B.08	Oil products wastes without water
B.09	Oil/water, hydrocarbon/water (mixtures and emulsions)
B.10	Wastes containing or contaminated with polychlorinated diphenyls, triphenyls or polybrominated diphenyls
B.11	Tarry materials arising from refining, distillation and any pyrolytic treatment
B.12	Wastes of paints, dyes, pigments
B.13	Waste of resins, latex, plasticizers, glues/adhesives
B.14	Waste of chemicals, which are not identified or are new and whose effects on man and/or environment are not known
B.15	Pyrotechnics and explosive materials waste
B.16	Photographic processing materials waste (developers, fixing agents, photo-materials)
B.17	Wastes contaminated with polychlorinated dibenzofuran

B.18	Wastes contaminated with polychlorinated dibenzo dioxin
B.19	Animal soaps, fats, waxes
B.20	Non-halogenated organic substances excluding solvents (residuals of antifreeze, solvents containing formaldehydes, residuals of organic synthesis)
B.21	Inorganic waste without heavy metals
B.22	Cinders, ashes (boilers cinders, chimney ashes)
B.23	Contaminated soil (specify contaminant)
B.24	Hardening salts without cyanides
B.25	Metallic dust (specify metals)
B.26	Catalysts waste
B.27	Solutions and sludge containing heavy metals
B.28	Spent filter materials (contaminated with chemicals)
B.29	Scrubber sludges
B.30	Sewage sludges
B.31	Decarbonisation residuals
B.32	Ion-exchange column residual
B.33	Residual from cleaning and washing of equipment
B.34	Wastes of lamps and batteries
B.35	Vegetable oil waste
B.36	Radioactive residual (waste containing radionuclides or contaminated with them)
B.37	Any other hazardous waste not mentioned above in this list

Table 8-10. Waste disposal and recovery operations 1990

Waste disposal operations	
D1	Deposit onto land (in dumps)
D2	Land treatment (e.g. biodegradation of liquid or sludgy discards in soils, etc. In this case soil is only medium of wastes neutralisation. If waste is used as fertiliser, its code is R10. Biological treatment of polluted soil belongs to group D8.
D3	Deep injection (e.g. injection of pumpable discards into wells, salt domes or naturally occurring repositories, etc.)
D4	Surface impoundment (e.g. placement of liquid or sludge discards into pits, ponds or lagoons, etc.)
D5	Specially engineered landfill (e.g. placement into lined discrete cells which are capped and isolated from one another and the environment, etc.
D6	Release into a water body except seas
D7	Release into seas
D8	Biological treatment not specified elsewhere in this table
D9	Physical chemical treatment not specified in this table. The materials which are formed during this treatment must be disposed of according table 5a
D10	Incineration without energy or incineration using additional fuel when quantity of incoming energy is not higher than additional energy
Waste recovery operations	
R1	Use as a fuel or other means to generate energy
R2	Solvent regeneration
R3	Recycling of organic substances which are not used as solvents
R4	Recycling and utilisation of metals and metal compounds

R4.1	Utilisation of metals in ceramics
R4.2	Other methods of regeneration and utilisation
R5	Regeneration of other inorganic materials (except metals and metal compounds)
R6	Regeneration of acids or bases
R7	Recovery of components used for pollution abatement
R8	Recovery of components from catalysts
R9	Used oil re-refining or other reuses of previously used oil (except using for fuel) If waste from oil products are used for fuel or energy, it belongs to group R.1.
R9.1	Regeneration of waste from oil products
R9.2	Recovery of spent oil products in ceramic production
R9.3	Other methods of recovery and recycling of spent oil products
R10	Land treatment resulting in benefit to agriculture
R12	Buying and selling of wastes for recycling or recovery
R14	Wastes usage as secondary raw materials
R15	Wastes composting
R16	Waste recovery using other methods

Table 8-11. Waste disposal and recovery operations 1999

1	Waste disposal
1.1	Disposal of non-hazardous waste into or onto land
1.2	Storage of non-hazardous waste more than a year
1.3	Incineration of non-hazardous waste without energy recovery
1.4	Disposal of non-hazardous waste by other methods
1.5	Disposal of hazardous waste into or onto land
1.6	Storage of hazardous waste more than three months
1.7	Incineration of hazardous waste without energy recovery
1.8	Disposal of hazardous waste by other methods
1.9	Export of wastes for disposal
2	Use of waste for energy recovery
2.1	Use of non-hazardous waste for energy recovery
2.2	Use of hazardous waste for energy recovery
2.3	Export of wastes for energy recovery
3	Waste recycling
3.1	Physical-chemical treatment of non-hazardous waste
3.2	Biological treatment of non-hazardous waste
3.3	Treatment of hazardous waste
3.4	Treatment of bulky waste
3.5	Waste export for recycling
4	Waste collection and transport
4.1	Collection of wastes from population and organizations which are not obliged to record wastes
4.2	Collection and transport of industrial waste
4.3	Loading, repacking and sorting of non-hazardous waste to be transported
4.4	Collection and transport of hazardous waste
4.5	Loading, repacking and sorting of hazardous waste to be transported
5	Brokerage in waste management sector

New version of the Waste Management Regulation was approved by the Minister of Environment in December 2003 (Order of the Minister of Environment No. 722 from December 30, 2003). The new Regulation contains several changes in reporting requirements including classification of waste treatment, recovery and disposal operations provided in Annex II to the directive 75/442/EEC. Waste generation and management reports according to the new requirements were provided by both waste generating industries and waste management undertakings in the beginning of 2005 covering year 2004.

According to the Waste Management Regulation, waste management undertakings including waste importing companies as well as waste generating industries which are obliged to have IPPC permits must keep records of waste generation and treatment. Waste recoding is also mandatory for enterprises involved in technical maintenance of vehicles and generating hazardous waste.

Waste recording log must be kept in the location of waste generation and must be submitted to the authorised officials of the Ministry of Environment, counties or municipalities upon their request.

Waste generation and treatment should be recorded at least once per week. If waste is generated or treated not continuously, each separate generated or treated quantity must be recorded.

Recording should include:

- geographic origin of waste,
- industrial origin of waste,
- source name,
- waste code in Waste List,
- statistical classification code,
- waste name,
- amount of generated, received, treated or dispatched waste,
- treatment method,
- receiving facility (if waste was dispatched),

Waste recovery and disposal undertakings are obliged to provide annual reports on waste management to the regional environmental protection departments of the Ministry of Environment. Waste generating industries obliged to have IPPC permits must provide annual recording reports. Both types of reports are very similar and have only minor differences and must include summarised waste recording data.

The reports are collected by the regional environmental protection departments and transferred to the Environmental Protection Agency which is responsible for data processing and keeping waste database.

In May 2011 the Minister of Environment approved new Rules on Recoding and Reporting of Waste Generation and Management which came into force in 2012. Reporting according to the new Rules will start in 2013 covering waste generation and management in 2012.

8.2.2 Source category description

Municipal waste generation and disposal

In the initial stages of data collection waste was not weighed and amount of waste disposed to landfills and dumps was evaluated on volume basis. In early 1990s municipal waste was collected and transported to landfills by municipal waste collection companies and their income (as well as salaries of truck drivers) depended on the amount of waste delivered to landfills. Therefore very often they were going to landfills with half-empty collection trucks but recording full loads.

It is generally agreed that the amount of generated and disposed waste in early 90s was overestimated. In the report on the status of environment in Lithuania in 2001 published by the Lithuanian Ministry of Environment[160] it was assumed that generation of municipal waste should be about 750 k tonnes annually.

Starting from 1999 amount of waste disposed to landfills has stabilised at approximately 1 million tonnes. It was agreed in the discussion at the Ministry of Environment[161] that this value should be the most realistic evaluation of municipal waste disposal for the period 1990-1998.

Reliability of waste disposal data was further discussed with the leading Lithuanian experts in waste management statistics[162]at the Ministry of Environment on 27th of October 2010. During the meeting was agreed that even the information from waste generation and disposal are collected from 1991, but during the period 1991-1998 recorded data are clearly not reliable and overestimated. At this period there were no weighing of waste at the disposal sites and the amounts of disposed waste were estimated visually causing substantial errors. Waste handlers were interested in showing higher amounts of collected waste and used to apply higher factors for volume-to-weight conversion.

Reliability of waste disposal data has increased with improved control and monitoring of reporting system, recording process and accumulated experience, It should be considered that waste disposal data collected from 1999 are reliable and could be used for evaluating CH_4 generation in landfills.

The experts also concluded that there is no reason to believe that municipal waste generation and disposal during 1991-1998 were substantially different from generation and disposal during 1999-2008, i.e. the total annual amount of municipal waste disposed of in Lithuania should have been about 1 million tonnes or about 300 kg per person per year.

Based on comparison of variation of data on gross domestic product (GDP) and waste disposal per capita (Figure 8-2) it is reasonable to assume that changes of waste generation

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[160] State of the Environment 2001, p. 85th Ministry of Environment of the Republic of Lithuania, Vilnius, 2002

[161] Meeting at the Ministry of Environment with the Head of Waste Division Ingrida Kavaliauskienė and senior specialist Ingrida Rimaitytė, September 25, 2009

[162] Meeting at the Ministry of Environment with participation of Ingrida Kavaliaiuskienė, Head of the Waste Management Strategy Division of the Ministry of Environment, Audrius Naktinis, Chief Specialist of the Waste Management Division of the Ministry of Environment and Sandra Netikšaitė, Chief Specialist of the Pollution and Waste Management Accounting Division, Lithuanian Environmental Protection Agency

and disposal per capita are correlated with the changes of GDP but annual changes of waste generation are approximately 10 times lower than changes of GDP.

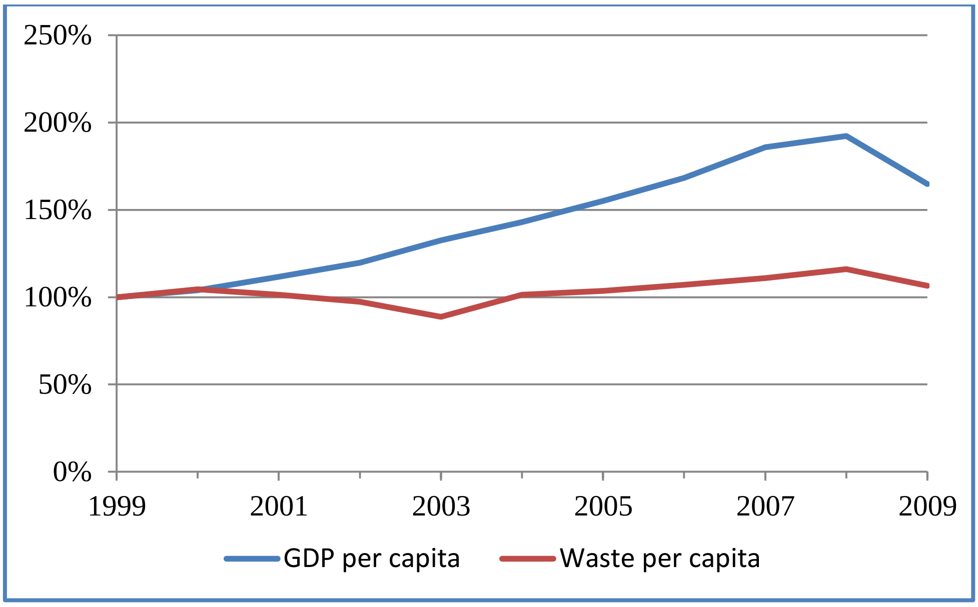

Figure 8-2. Variations of GDP and waste disposal per capita during 1999-2009

Evaluated changes of waste generation and disposal per capita during 1991-1998 based on assumption that annual change of waste generation and disposal comprises one tenth of annual variation of GDP per capita are shown in Table 8-3.

Table 8-12. Variation of GDP per capita and evaluated changes of municipal waste generation and disposal per capita

Year	Per capita	
	GDP	Waste generation and disposal
1991	-5,8%	-0,58%
1992	-21,2%	-2,12%
1993	-15,8%	-1,58%
1994	-9,1%	-0,91%
1995	5,4%	0,54%
1996	6,0%	0,60%
1997	8,3%	0,83%
1998	8,4%	0,84%

The meeting of experts at the Ministry of Environment agreed that calculated waste disposal data for 1991-1998 based on assumption that annual change of per capita amount of waste disposed to landfills makes 10% of per capita GDP change provide much more realistic information than the data collected by statistics.

Actual statistical data on municipal waste disposal to landfills were used for calculation of CH_4 emissions from landfills during 1999-2010. For the period 1990-1998 waste disposal was evaluated (Figure 8-3) using estimated annual changes shown in Table 8-12 and population number provided by the Statistics Lithuania.

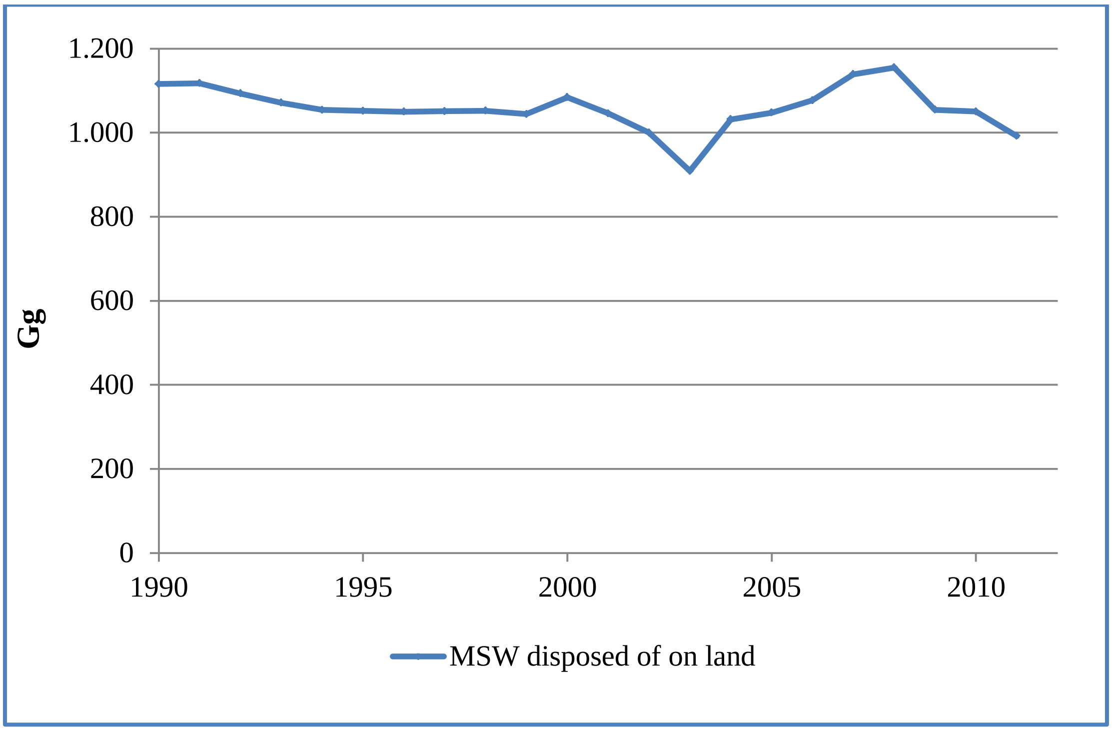

Figure 8-3. Total waste generation in 1990-2011

Biodegradable waste of industrial and commercial origin

Together with mixed municipal waste, biodegradable waste is disposed to the landfills by industries and commercial organisations.

From 1991 when collection of data of waste handling and treatment was started, waste classification and definitions of various waste disposal and treatment operations have been changed several times. Currently waste statistical data collected by the Lithuanian Environmental Protection Agency are ordered according to with two classification systems: European waste list adopted by the European Commission[163] and mainly substance oriented waste statistical nomenclature developed by the EUROSTAT and provided in the EU waste statistics regulation (EC) No 2150/2002 as amended[164]. However, data collected prior to adoption of EU waste classification, especially during 1991-1999, cause certain difficulties in interpretation and identification of specific waste categories and disposal methods.

The following categories of industrial and commercial waste were selected from the EUROSTAT statistical nomenclature for including in calculation of CH_4 emissions from landfills:

- Paper and cardboard waste
- Wood waste
- Textile waste

[163] Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste (2000/532/EC)
[164] *Official Journal L 332 , 09/12/2002 P. 0001 - 0036,*
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:332:0001:0036:EN:PDF

- Waste of food preparation and products
- Green waste
- Sewage sludge

Data reported on disposal of biodegradable waste of industrial and commercial origin in landfills are provided in Table 8-13.

Table 8-13. Reported data on disposal of biodegradable waste of industrial and commercial origin in landfills in 1991-2011, thou tonne

Year	Paper and cardboard wastes	Wood wastes	Textile wastes	Food waste	Green wastes	Sewage sludge	Total
1991	12.93	33.02	12.37	45.32	30.38	197.1	331.1
1992	4.92	30.00	4.15	56.61	26.43	258.4	380.5
1993	7.77	19.23	6.75	31.60	29.65	149.6	244.6
1994	5.84	20.19	1.86	14.79	22.00	209.9	274.6
1995	4.68	42.83	1.04	15.98	26.24	308.9	399.6
1996	5.49	25.30	1.39	33.11	14.87	306.9	387.1
1997	5.10	27.31	1.25	13.65	9.68	328.0	385.0
1998	4.33	6.28	2.31	12.55	7.87	355.2	388.5
1999	5.34	4.80	2.23	68.10	7.33	322.1	409.9
2000	1.26	3.64	6.06	215.88	3.51	312.7	543.0
2001	0.82	2.00	3.14	151.09	4.27	233.8	395.1
2002	0.73	3.01	3.82	185.52	4.60	227.0	424.7
2003	1.44	2.94	1.70	88.50	3.84	142.1	240.5
2004	0.40	4.61	2.86	2.27	5.06	176.9	192.1
2005	0.53	24.05	2.50	1.91	7.59	135.0	171.6
2006	0.19	4.88	1.83	1.91	13.78	113.6	136.2
2007	0.67	0.81	1.96	3.30	9.32	121.5	137.6
2008	0.13	4.61	1.37	3.18	6.54	61.7	77.5
2009	0.05	5.12	2.02	2.57	8.02	49.0	66.8
2010	0.04	0.98	3.18	2.39	5.64	32.96	45.2
2011	0.00	0.94	3.77	0.000	10.96	27.94	43.6

The amounts of industrial waste disposed of in landfills in 1990 were assumed to be the same as in 1991.

In early 1990s, the revenues for MSW collection companies depended on the amount of waste delivered to landfills, but the loads were not weighed and an overestimation of the weight of the loads is therefore suspected. On the other hand, industrial and commercial waste was transported by the companies generating the waste and was subject to a fee per truckload of waste deposited, not per the weight of each truckload of waste. Therefore the industries were interested to send trucks to landfills as full as possible. Substantially smaller variations of disposed industrial wastes in early nineties also confirms that reported amounts of industrial waste were more realistic.

Higher amounts of disposed industrial waste in early 90s were caused by inadequate control and inspection during the first years of independence. Later control of waste disposal was improved and industries were forced to find other ways of waste management.

High amount of food waste in 2000-2002 were disposed in municipal landfills by sugar production plants which at that time were bought by Danish companies and increased production very significantly. Later food waste generated in sugar production plants was used as fodder for animals, mainly swine, and its disposal stopped.

Waste Composition

Average composition of municipal solid waste was evaluated in a number of cases in 1996-2003 by experimental measurements carried out during the feasibility studies of development of regional waste management system and construction of new landfills in various regions of Lithuania (Table 8-14). As seen from the data, there are no significant changes of waste composition in time or by different regions. Based on this, it was assumed that waste composition was comparatively stable during investigated period.

The data were summarized by the Ministry of Environment and published in the report "Status of the Environment 2004[165] (Table 8-15).

The report provides summary of data obtained by various analytical tests. Bearing in mind that waste analyses were performed by various companies using different methodologies, and distinguishing different waste components, it is impossible to tell what specific waste was included in the category 'other waste'.

The lowest fraction of biowaste was found in waste collected from rural areas in Panevėžys region. It is understandable that biowaste fraction in waste collected from rural areas is substantially lower than in urban areas. Fluctuations of average waste composition including waste of both rural and urban origin are less significant. From available data it is not possible to establish any specific trends, therefore a single set of values was selected for calculations.

The measurements were performed in the framework of feasibility studies for establishment of the regional waste management systems. Samples for analysis were collected from municipal waste, industrial waste was not sampled. Analyses were performed by companies performing feasibility studies. Analytical procedures were not described in the studies, separate companies used different methodologies, even the components of waste composition were different. Therefore it is difficult to compare and summarize the results.

[165] Ibid.

Table 8-14. Measured waste composition of various regions of Lithuania.

<table>
<tr><th rowspan="2">Waste composition</th><th colspan="4">Kaunas</th><th colspan="3">Kaunas region 2003</th><th>Klaipėda</th><th colspan="3">Vilnius</th><th>Utena</th><th colspan="4">Panevėžys, 2004</th></tr>
<tr><th>1996</th><th>1997</th><th>1998</th><th>1999</th><th>City</th><th>Towns</th><th>Rural</th><th>2000</th><th>1999</th><th>2001</th><th>County average</th><th>2003</th><th>City</th><th>Towns</th><th>Rural</th><th>Overall</th></tr>
<tr><td>Biowaste</td><td>39%</td><td>46%</td><td>35%</td><td>41%</td><td>41%</td><td>53%</td><td>34%</td><td>56%</td><td>47%</td><td>52%</td><td>42%</td><td>43%</td><td>43%</td><td>39%</td><td>28%</td><td>38%</td></tr>
<tr><td>Paper</td><td>10%</td><td>7%</td><td>12%</td><td>12%</td><td>8%</td><td rowspan="2">10%</td><td rowspan="2">10%</td><td rowspan="2">19%</td><td rowspan="2">13%</td><td rowspan="2">9%</td><td rowspan="2">13%</td><td rowspan="2">15%</td><td rowspan="2">6%</td><td rowspan="2">9%</td><td rowspan="2">1%</td><td rowspan="2">5%</td></tr>
<tr><td>Cardboard</td><td>6%</td><td>7%</td><td>9%</td><td>1%</td><td>8%</td></tr>
<tr><td>Plastic</td><td>7%</td><td>10%</td><td>11%</td><td>10%</td><td>7%</td><td>5%</td><td>5%</td><td>8%</td><td>7%</td><td>13%</td><td>9%</td><td>8%</td><td>6%</td><td>8%</td><td>5%</td><td>6%</td></tr>
<tr><td>Glass</td><td>9%</td><td>6%</td><td>8%</td><td>8%</td><td>9%</td><td>7%</td><td>12%</td><td>9%</td><td>10%</td><td>6%</td><td>9%</td><td>6%</td><td>9%</td><td>5%</td><td>11%</td><td>9%</td></tr>
<tr><td>Metal</td><td>3%</td><td>3%</td><td>3%</td><td>4%</td><td>3%</td><td>3%</td><td>3%</td><td>2%</td><td>4%</td><td>4%</td><td>3%</td><td>3%</td><td>2%</td><td>2%</td><td>4%</td><td>3%</td></tr>
<tr><td>Wood</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1%</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Other burnable</td><td>14%</td><td>14%</td><td>16%</td><td>11%</td><td>14%</td><td>9%</td><td>9%</td><td></td><td></td><td></td><td></td><td>6%</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Other non-burnable</td><td>12%</td><td>7%</td><td>6%</td><td>13%</td><td>5%</td><td>8%</td><td>18%</td><td></td><td></td><td></td><td></td><td>10%</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Hazardous</td><td></td><td></td><td></td><td></td><td>1%</td><td>1%</td><td>1%</td><td>1%</td><td></td><td></td><td></td><td>0%</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Other</td><td></td><td></td><td></td><td></td><td>4%</td><td>4%</td><td>8%</td><td>5%</td><td>19%</td><td>16%</td><td>24%</td><td>8%</td><td>34%</td><td>38%</td><td>52%</td><td>40%</td></tr>
</table>

Table 8-15. Average composition of MSW in Lithuania as reported in 'Status of the Environment 2004'

Ingredient	**Amount**
Paper and cardboard	14%
Wood	2%
Textile	4%
Food (kitchen) waste	42%
Green waste	0%
Total biodegradable	**62%**
Plastic	9%
Metal	3%
Composite packaging	2%
Glass	9%
Leather and rubber	1%
Construction and demolition waste	4%
Sand, sweepings	4%
Hazardous waste	2%
Other	4%

Source: *"Status of the Environment 2004" published by the Lithuanian Ministry of Environment*

In 2011 the Minister of Environment obliged regional waste management centres responsible for landfill operation in Lithuania to carry out analysis of composition of municipal waste in all landfills in Lithuania.

Waste composition should be evaluated in 2012, 2013, 2016, 2018 and 2020 four times per year: in winter, spring, summer and autumn.

For sample collection, a waste collection truck from each municipality delivering waste to landfill is to be selected by landfill operator. Waste sample for analysis is collected from five spots of unloaded waste heap ("envelope" method). At least 0.5 tonne sample is to be collected from municipalities with population more than 100 thou., and 0.3 tonne from municipalities with population less than 100 thou.

Waste fractions to be identified during analysis are listed in Table 8-16.

Table 8-16. Waste fractions to be identified during municipal waste analysis

1	Paper and cardboard including packaging
2	Green waste
3	Wood waste including packaging
4	Biodegradable food production waste
5	Natural fibre waste
6	Other municipal biodegradable waste
7	Total municipal biodegradable waste
8	Plastic waste including packaging
9	Composite packaging waste

10	Metal waste including packaging
11	Glass waste including packaging
12	Inert waste (ceramics, concrete, stones, etc.)
13	Other non-hazardous waste
14	Waste electric and electronic equipment
15	Waste batteries and accumulators
16	Other hazardous waste
17	Other municipal waste

Analyses started from the beginning of 2012, however, as there is no external control, it is not possible to follow the activities in the regions and obtain the results. In addition, it seems that in many cases the analyses are performed carelessly and results are not reliable.

Comparison of available data showed that significant correlation is observed between the total amount of biodegradable waste and ”other municipal waste” (fraction 17) (r = -0.81) which means that biodegradable waste was not fully segregated and certain part of biodegradable waste was accounted as other waste (Fig. 8-4, a).

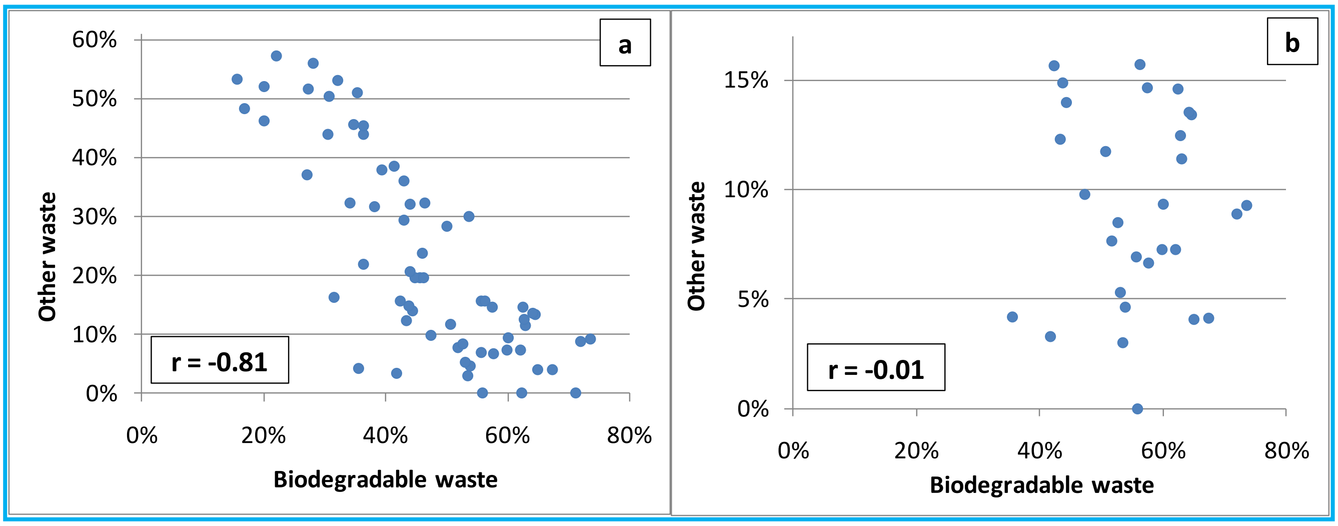

Figure 8-4. Correlation between the total fraction of biodegradable waste and unidentified fraction of "other waste" in reported data on waste composition; a - all available data, b - data from regions in which "other waste" is less than 20%

It is obvious that data showing large amount of "other municipal waste" are not reliable. Therefore data reported by waste management centres which have provided at least a single data set with "other municipal waste" exceeding 20% (Alytus, Kaunas, Klaipėda and Tauragė regions) were discarded. Data provided from the remaining regions (Marijampolė, Šiauliai, Panevėžys and Vilnius) seemed to be more reliable showing no correlation between the amount of biodegradable waste and other waste (r = -0.01, Fig. 8-4, b). These data were used for further analysis and evaluation of average waste composition.

Summary of data on the total amount of biodegradable waste (fraction 7) reported by Marijampolė, Šiauliai, Panevėžys and Vilnius regional waste management centres is provided in Table 8-17.

Table 8-17. Summary of data on the total amount of biodegradable waste (fraction 7) reported by Marijampolė, Šiauliai, Panevėžys and Vilnius regional waste management centres

Parameter	Total	Cities	Towns	Spring	Summer
Number of analyses	30	7	23	16	13
Minimum	35.6%	35.6%	35.6%	35.6%	42.4%
Maximum	73.6%	73.6%	73.6%	67.4%	73.6%
Average	55.8%	55.9%	55.9%	55.7%	55.9%
Standard deviation	9.2%	9.1%	9.1%	8.8%	9.9%

As can be seen from the Table, there is no significant difference between data on biodegradable waste established in cities and towns or in spring and summer and it was decided to use average values for calculations (Table 8-18).

For emission calculations it was assumed that waste compositions up to 2003 corresponded to

Table 8-18. Summary data on municipal waste composition, 2012

No	Ingredient	Minimum	Maximum	Average	Standard deviation
1	Paper and cardboard including packaging	2.3%	17.1%	8.4%	3.1%
2	Green waste	2.7%	33.8%	15.4%	8.6%
3	Wood waste including packaging	0.0%	20.3%	3.5%	5.1%
4	Biodegradable food production waste	0.0%	44.0%	16.7%	13.6%
5	Natural fibre waste	0.9%	21.7%	6.1%	4.3%
6	Other municipal biodegradable waste	0.0%	38.7%	5.7%	9.9%
7	**Total municipal biodegradable waste**	**35.6%**	**73.6%**	**55.8%**	**9.2%**
8	Plastic waste including packaging	4.6%	22.7%	13.5%	5.2%
9	Composite packaging waste	0.0%	4.0%	1.0%	1.1%
10	Metal waste including packaging	0.4%	8.6%	2.5%	1.5%
11	Glass waste including packaging	1.0%	10.2%	5.8%	2.2%
12	Inert waste (ceramics, concrete, stones, etc.)	0.0%	31.3%	9.8%	7.2%
13	Other non-hazardous waste	0.0%	21.8%	2.3%	4.4%
14	Waste electric and electronic equipment	0.0%	2.0%	0.1%	0.4%
15	Waste batteries and accumulators	0.0%	1.3%	0.1%	0.2%
16	Other hazardous waste	0.0%	0.2%	0.0%	0.0%
17	Other municipal waste	0.0%	15.7%	9.1%	4.3%

Composition of biodegradable waste in municipal waste stream was determined in the following way (Table 8-19):

- in 1990-2003: assumed corresponding to composition reported by the Ministry of Environment in *"Status of the Environment 2004"*

- in 2011: assumed corresponding to average composition determined in 2012 (see Table 8-18)
- in 2004-2010: established by linear interpolation of 2003 and 2011 data.

Table 8-19. Assumed composition of municipal biodegradable waste

Year	Paper and cardboard waste	Wood waste	Textile waste	Food waste	Green waste
1990	14.0%	2.0%	4.0%	42.0%	0.0%
1991	14.0%	2.0%	4.0%	42.0%	0.0%
1992	14.0%	2.0%	4.0%	42.0%	0.0%
1993	14.0%	2.0%	4.0%	42.0%	0.0%
1994	14.0%	2.0%	4.0%	42.0%	0.0%
1995	14.0%	2.0%	4.0%	42.0%	0.0%
1996	14.0%	2.0%	4.0%	42.0%	0.0%
1997	14.0%	2.0%	4.0%	42.0%	0.0%
1998	14.0%	2.0%	4.0%	42.0%	0.0%
1999	14.0%	2.0%	4.0%	42.0%	0.0%
2000	14.0%	2.0%	4.0%	42.0%	0.0%
2001	14.0%	2.0%	4.0%	42.0%	0.0%
2002	14.0%	2.0%	4.0%	42.0%	0.0%
2003	14.0%	2.0%	4.0%	42.0%	0.0%
2004	13.3%	2.2%	4.3%	39.5%	1.9%
2005	12.6%	2.4%	4.5%	37.1%	3.9%
2006	11.9%	2.6%	4.8%	34.6%	5.8%
2007	11.2%	2.7%	5.0%	32.2%	7.7%
2008	10.5%	2.9%	5.3%	29.7%	9.6%
2009	9.8%	3.1%	5.6%	27.3%	11.6%
2010	9.1%	3.3%	5.8%	24.8%	13.5%
2011	8.4%	3.5%	6.1%	22.4%	15.4%

Table 8-20 provides data on the total amount of biodegradable waste disposed of in landfills obtained by adding biodegradable waste of industrial and commercial origin (Table 8-13) to municipal biodegradable waste estimated using percentages provided in Table 8-19.

As data on waste disposal in 1990 are not available, the amount of municipal waste disposed of in 1990 was evaluated in the same way as for years 1991-1998, for industrial/commercial wastes it was assumed that amount and composition of waste of industrial and commercial origin was the same as in 1991.

Table 8-20. Biodegradable components in landfilled waste evaluated for calculation of CH_4 generation (Gg)

Year	Paper and cardboard	Wood wastes	Textile wastes	Food waste	Green wastes	Total
1990	13.5%	4.4%	4.6%	41.1%	2.4%	66.1%
1991	13.5%	4.4%	4.6%	41.1%	2.4%	66.1%
1992	13.0%	4.3%	3.9%	42.4%	2.2%	65.8%
1993	13.5%	3.5%	4.3%	41.3%	2.5%	65.1%
1994	13.7%	3.7%	3.9%	40.9%	2.0%	64.2%

1995	13.3%	5.6%	3.8%	40.1%	2.3%	65.0%
1996	13.5%	4.1%	3.8%	42.0%	1.3%	64.7%
1997	13.7%	4.4%	3.9%	41.1%	0.9%	64.0%
1998	14.0%	2.5%	4.1%	41.9%	0.7%	63.2%
1999	13.4%	2.3%	3.9%	44.8%	0.6%	64.9%
2000	11.6%	1.9%	3.8%	51.1%	0.3%	68.7%
2001	12.2%	1.9%	3.7%	48.9%	0.4%	67.1%
2002	11.8%	1.9%	3.7%	50.6%	0.4%	68.3%
2003	12.8%	2.1%	3.8%	46.7%	0.4%	65.7%
2004	13.1%	2.6%	4.5%	39.2%	2.4%	61.8%
2005	12.2%	4.5%	4.6%	36.0%	4.4%	61.8%
2006	11.7%	2.9%	4.9%	34.1%	6.9%	60.5%
2007	11.1%	2.8%	5.1%	32.0%	8.4%	59.5%
2008	10.4%	3.3%	5.4%	29.6%	10.1%	58.7%
2009	9.7%	3.5%	5.7%	27.1%	12.1%	58.0%
2010	9.0%	3.3%	6.1%	24.8%	13.9%	57.1%
2011	8.3%	3.5%	6.4%	22.0%	16.3%	56.5%

There are no data and even no speculations on waste composition during the historic period 1950-1989. Assumption that waste composition in years 1950-1990 was the same as in later period has some, though not very firm, background, while we have no background at all for assuming that composition was different with higher or lower fraction of biodegradables. Therefore, the final composition of biodegradable waste determined for 1990 was used also for calculation of methane emissions in historic years 1950-1989.

Historic waste disposal

Using the first order decay method for calculation of CH_4 emissions from landfilled biodegradable waste requires historical data of waste disposal as the model takes into consideration long-term digestion process. Therefore information of historic waste disposal is necessary.

The amount of waste disposed to landfills during 1950-1989 was evaluated on the basis of the following considerations.

During the period of 1950–1990 Lithuanian population grew approximately 1% per year, but started to decline after the restoration of independence (Figure 8-5).

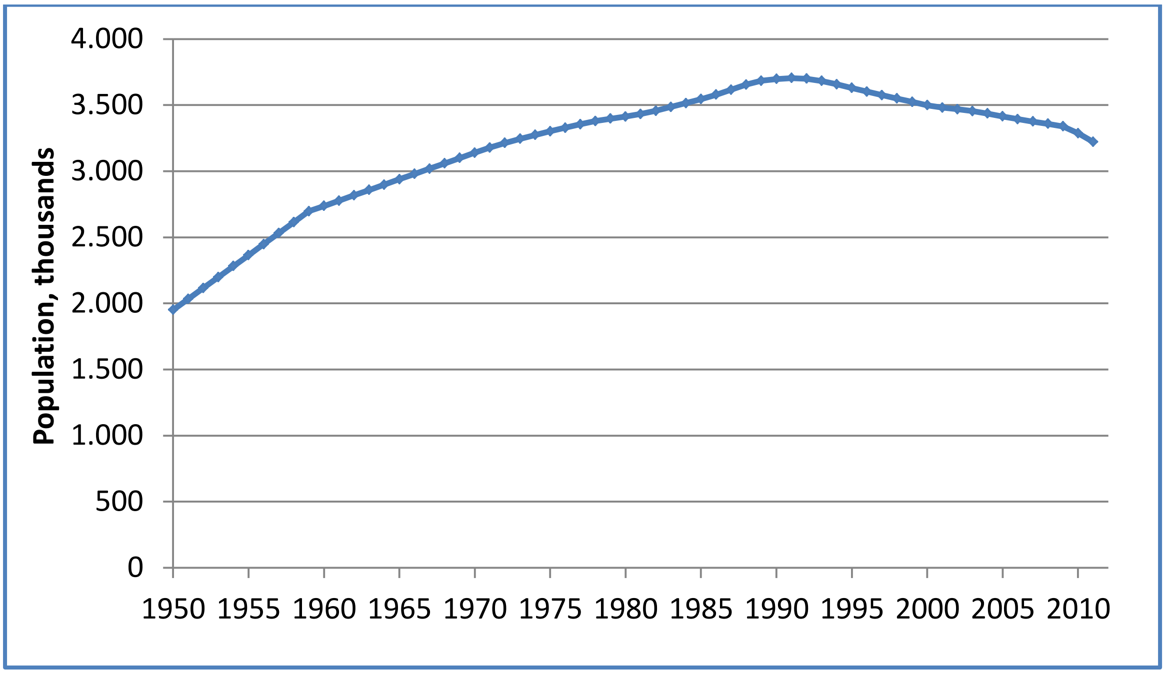

Figure 8-5. Variation of population in Lithuania in 1950-2011[166]

Economic indicators characterizing standards of welfare in Soviet command economy during 1950-1990 and economic indicators of free market economy since restoration of independence in 1990 are completely different and their direct comparison is not possible.

Economic development during the Soviet period was characterized by the "total public product". Changes of the total public product[167] evaluated by the Statistics Lithuania are shown in Figure 8-6. It should be noted, however, that it was measured in current prices and did not reflect correctly the change in living standard.

[166] Statistics Lithuania

[167] GDP: Conversion from material product balances to the system of national accounts in 1980-1990 at current prices. Lithuanian Department of Statistics, Vilnius, 1994

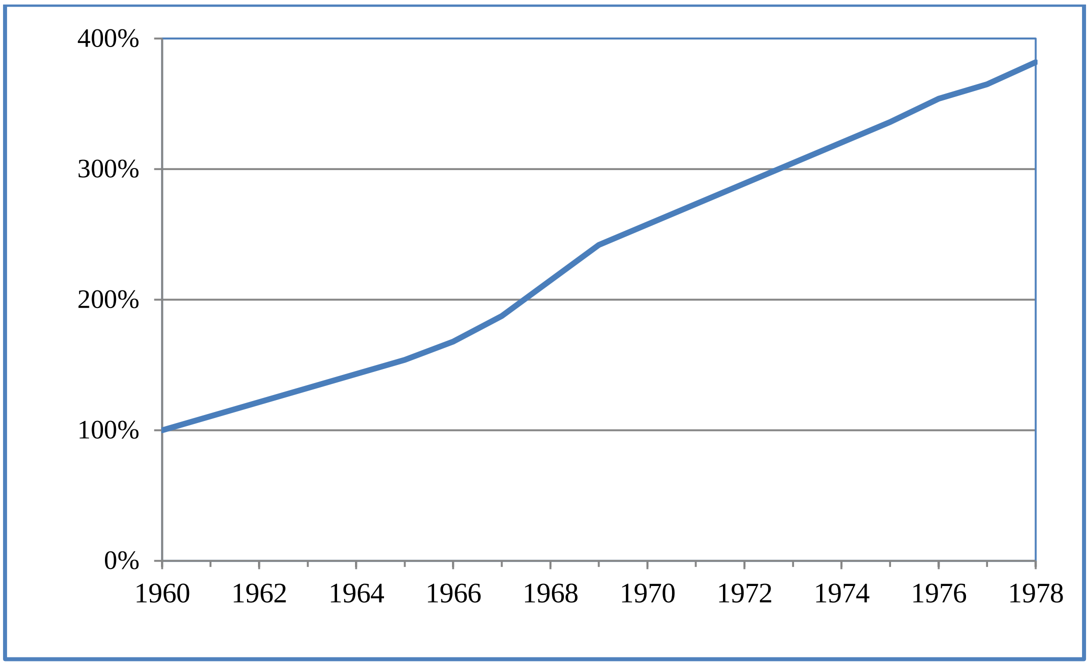

Figure 8-6. Variation of the total public product from 1960 to 1978

The Statistics Lithuania have recalculated economic indicators of the last decade of the Soviet power in Lithuania and obtained GDP values which are comparable to GDP after transition to free market economy[168]. Relative variations of population and GDP per capita from 1980 (1990 = 100%) are shown in Figure 8-7.

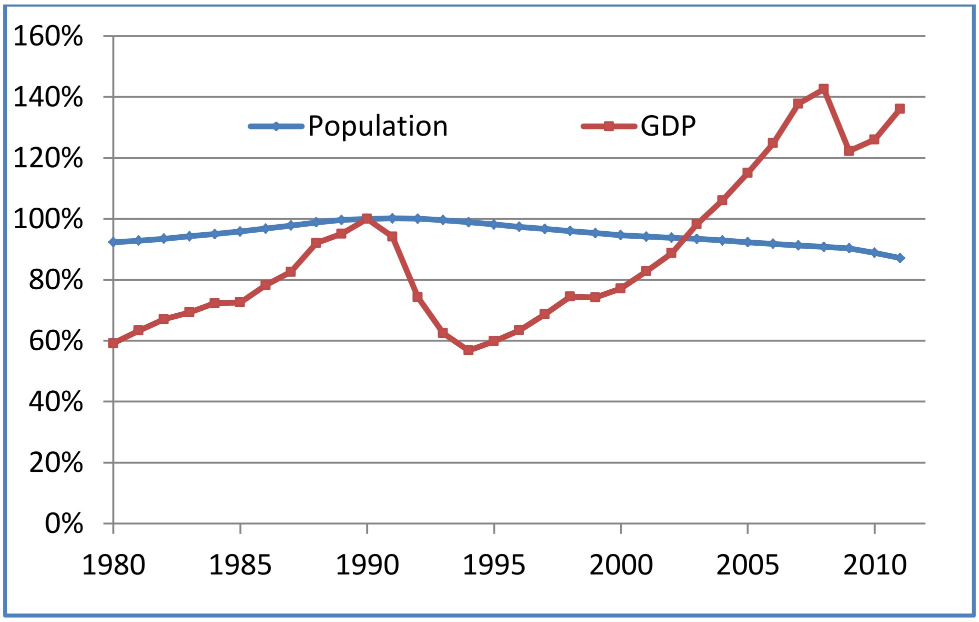

Figure 8-7. Relative variation of population and GDP per capita from 1980 (1990 = 100%)

It was assumed that the amount of waste per capita disposed of in landfills depends on consumption (standard of living) and availability of waste disposal facilities.

[168] Ibid.

For evaluation of waste generation it was assumed that waste generation during the period 1950-1990 was increasing continuously and the growth rate was depending on two factors: number of population and consumption. As it was quoted above, population growth during this period was close to 1% determining at least 1% growth in the total waste generation.

The period of 1950-1989 starts just 5 years after the World War II when the most of Lithuania was still in ruins, facilities and infrastructure for waste collection were actually nonexistent. Therefore application of the same parameters for evaluation of waste disposed of in landfills in post-war period and 1990s when waste collection and disposal facilities and infrastructure were already in place, though inadequately managed, was considered not correct.

In 1950s waste collection services were provided only to small fraction of population in major cities and growth of the amount of waste disposed of in landfills was instigated not so much by increasing consumption but rather by expansion of waste collection areas and infrastructure. Therefore it was assumed that disposal of waste during this period was increasing substantially faster than in 90s.

It was assumed that expansion of provided waste management services and improvement of living standards caused increase of waste generation per capita by about 1% annually.

When extrapolating waste disposal, it was assumed that composition of degradable waste (in per cent), including both municipal and industrial waste, was the same as in 1990.

The estimated total amounts of waste were then in a next step divided over 3 types of disposal sites based on the relation between the types of disposal sites and the population in major cities, smaller towns and rural areas. From 2007 out-phasing of the old landfill sites and putting in operation of new landfills was taken into consideration.

Variation of municipal waste disposal (not including separately disposed biodegradable waste of industrial and commercial origin) from 1950 to 1990 is based on these assumptions and is shown in Figure 8-8.

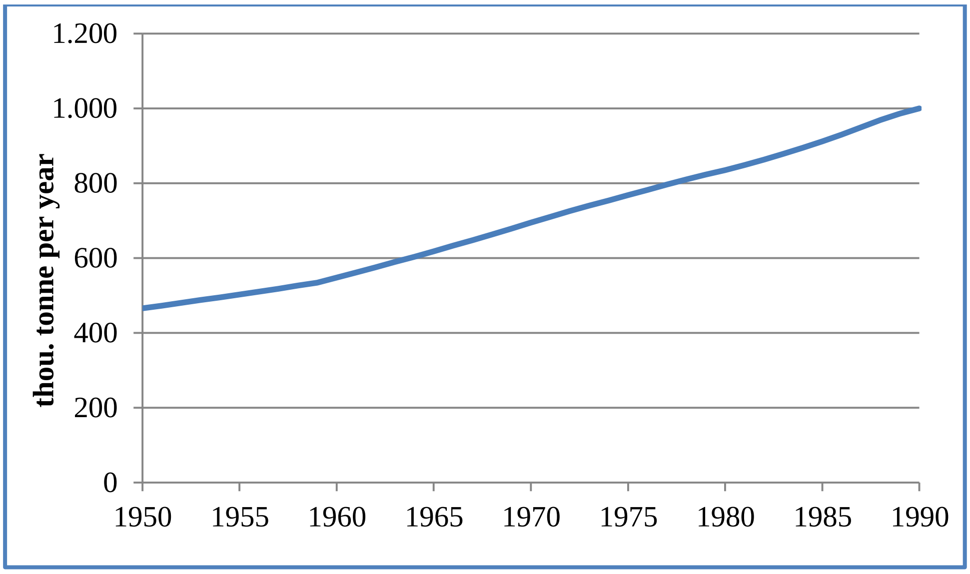

Figure 8-8. Assumed variation of municipal waste disposal from 1950 to 1990

Sensitivity analysis

Assumption that the amount of waste disposed of per capita in landfills in 1950-1989 was increasing on average by 1% should be considered as very rough, most probably containing significant error, and it is very important to evaluate whether erroneous assumption could have a significant impact on the final results of methane emission.

Growth of the amount of disposed per capita waste in 1950-1989 by 1% was taken as base scenario and for comparison, methane emissions were calculated using alternative assumptions that disposed per capita waste amount in 1950-1989 was increasing by 0.5% and 2%.

It is obvious that in case of faster growth, in order to reach the same level in 1990, the initial waste amount disposed of in 1959 should be lower, and vice versa, in case of slower growth the initial amount should be higher. Evaluated initial amounts of waste that should have been disposed in 1950 in case of 0.5%, 1% and 2% average growth of disposed per capita waste are shown in Table 8-21.

Table 8-21. Evaluated initial amounts of waste that should have been disposed in 1950 in case of 0.5%, 1% and 2% average growth of disposed per capita waste

Parameter	Growth 0.5%	Growth 1%	Growth 2%
Disposal kg/person/year	277	226	151
Total disposal, Gg per year	712	582	388

In case of waste growth rate reduced by halve compared to base scenario, initial waste amount increases only by 22.3%, while twice higher growth rate requires decline of initial waste amount by 33.4%.

Impact of different growth rates waste disposal in 1959-1989 on methane emissions in 1990-2011 is shown in Table 8-22.

Table 8-22. Impact of assumed different growth rates of waste disposal in 1959-1989 on methane emissions in 1990-2011 compared to base scenario (1% growth)

Year	Growth 0.5%	Growth 2%
1990	4.3%	-7.8%
1991	3.9%	-6.9%
1992	3.5%	-6.2%
1993	3.1%	-5.6%
1994	2.8%	-5.1%
1995	2.6%	-4.7%
1996	2.4%	-4.3%
1997	2.2%	-4.0%
1998	2.1%	-3.7%
1999	1.9%	-3.4%
2000	1.8%	-3.2%
2001	1.6%	-2.9%
2002	1.5%	-2.7%
2003	1.4%	-2.5%
2004	1.3%	-2.3%

2005	1.3%	-2.2%
2006	1.2%	-2.1%
2007	1.2%	-2.0%
2008	1.1%	-1.9%
2009	1.0%	-1.8%
2010	1.0%	-1.7%
2011	0.9%	-1.6%

As could be seen from the Table, in case of growth rate reduced by halve, i.e. larger amount of initial and, consequently, the total amount of disposed waste, maximum increase of methane emissions is 4.3%, average increase during the period 1990-2011 only 2%.

Assumption that waste disposal growth rate in 1950-1989 was twice higher than in the base scenario results in reduction of methane emissions by maximum 7.8%, on average 3.6%.

It is obvious that variations of obtained results using three various scenarios are quite small, significantly lower than uncertainty of evaluation of methane emissions, and possible error in estimating waste disposal in 1950-1989 could have only minor impact on final results.

Waste disposal practices

Historically Lithuanian landfills can be divided into three categories:

- landfills of major cities (county centres),
- landfills of smaller towns, and
- small landfills and dumps in rural areas.

Waste management in landfills of major cities include controlled placement of waste, periodic covering and mechanical compacting, These landfills correspond to the definition of managed landfills.

Landfills of smaller towns are comparatively deep (>5 m of waste) but their management especially in the past was poor. These landfills correspond to the definition of deep unmanaged landfills.

Small landfills and dumps in rural areas were assigned to unmanaged shallow landfills (<5 m waste).

The amounts of waste disposed to the landfills of each type were evaluated in the following way.

Variations of urban and rural population in Lithuania during 2001-2008 are shown in Table 8-8. Separately data of populations in major cities and towns are not available from 1950. However, as seen from this table, the share of major cities in the total urban population is fairly constant and makes approximately 70%. It was assumed that this ratio continued for the whole discussed period starting from 1950. Estimated variations of population in major cities, towns and rural areas from 1950 are provided in Figure 8-9.

Table 8-23. Variations of urban and rural population (k) in Lithuania during 2001-2011

Year	Major cities	Towns	Total urban	Rural	Total
2001	1,629	702	2,330	1,151	3,481
2002	1,622	699	2,322	1,147	3,469
2003	1,616	691	2,307	1,147	3,454
2004	1,604	685	2,289	1,146	3,436
2005	1,593	682	2,275	1,139	3,414
2006	1,585	679	2,265	1,130	3,394
2007	1,580	676	2,256	1,120	3,376
2008	1,556	690	2,246	1,112	3,358
2009	1,551	684	2,235	1,104	3,339
2010	1,531	669	2,200	1,086	3,287
2011	1,499	658	2,157	1,065	3,222

Source: Statistics Lithuania

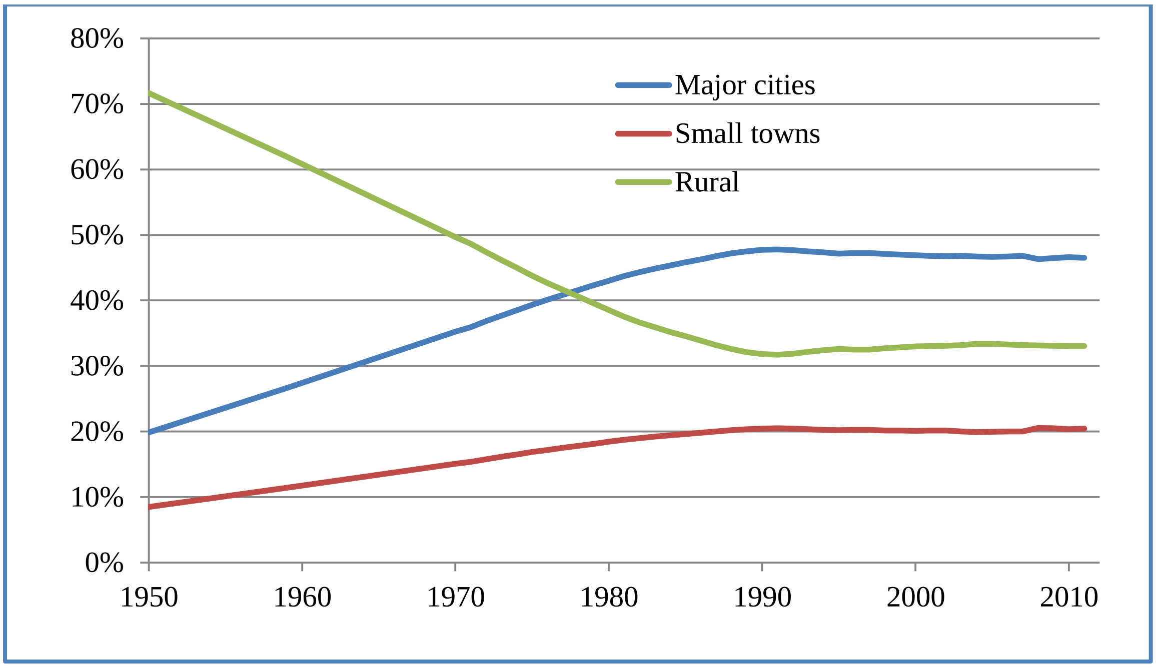

Figure 8-9. Estimated variations of population in major cities, towns and rural areas from 1950[169]

Conditions described above were applicable until 2007. From 2007 disposal practices started to change. Implementation of the Landfill directive 1999/31/EC requires construction of new solid waste landfills corresponding to the requirements set in the directive and closure of all existing landfills not complying with the requirements.

As a result, 10 municipal waste management regions were established in Lithuania and new landfills complying with the requirements of the Landfill directive were constructed. Old landfills and dumps were closed and all waste including waste from small towns and rural areas are currently disposed in a new managed landfills. Date of starts of disposal of all wastes in managed regional landfills complying with the requirements of landfill directive are shown in Table 8-24.

[169] Statistics Lithuania

Table 8-24. The beginning of waste disposal in new managed regional landfills

Region	Start of the disposal
Alytus	January 2008
Marijampolė	April 2009
Tauragė	April 2009
Šiauliai	July 2007
Vilnius	January 2008
Telšiai	January 2008
Klaipėda	July 2008
Kaunas	July 2009
Utena	April 2008
Panevėžys	October 2009

For the transition period 2007-2009, the regional waste management companies provided data (percentage) of wastes disposed in old and new landfills. Waste disposed in old landfills was divided into 3 categories depending on population distribution in cities, towns and rural areas, waste disposed of in new landfills was assigned to deep managed category.

Evaluated disposal of municipal waste in new regional landfills are shown in Table 8-25.

Table 8-25. Disposal of municipal waste in new regional landfills during 2007-2009

Region	2007			2008			2009		
	Population, %	Disposal		Population, %	Disposal		Population, %	Disposal	
		%	kt		%	kt		%	kt
Alytus	5,2	NO	NO	5,2	100	62	5,2	100	56
Kaunas	20,0	NO	NO	20,0	86	202	20,0	92	197
Klaipėda	11,3	NO	NO	11,3	76	100	11,3	79	96
Marijampolė	5,4	NO	NO	5,4	NO	NO	5,4	59	34
Panevėžys	8,4	NO	NO	8,4	NO	NO	8,4	57	51
Šiauliai	10,3	50	58	10,4	80	97	10,3	61	67
Tauragė	3,8	NO	NO	3,8	NO	NO	3,8	79	32
Telšiai	5,1	NO	NO	5,2	100	60	5,1	100	55
Utena	5,1	NO	NO	5,1	100	60	5,1	100	55
Vilnius	25,4	NO	NO	25,2	90	266	25,4	95	258
Total			58			846			902
Fraction of the total municipal waste			5,2%			72,2%			84,1%

The amount of waste disposed of in regional landfills (58 kt in 2007, 846 kt in 2008 and 902 kt in 2009) were added to the amount disposed in new managed landfills, the remaining amount was divided among the three types of landfills depending on the number of population in major cities, towns and rural areas and evaluated generation of municipal waste per capita.

During the meeting at the Ministry of Environment[170] it was agreed that the ratio of waste generation in major cities, towns and rural areas is approximately 2:1,5:1, Based on this assumption, waste disposal per capita in major cities, towns and rural areas (excluding waste disposed of in new landfills) were calculated as:

$$G_R = \frac{WT}{2 \times P_C + 1.5 \times P_T + P_R},$$

$$G_C = 2 \times G_R,$$

$$G_T = 1.5 \times G_R$$

where:
G_C,G_T and G_R are annual amount of waste disposed in cities, towns and rural areas (kg per capita per year),
WT is the total amount of disposed waste (tonne) minus waste disposed on the new regional landfills,
P_C, P_T and P_R are the number of population in cities, towns and rural areas (thousands).

The amounts of waste disposed of in managed, deep unmanaged and shallow unmanaged landfills (corresponding to waste delivered for disposal from major cities, towns and rural areas) were calculated by multiplying corresponding population number with the waste generation per capita of the corresponding category, namely for managed waste disposal sites: 2.G_R.Pc; for unmanaged deep: 1,5 . G_R.Pt; for unmanaged shallow: 1. G_R.P_R.

Sewage sludge disposal

Sewage sludge is disposed separately from solid waste on sites comparable to landfills. Statistical information on sewage sludge disposal are collected and stored in the same data base together with data on waste generation and management. Data on sewage sludge disposal were provided by the Lithuanian EPA responsible for collection and management of statistical information on waste management.

Up to 2005 wet sewage sludge generation and management data are reported and stored in the EPA database. From 2006 some companies started reporting sludge dry matter. All data were carefully checked and converted to wet sludge using dry matter/wet sludge conversion factor 0.2[171]

Sewage sludge disposal conditions, same as solid waste, depend on the size of disposal site - in large cities large amounts of sludge are disposed, while in small towns disposal sites are smaller and thinner. A study on sewage sludge management[172] performed in 2012 concluded that about 73% of sewage sludge are disposed on shallow (depth <5 m) sites for which use of MCF value 0.4 is recommended. Remaining 27% are disposed on deep (depth >5 m) sites for which MCF value 0.8 should be used.

[170] Meeting at the Ministry of Environment with the Head of Waste Division Ingrida Kavaliauskienė and senior specialist Ingrida Rimaitytė, September 25, 2009
[171] Wet - dry conversion of sludges. ARGUS for Eurostat - Environment Statistics. Meeting of the Working Group "Statistics of the Environment", Sub-Group "Waste". Eurostat, 2008.
[172] Evaluation of methane generation from wastewater and sludge at wastewater treatment plants in Lithuania (Lietuvos nuotekų valymo įrenginių nuotekose ir dumble susidarančio metano kiekio tyrimai ir įvertinimas)Ekotermija, 2012

Part of sludge is treated in anaerobic digesters, composted or used as fertilizer in the agriculture sector. There is no methodology provided in the IPCC guidelines for estimation of CH4 or N2O from composting facilities or compost spreading on agricultural soil. Some countries (e.g. Belgium, Netherlands) have provided estimates from composting sites based on country-specific investigations. Such investigations were not performed in Lithuania.

Methane recovery

Landfill gas collection started in 2008 in closed Kaunas and Utena landfills. From 2010 landfill gas recovery started also in closed Vilnius, Klaipėda and Marijampolė landfills.

Data on landfill gas recovery in TJ are provided by Statistics Lithuania. As these data are used for establishing GHG emissions in energy sector, it was decided to be consistent and use the same data for establishing methane recovery. Amount of recovered methane in Gg was calculated assuming that methane lower heating value is 50 TJ/Gg[173].

Recovered methane both in landfills and in wastewater treatment plants, is used for energy purposes and emissions from these electricity- and heat-producing activities are included under the energy sector and reported in the 1A sector as biogas which includes biogas generated from landfills, sewage sludge and manure.

Data of CH_4 recovery from landfills are provided in Table 8-26.

Table 8-26. Methane recovery from landfills, Gg

Year	Recovery
2008	0,34
2009	1,12
2010	1,66
2011	4,90

Source: Statistics Lithuania

At the municipal wastewater treatment plants methane is recovered in anaerobic digestion installations from sludge generated during wastewater treatment. Sludge for anaerobic digestion is collected separately and not accounted together with disposed sludge. Therefore methane recovery in anaerobic digestion plants is discussed in wastewater handling section.

Automatic anaerobic digestion facilities are operated under pressure lower than atmospheric and exclude any leakages of CH_4 .

[173] http://www.engineeringtoolbox.com/gross-net-heating-values-d_420.html

8.2.3 Methodology

First Order Decay Model

The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (1996 Guidelines, IPCC, 1997) and the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (GPG 2000, IPCC, 2000) describe two methods for estimating CH4 emissions from solid waste disposal sites (SWDS): the mass balance method (Tier 1) and the First Order Decay (FOD) method (Tier 2). Use of the mass balance method is strongly discouraged in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories as it produces results that are not comparable with the FOD method which produces more accurate estimates of annual emissions. Therefore, CH4 emissions from solid waste disposal sites were estimated using FOD model provided in the 2006 IPCC Guidelines.

The FOD method was selected using Decision Tree (figure 5.1) provided in the GHG 2000, p. 5.6. Parameters required for calculation are provided in the GHG 2000, however certain reservations concerning their use are provided in the guidelines. Therefore, the parameters provided in the GHG2000 were compared to parameters provided in the 2006 IPCC guidelines.

GHG 2000 provide only general discussion on possible value of methane rate generation constant *k* and do not associate definite values with specific components. On the other hand, 2006 IPCC guidelines provide k values for each specific component based on the results of latest investigations.

Only roughly estimated data are provided in the GHG 2000 on fractions of degradable organic carbon DOC), while 2006 IPCC guidelines more detailed evaluations and, what is especially important, provide references to the results of latest investigations on which evaluation of DOC values is based.

GHG 2000 provide default value of 0.77 for fraction of degradable organic carbon (DOC_f) but warn that this default value is probably overestimated. 2006 IPCC guidelines give DOC_f value 0.5 which corresponds to the suggestion in the GHG 2000.

Finally, GHG 2000 do not provide the values of parameters for sludge which was included in calculations.

The FOD method was selected to estimate the CH4 emissions from solid waste disposal, in line with the IPCC good practice guidance taking into consideration that the 2006 IPCC Guidelines take into account the latest research (e.g. the degradable organic carbon (DOC) values provided therein allow to disaggregate the emissions more finely by waste type). In addition, the Revised 1996 IPCC Guidelines and the IPCC good practice guidance do not provide differentiated parameter values for the methane generation rate constant, but that the 2006 IPCC Guidelines do provide differentiated methane generation rate constants per type of waste. The IPCC good practice guidance does not provide any parameter values for sludge, but the 2006 IPCC Guidelines do.

Therefore it was concluded that parameter values provided in the 2006 IPCC guidelines are more reliable and precise and were used for calculation of methane emissions by FOD model.

CH_4 generation was evaluated using FOD model according to an IPCC Tier 2 approach (IPCC 1997, 2000 and 2006). The model calculations were performed using national statistics of landfill site characteristics and amounts of waste fractions deposited each year.

The basic equation for the first order decay model is made available in the Excel file containing first order decay model provided by the European Commission[174]:

$$DDOC_m = DDOC_m(0) \cdot e^{-kt}$$

where:

$DDOC_m$ is the mass of decomposable degradable organic carbon (DOC) at any time,
$DDOC_m(0)$ is the mass of DOC at the start of the reaction, when t=0 and $e^{-kt}=1$,
t is time in years, and
k is the reaction constant.

The default assumption is that CH_4 generation from all the waste deposited each year begins on the 1st of January in the year after deposition. This is the same as an average six month delay until substantial CH_4 generation begins (the time it takes for anaerobic conditions to become well established).

The amount of degradable organic carbon disposed during a year decreases exponentially over time according to the first order decay equation resulting in corresponding exponential reduction of CH_4 generation. The total CH_4 generation at a given time *t* is a sum contributions from degradation of organic carbon disposed during the years from 1 to t.

Annual CH_4 emissions were calculated using formula (IPCC GPG 2000, p. 5.7):

$$CH_4 \text{ emitted in year } t \text{ (Gg/yr)} = [CH_4 \text{ generated in year } t - R(t)] \cdot (1 - OX)$$

Where:

R(t) is recovered CH_4 in inventory year t (Gg/yr),
OX is oxidation factor (assumed *OX* = 0).

FOD model provided by the European Commission already contains all default parameters used in calculations.

The methodology was used for the whole waste including both municipal and industrial waste.

Separate values of parameters, when available, were applied for different waste components (food waste, paper, wood, textiles, green waste and sewage sludge) and different types of landfills (deep managed, deep unmanaged, shallow unmanaged).

Methane correction factor

Waste management in landfills of major cities include controlled placement of waste, periodic covering and mechanical compacting. These landfills correspond to the definition of managed landfills with CH_4 correction factor = 1 (IPCC GPG 2000, p. 5.9).

[174] 2006 IPCC GPG vol 5

Landfills of smaller towns are comparatively deep (>5 m of waste) but their management, especially in the past, was poor. These landfills correspond to the definition of deep unmanaged landfills with CH_4 correction factor = 0,8 (IPCC GPG 2000, p. 5.9).

Small landfills and dumps in rural areas were assigned to unmanaged shallow landfills (<5 m waste) with CH_4 correction factor = 0,4 (IPCC GPG 2000, p. 5.9).

Other parameters

Other parameters were taken as IPCC 2006 default values.

DOC (weight fraction, wet basis) (IPCC 2006, v. 5, p. 2.14) :

Food waste	0,15
Paper	0,4
Wood	0,43
Textiles	0,24
Green waste	0,20

Country specific DOC value was used in calculations of methane emissions from sewage sludge. Average DOC value reported in the study[175] performed in 2012 was evaluated at 30% of sludge dry matter based on experimental analyses performed in various wastewater treatment facilities in Lithuania. Assuming that dry matter content in sewage sludge is about 20%, DOC value 0.06 was used for calculation of methane emissions from wet sludge.

CH_4 generation rate constant was chosen for the wet climate condition under the boreal and temperate climate zone provided in the 2006 IPCC Guidelines (v. 5, p. 3.17). The reason for the selection of this value is that Lithuania is situated in the temperate climate zone, i.e. north of subtropics and south of subarctic area, and its climate is characterized as wet, i.e. precipitation exceeds evaporation.

CH_4 generation rate constant (years^{-1})

Food waste	0,185
Paper	0,06
Wood	0,03
Textile	0,06
Green waste	0,1
Sewage sludge	0,185

DOC_f (fraction of DOC dissimilated)	0,5 (IPCC 2006, v. 5, p. 3.13)
Delay time (months)	6 (IPCC 2006,v. 5, p. 3.19)
Fraction of CH_4 in developed gas	0,5 (IPCC 2006, v. 5, p. 3.26)
Conversion factor, C to CH_4	16/12 = 1,33 (IPCC 2006, v. 5, p. 3.37)
Methane oxidation	0 (IPCC 2006, v. 5, p. 3,15)

[175] Evaluation of methane generation from wastewater and sludge at wastewater treatment plants in Lithuania (Lietuvos nuotekų valymo įrenginių nuotekose ir dumble susidarančio metano kiekio tyrimai ir įvertinimas) Ekotermija, 2012

Separate methane generation rate constant (k) values specific for each component were used in calculations (see NIR, p. 340). k value entered in the CRF database represents weighed average for all components and slightly changes from year to year depending on waste composition. Only single line is provided in the CRF database for entering additional information on k value therefore we decided to enter weighed average rather than separate k for a separate component. Calculated average values were not included in calculations and have no impact on calculation results.

Methane is recovered only from major old closed landfills, methane from newly constructed landfills is not yet recovered.

Same as in case of methane generation rate constant, weighed average DOC values were calculated for entering in the CRF database using values for separate components provided in NIR p. 340 and waste composition for each year.

8.2.4 Uncertainties and Time-Series Consistency

Uncertainties

Uncertainty of activity data was assumed to be 30% (IPCC 2006, v. 3, Table 3.5).

Uncertainties of separate input parameters for Tier 1 uncertainty analysis were taken as average values of uncertainties provided in IPCC 2006, v. 3, Table 3.5.

Table 8-27. Uncertainties of separate input parameters

Parameter	**IPCC 2006, v. 3, Table 3.5**	**Assumed average uncertainty**
Degradable organic carbon	±20%	20%
Fraction of degradable organic carbon dissimilated	±20%	20%
Methane correction factor:		
MCF = 1	-10%, +0%	5%
MCF = 0,4	±30%	30%
MCF = 0,8	±20%	20%
Methane fraction in landfill gas	±5%	10%
Methane generation rate constant*	-40%, +300%	170%

* GPG 2000, p. 5.12, Table 5.2)

Uncertainty of implied emission factor for three separate MCF values was established using IPCC 2000, equation 6.4 (p. 6.12):

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \ldots + U_n^2},$$

Where:
U_{total} is the percentage uncertainty in the product of the quantities (half the 95% confidence interval divided by the total and expressed as a percentage);
U_i are the percentage uncertainties associated with each of the quantities.

Uncertainties of implied emission factors calculated using values from the third column of Table 8-27 are provided in Table 8-28.

Table 8-28. Overall uncertainties of implied emission factors

Methane correction factor	Uncertainties of implied emission factor
MCF = 1	172%
MCF = 0,4	175%
MCF = 0,8	174%

The overall uncertainty of emission factor for the total CH_4 emission comprising all three types of landfills was calculated using IPCC 2000, equation 6.3 (p. 6.12):

$$U_{total} = \frac{\sqrt{(U_1 \cdot x_1)^2 + (U_2 \cdot x_2)^2 + \ldots + (U_n \cdot x_n)^2}}{x_1 + x_2 + \ldots x_n}$$

where:
U_{total} is the percentage uncertainty in the sum of the quantities,
x_i and U_i are the uncertain quantities and the percentage uncertainties associated with them, respectively.

Calculated overall uncertainty of implied emission factor using average CH_4 emission values of disposed solid waste and sewage sludge over the period 1990-2011 is 129%.

Time-Series Consistency

Emissions from waste disposal on land were calculated for the whole time series using the same method and data sets.

Statistical data on waste disposal are available from 1991. It was assumed after consultations with the specialists of the Ministry of Environment that data on municipal waste disposal in 1991-1997 were overestimated, hence the data were corrected based on correlation with GDP. Historic data on waste disposal starting from 1950 were evaluated taking into account available data on variations of population, economic development and considering expansion of waste management infrastructure.

8.2.5 Completeness

Inventory of emissions from solid waste disposal on land covers methane emissions occurring in the whole territory of Lithuania during the period 1990 to 2011. The inventory takes account of all existing landfills and dumps divided in three categories (deep managed, deep unmanaged and shallow unmanaged) and includes emissions from various types of biodegradable materials (food waste, paper, wood, textile, green waste , sewage sludge) disposed of with municipal, industrial and commercial waste.

8.2.6 Source-specific QA/QC and verification

Data collection and calculations were performed in accordance with the requirements outlined in Section 6 of the Quality Assurance(QA) and Quality Control(QC) Plan[176].

Tier 1 General Inventory Level QC was performed based on recommendations provided in IPCC 2000, page 8.8-8.9, Table 8.1 and outlined in the QA/QC plan.

Consistency of data between NIR and CRF has been checked.
Documentation on activity data and emission factors was crosschecked with the corresponding data in calculation model.

In case of large fluctuations in data, other experts or data providers were consulted to either provide the explanation or to identify a possible inconsistency or an error.

Explanations for recalculations were checked to ensure that they are clearly documented.

After the calculation is finished, EPA waste experts not directly involved in the emissions calculation of that year have reviewed the final report and CRF data checking the applied parameters, calculation methodology, as well as trend description in the NIR.

In addition, verification of methane emissions from solid waste disposal on land was performed by comparing per capita emission data with neighbouring countries: Latvia, Estonia, Poland, and Denmark. The results are shown in Table 8-29.

Table 8-29. Comparison of GHG emissions from solid waste disposal on land (kg per capita)

Year	Lithuania 2011	Denmark 2010	Latvia 2010	Estonia 2010	Poland 2010
1990	11.7	13.7	5.9	5.5	8.7
1991	11.9	13.7	6.1	5.9	9.0
1992	12.2	13.5	6.4	6.3	9.2
1993	12.4	13.2	6.7	7.1	9.3
1994	12.6	12.4	6.9	7.5	9.4
1995	12.7	11.5	7.1	6.7	9.5
1996	12.8	11.0	7.2	7.3	9.5
1997	12.9	10.2	7.4	9.3	9.6
1998	13.1	9.5	7.6	10.9	9.7
1999	13.1	9.5	7.8	11.3	9.9
2000	13.3	9.4	8.1	12.6	10.1
2001	13.8	9.3	8.3	12.9	10.5
2002	14.0	8.7	8.3	12.4	10.6
2003	14.2	8.8	7.7	12.3	10.3
2004	14.1	7.7	7.4	12.5	10.3

[176] National Greenhouse Gas Emission Inventory of the Republic of Lithuania. Quality Assurance and Quality control Plan 2011-2012. Vilnius, 2011.

2005	13.9	7.5	7.7	11.5	10.2
2006	13.8	7.7	8.0	11.3	10.1
2007	13.7	7.3	8.5	10.9	10.2
2008	13.5	7.0	8.9	11.1	10.2
2009	13.3	6.6	9.0	11.6	10.2
2010	13.3	6.0	9.3	11.5	9.8

Established methane emissions per capita from solid waste disposal on land in Lithuania are 17% lower than in Denmark in 1990 but higher in 2010 apparently because of significantly increasing methane recovery in Denmark. Lithuania's emissions per capita in 2009 are 14% higher than in Estonia and about 26% higher than in Poland.

In general, it may be concluded that evaluated methane generation in Lithuania is in the middle between Danish data and emissions reported by other compared countries.

8.2.7 Source specific recalculations

CH_4 emissions were recalculated separately for solid waste disposal on land and for sewage sludge disposal. In addition, data on sewage sludge disposal were upgraded by checking disposal codes used by reporting companies and reporting data (starting from 2006 some companies reported sewage sludge disposal as dry mattes, other companies as wet sludge).

Impact of recalculations of CH_4 emission (Gg) from solid waste disposal on land is shown in Table 8-30.

Table 8-30. Impact of recalculations of CH_4 emissions (Gg CO_2 eq.) from solid waste disposal on land

Year	Previous submission	This submission	Difference	
			Gg	%
1990	907.0	864.2	-42.8	-4.7%
1991	928.8	885.1	-43.8	-4.7%
1992	947.9	903.9	-44.0	-4.6%
1993	960.4	920.1	-40.2	-4.2%
1994	964.7	924.9	-39.8	-4.1%
1995	964.1	926.3	-37.8	-3.9%
1996	967.7	933.3	-34.4	-3.6%
1997	971.6	939.9	-31.6	-3.3%
1998	974.1	943.4	-30.7	-3.1%
1999	972.6	945.8	-26.8	-2.8%
2000	979.5	954.3	-25.3	-2.6%
2001	1010.1	985.2	-24.8	-2.5%
2002	1022.4	995.0	-27.4	-2.7%
2003	1032.6	1004.1	-28.5	-2.8%
2004	1014.8	986.1	-28.7	-2.8%
2005	996.5	967.5	-29.0	-2.9%
2006	982.6	951.0	-31.6	-3.2%
2007	972.6	935.9	-36.7	-3.8%
2008	961.8	919.4	-42.3	-4.4%

2009	959.7	903.6	-56.1	-5.8%
2010	954.4	883.9	-56.1	-5.9%

8.2.8 Planned improvements

No improvements are planned in this sector.

8.3 Wastewater Handling (CRF 6.B)

8.3.1 Source category description

Wastewater treatment

There are more than 1700 wastewater treatment facilities in Lithuania but about 84% of wastewater is treated in municipal biological treatment facilities with N and P removal (Table 8-31).

Table 8-31. Wastewater treatment facilities in Lithuania

Treatment method		Treated BOD	
	No of facilities	Fraction of total	Cummulative total
Biological treatment with N and P removal	57	83.6%	83.6%
Pneumatic aeration tanks	370	10.9%	94.5%
Infiltration fields	11	1.5%	95.9%
Discharge without treatment	674	0.8%	96.7%
Biological treatment	18	0.8%	97.4%
Mechanical aeration tanks	26	0.6%	98.0%
Pneumatic aeration channels	46	0.4%	98.5%
Mechanical aeration channels	56	0.4%	98.9%
Mechanical treatment	48	0.4%	99.3%
Biofilters	18	0.2%	99.5%
Other facilities	1	0.1%	99.6%
Storm water treatment	343	0.1%	99.7%
Other biological treatment facilities	38	0.1%	99.8%
Biological ponds	13	0.1%	99.9%
Natural treatment methods	25	0.0%	100.0%
Infiltration fields without discharge	27	0.0%	100.0%
Primary physica-chemical treatment	1	0.0%	100.0%
Agricultural irrigation fields	5	0.0%	100.0%
Physical-chemical treatment	2	0.0%	100.0%

Wastewater discharge

CH_4 is generated from wastewater in anaerobic conditions while N_2O can be produced as nitrification and denitrification product in both aerobic and anaerobic conditions. This section covers CH_4 emissions from wastewater transportation and treatment as well as from septic tanks used by population not connected to centralised sewerage networks. CH_4 emissions from sewage sludge formed during wastewater treatment are covered by solid waste disposal on land section.

Wastewater treatment facilities in Lithuania are aerobic and CH_4 emissions can occur only in pipelines or treatment facilities if anaerobic conditions develop.

Substantial part of Lithuanian population is still not connected to centralised sewer networks as shown in Table 8-32.

Table 8-32. Fraction of population having no connection to sewerage networks

Year	Fraction, %
1999	49,5
2000	48,1
2001	46,9
2002	46,3
2003	43,8
2004	42,6
2005	41,7
2006	39,0
2007	39,0

2008	42,4
2009	40,8
2010	38,9
2011	39,5

Source: Lithuanian Water Suppliers Association

Revised 1996 IPCC Guidelines recommend calculation of CH_4 emissions separately from domestic and from industrial wastewater assuming that organic matter is measured as biochemical oxygen demand (BOD) in municipal wastewater and as chemical oxygen demand (COD) in industrial wastewater. However in most cases in Lithuania industrial wastewater is discharged to centralised municipal sewage collection networks and treated together with the domestic wastewater in centralised municipal treatment plants.

According to the information provided by the Lithuanian Water Suppliers Association[177] fraction of industrial wastewater exceeds 50% in six of 38 agglomerations with population equivalent more than 10 thousand. In one of them (Pasvalys) fraction of industrial wastewater comprises 87,5% of the total wastewater discharge. On average, industrial wastewater comprises about 20% of the total load of municipal wastewater treatment systems in Lithuania.
In addition, separate evaluation of CH_4 emissions from domestic and industrial wastewater as recommended by the IPCC Guidelines is problematic because organic load in both domestic and industrial wastewater is measured predominantly as BOD.

There are close to 1800 wastewater discharge points in Lithuania registered by the Lithuanian EPA. Among them, some discharges from industries are also registered but representing only miner fraction of industrial discharges mainly from industries located in remote areas not covered by municipal sewerage collection systems. The major part of industrial wastewater is discharged into municipal sewerage networks and cannot be separated from municipal wastewater.

It is possible to identify 3 or 4 major industrial sectors with the largest potential for CH4 emissions but COD data cannot be collected as industrial wastewater is discharged mainly together with municipal wastewater and, in addition, in most cases only BOD data are available. Default values or expert judgement for estimating COD values can be applied for these major industries but calculation of emissions based on these values will cause double counting as discharges of these industries have already been accounted for in emissions from municipal wastewater.

Expert judgements as well as default values are associated with substantial errors and uncertainties. We have country specific instrumental measurements of wastewater discharges and organic matter (BOD) content, and we are convinced that country specific instrumental measurements provide much more reliable and precise results than default data based on conditions in other, most frequently remote countries, or expert judgements.

Information of wastewater treatment and discharge in Lithuania is collected by the Lithuanian Environmental Protection Agency (EPA). Data collection is regulated by Order No.408 of the Minister of Environment of the Republic of Lithuania of calculation of pollutant emissions to environment of 20th December 1999 as last amended on 20th September 2001. Pursuant to this legal act water users

[177] Lithuanian Water Suppliers Association. Certificate on municipal wastewater treatment plant capacity assessment, 2011.03.04.

and/or wastewater dischargers must submit annual reports to institutions subordinated to Ministry of Environment - Regional Environmental Protection Departments (REPDs). REPDS perform primary data check of regional level and checked data are forwarded to the EPA. The EPA performs the final validation, processing and aggregation at national level.

Collected data include both BOD and COD, however, as seen from Table 8-33 both parameters are provided for the same samples without specification of municipal or industrial wastewater sources. Therefore, there is no possibility to separate industrial and municipal wastewater streams.

Table 8-33. Number of discharge points for which data on BOD and COD are provided in the statistics

Year	Number of discharge points included in the statistics		
	BOD	COD	Both BOD and COD
1991	657	46	45
1992	674	42	40
1993	612	37	34
1994	614	29	28
1995	641	35	33
1996	694	39	36
1997	697	42	41
1998	721	53	51
1999	745	52	50
2000	766	62	60
2001	724	59	56
2002	766	95	83
2003	781	162	158
2004	781	325	323
2005	808	452	447
2006	769	436	436

CH_4 recovery from wastewater sludge has been started in 1999 by Utena waste supply company. Currently CH_4 production facilities are in operation in four water supply companies.

Evaluated CH_4 emissions from wastewater are shown in Table 8-34.

Table 8-34. Evaluated CH_4 emissions from wastewater (Gg)

Year	Wastewater treatment	Septic tanks	Total
1990	0,18	8,10	8,28
1991	0,18	8,11	8,29
1992	0,13	8,10	8,23
1993	0,12	8,06	8,18
1994	0,10	8,01	8,11
1995	0,10	7,95	8,05
1996	0,10	7,89	7,99
1997	0,11	7,83	7,94

1998	0,12	7,77	7,90
1999	0,09	7,64	7,73
2000	0,11	7,37	7,48
2001	0,11	7,10	7,22
2002	0,09	6.91	7,00
2003	0,11	6,45	6,56
2004	0,12	6,13	6,25
2005	0,11	5.80	5,91
2006	0,13	5,21	5,33
2007	0,13	5,09	5,23
2008	0,13	5.50	5,62
2009	0,12	5,17	5,29
2010	0,13	4,76	4,89
2011	0,13	4,73	4,86

8.3.2 Methodological issues

Wastewater discharge

Data of wastewater composition and discharge are collected by the EPA from 1991. There are some very large fluctuations of data in the beginning of the monitoring period. This data was analyzed and some corrections were made.

Bearing in mind that water usage and wastewater discharges have shrunk very substantially after the restoration of independence, with steeply increasing energy and water prices, wastewater discharge in 1990 was evaluated by linear extrapolation of 1991-1993 data.

Reported BOD load to the Raseiniai mechanical treatment plant in 1992 was 284 tonnes BOD. Bearing in mind that the plant provides service for approximately 12 thousands population, this amount corresponds to BOD generation of 2267 kg per capita per year, which is roughly 100 times higher than expected. It was considered as an obvious outlier and corresponding figure was divided by 100.

According to the data provided for 1992. 284 tonnes of BOD (or about 10% of the total amount) were generated by small construction company which wasn't included in the records neither before nor after 1992. Once again it was considered to be an obvious outlay and corresponding data were deleted from the database.

BOD data reported by the Šiauliai wastewater treatment facility in 1992 and 1994 were roughly 10 times higher than during the remaining period. These deviations were considered as outlays and were reduced 10 times.

BOD discharge in 1990 was assumed to be the same as in 1991.

Discharges of degradable organic matter in Lithuania in 1990-2010 are shown in Table 8-35.

Table 8-35. Discharge of degradable organic matter, Gg BOD

Year	Discharge of degradable organic matter, Gg BOD
1990	100,4
1991	100,4
1992	70,3
1993	66,2
1994	58,1
1995	55,3
1996	56,4
1997	63,0
1998	68,3
1999	48,6
2000	59,2
2001	62,3
2002	49,2
2003	61,1
2004	67,9
2005	63,8
2006	69,9
2007	74,6
2008	70,8
2009	69,0
2010	69,9
2010	72,3

Methodology

CH_4 emissions from wastewater were estimated following Revised IPCC 1996 Guidelines and IPCC 2000 Good Practice Guidance, Emissions from sewer systems, primary settling tank and biological N and P removal processes were estimated as:

$$CH_4\ emission = TOW_{influent} \cdot B_0 \cdot MCF_{sewer+WWTP}$$

where:

$TOW_{influent}$ is influent organic degradable matter measured as biological oxygen demand (BOD) in the influent waste water flow,
B_0 is default maximum CH_4 producing capacity 0,6 kg CH_4 per kg BOD (IPCC, 1997),
$MCF_{sewer+WWTP}$ is the fraction of DOC that is anaerobically converted in sewers and WWTPs.
$MCF_{sewer+WWTP}$ was taken from the Denmark's national report[178] in which it was evaluated equal to 0,003 based on an expert judgement of a conservative estimate of the fugitive CH_4 emission from the primary settling tanks and biological treatment processes.

[178] Denmar k's National Inventory Report 2011. Emission Inventories 1990-2009 NERI Technical Report no. 827, 2011, p. 490

Denmark was involved in the development of the Lithuanian wastewater handling system after the declaration of independence and the two systems are very similar. Therefore use of data on anaerobically convertible DOC fraction should be considered justifiable.

It should be emphasised that country specific instrumental measurements were used for establishing methane emissions which provide more reliable and precise results than the IPCC default data (EFs and AD) which are based on conditions in other countries.

BOD load from population not connected to sewerage networks was evaluated according to methodology provided in Revised 1996 IPCC Guidelines (v. 3, p. 6.23, Table 6.5) using default BOD_5 generation value 18,25 kg per person per year. The total BOD load is sum of BOD discharge from sources connected to sewerage networks and calculated BOD load from population having no connection to sewerage networks.

Methane recovery from sewage sludge

Anaerobic digestion installations with CH_4 recovery are operated by several water supply companies. Statistical data on biogas recovery from sewage sludge are reported by the Statistics Lithuania in TJ. The data were converted to Gg using methane Lower Heating Value (LHV) = 50 TJ/Gg.

It should be noted that statistical data are provided by the Statistics Lithuania from 2002 while methane recovery in UAB Utenos Vandenys was started in 1999 and in UAB Kauno Vandenys in 2000.

Data on recovered biogas volume provided by the Statistics Lithuania correspond well with the data provided by water supply companies starting from 2004, showing relation between mass and volume 0.4 Gg per million m^3. Data provided by water supply companies for 2002-2003 are a bit higher than provided by the Statistics Lithuania. Data provided by the companies (in volume multiplied by 0.4 Gg per million m^3) were used for reporting (Table 8-36).

Table 8-36. CH_4 recovery, Gg

Year	Gg
1999	0,22
2000	0,84
2001	0,85
2002	0,85
2003	0,91
2004	0,94
2005	1,14
2006	1,24
2007	1,38
2008	1,40
2009	1,78
2010	2,50
2011	2,58

Recovered biogas is used for energy production and is reported in the 1A sector as biogas including biogas generated from landfills, sewage sludge and manure.

8.3.3 Uncertainties and time-series consistency

Uncertainty

Bearing in mind that certain problems related to reliability of data discussed above, it was assumed that uncertainty of $TOW_{influent}$ is ±30%. Uncertainty of CH_4 emission factor evaluated in the Danish NIR is 32%.

Uncertainties of parameters used for evaluating CH_4 emissions from septic tanks were taken from IPCC 2000 (p. 5.19, Table 5.3) Table 8-37.

Table 8-37. Uncertainties of parameters used for evaluating CH_4 emissions from septic tanks

Parameter	**Uncertainty Range**
Human Population	±5%
BOD/person	±30%
Maximum CH_4 Producing Capacity (B_0)	±30%
Fraction treated anaerobically	50% (average between 0 and 1)

Evaluated emission factor (EF) uncertainties of CH_4 emission from wastewater pipelines and treatment facilities calculated using equation 6.4 from GPG 2000, p. 6,12 is 44%. Calculated EF uncertainty of CH_4 emissions from septic tanks is 66%.

Evaluated overall EF uncertainty (IPCC 2000, equation 6.3 (p. 6.12) for CH_4 emissions from wastewater treatment is 65%.

Time-Series Consistency

Emissions from wastewater handling were calculated for the whole time series using the same method and data sets.

8.3.4 Source-specific QA/QC and verification

Data collection and calculations were performed in accordance with the requirements outlined in Section 6 of the Quality Assurance and Quality Control Plan[179].

Tier 1 General Inventory Level QC was performed based on recommendations provided in IPCC 2000. Table 8.1 and outlined in the QA/QC plan:

Consistency of data between NIR and CRF has been checked.
Documentation on activity data and emission factors was crosschecked with the corresponding data in calculation model.

In case of large fluctuations in data, other experts or data providers were consulted to either provide the explanation or to identify a possible inconsistency or an error.
Explanations for recalculations were checked to ensure that they are clearly documented.

[179] National Greenhouse Gas Emission Inventory of the Republic of Lithuania. Quality Assurance and Quality control Plan 2011-2012. Vilnius, 2011.

After the calculation is finished, EPA waste experts not directly involved in the emissions calculation of that year have reviewed the final report and CRF data checking the applied parameters, calculation methodology, as well as trend description in the NIR.

8.3.5 Source specific recalculations

New data on population connected to sewerage networks were obtained from Association of Water Supply Enterprises and methane emissions were recalculated using new data. In additions the Statistics Lithuania recalculated population data which starting from 2001 appeared to be lower than earlier established.

Impact of recalculations on CH_4 emissions (Gg) from wastewater handling is shown in Table 8-38.

Table 8-38. Impact of recalculations on CH_4 emissions (Gg CO_2 eq.) from wastewater handling

Year	Previous submission	This submission	Difference	
			Gg	%
1990	174.6	173.9	-0.7	-0.4%
1991	174.1	174.1	0.0	0.0%
1992	172.8	172.8	0.0	0.0%
1993	171.9	171.9	0.0	0.0%
1994	170.4	170.4	0.0	0.0%
1995	169.0	169.0	0.0	0.0%
1996	167.8	167.8	0.0	0.0%
1997	166.8	166.8	0.0	0.0%
1998	165.8	165.8	0.0	0.0%
1999	163.9	162.3	-1.6	-1.0%
2000	163.2	157.0	-6.2	-3.8%
2001	151.9	151.5	-0.3	-0.2%
2002	148.8	147.0	-1.9	-1.3%
2003	140.9	137.7	-3.1	-2.2%
2004	136.3	131.2	-5.1	-3.7%
2005	133.3	124.1	-9.2	-6.9%
2006	124.3	112.0	-12.4	-9.9%
2007	124.0	109.8	-14.2	-11.5%
2008	133.6	118.1	-15.5	-11.6%
2009	129.8	111.2	-18.6	-14.4%
2010	125.0	102.7	-22.3	-17.9%

8.3.6 Planned Improvements

No improvements are planned in this section.

8.3.7 Emissions from human sewage (CRF 6B 2.2)

8.3.7.1 Source category description

N_2O emissions were calculated using protein intake per capita evaluated at the Nutrition Centre under the Ministry of Health[180] (77,4 g/capita/day in 1998, 78,1 g/capita/day in 2002, and 81,91 g/capita/day in 2007). Linear interpolation of this data was used for calculation of N_2O emissions (Table 8-39).

Table 8-39. Evaluated N_2O emissions from human sewage

Year	Protein consumption/ kg/person/year	N_2O emissions, Gg
1990	27,7	0,26
1991	27,8	0,26
1992	27,9	0,26
1993	27,9	0,26
1994	28,0	0,26
1995	28,1	0,26
1996	28,1	0,25
1997	28,2	0,25
1998	28,3	0,25
1999	28,3	0,25
2000	28,4	0,25
2001	28,4	0,25
2002	28,5	0,25
2003	28,8	0,25
2004	29,1	0,25
2005	29,3	0,24
2006	29,6	0,24
2007	29,9	0,24
2008	30,2	0,24
2009	30,5	0,24
2010	30,7	0, 24
2011	31,0	0,24

8.3.7.2 Methodological issues

The emissions of N_2O from human sewage were calculated according to Revised 1996 IPCC Guidelines (p. 6.28) methodology (equation 15):

$$N_2O\ emission = Protein \times Frac_{NPR} \times NR_{PEOPLE} \times EF_6,$$

[180] A. Barzda. Study and evaluation of actual nutrition and nutrition habits of Lithuanian adult population. Doctoral dissertation (Suaugusių Lietuvos gyventojų faktiškos mitybos ir mitybos įpročių tyrimas ir vertinimas. Daktaro disertacijos santrauka.) Vilnius, 2011.

where:
N_2O emission is emissions from human sewage (kg N_2O-N/yr),
Protein is annual per capita protein intake (kg/person/yr),
NR_{PEOPLE} is number of people in country,
EF_6 is emission factor (0,01 kg N_2O-N/kg sewage-N produced with default fraction of nitrogen in protein 0,16 kg N/kg protein) (See Table 4-18 in Agriculture Chapter),
$Frac_{NPR}$ is fraction of nitrogen in protein (default = 0,16 kg N/kg protein) (see Table 4-19 in Agriculture Chapter).

8.3.7.3 Uncertainties

It was assumed that uncertainty of activity data is 30% and uncertainty of emission factors is 50%. Combined uncertainty for N_2O emissions from human sewage calculated using equation 6.4 (GPG 2000, p. 6.12) is 58%.

8.3.7.4 Source specific recalculations

Statistics Lithuania recalculated population data which starting from 2001 appeared to be lower than earlier established. Reduced number of population used in calculations lower emissions.

Impact of recalculations on N_2O emissions (Gg) from human sewage is shown in Table 8-40.

Table 8-40. Impact of recalculations on N2O emissions (Gg) from human sewage

Year	Previous submission	This submission	Difference	
			Gg	%
2001	0.25	0.25	-0.001	-0.3%
2002	0.25	0.25	-0.002	-0.8%
2003	0.25	0.25	-0.003	-1.2%
2004	0.25	0.25	-0.005	-1.8%
2005	0.25	0.24	-0.007	-2.9%
2006	0.25	0.24	-0.010	-4.0%
2007	0.25	0.24	-0.012	-4.6%
2008	0.25	0.24	-0.013	-5.0%
2009	0.26	0.24	-0.014	-5.5%
2010	0.26	0.24	-0.017	-6.5%

8.3.7.5 Planed improvements

No improvements are planned.

8.4 Waste incineration (CRF 6.C)

8.4.1 Source category description

Emissions from hazardous and clinical/hospital waste incineration without energy recovery are included in this category.

Emissions from waste incineration fluctuate quite strongly. There were no dedicated waste incineration facilities in Lithuania until 2006 and waste was incinerated on random basis in existing production facilities, which means that decisions on whether to incinerate or not was taken on ad hoc basis, therefore may fluctuate in quite wide range (it is worth noting that the total amount of incinerated waste is very small, even at its maximum).

New hazardous waste incineration facility with capacity 8000 tonnes waste per year was launched in 2010. However, after some test runs the facility was stopped because of disagreements between the operating company and equipment supplier.

Evaluated CO_2 emissions from waste incineration are provided in Table 8-41.

Table 8-41. CO_2 emissions from waste incineration, (Gg)

Year	Hazardous	Clinical Health care	Sewage sludge	Municipal	Total
1990	4,32	0,01	0,00	0,00	4,33
1991	4,32	0,01	0,00	0,00	4,33
1992	1,20	0,00	0,00	0,00	1,21
1993	3,48	0,00	0,00	0,10	3,59
1994	1,05	0,01	0,00	0,05	1,11
1995	4,07	0,01	0,00	0,00	4,08
1996	1,36	0,01	0,00	0,00	1,38
1997	1,33	0,03	0,00	0,00	1,37
1998	1,28	0,15	0,00	0,02	1,44
1999	0,56	0,06	0,00	0,01	0,62
2000	1,84	0,00	0,00	0,00	1,84
2001	2,34	0,09	0,00	0,00	2,44
2002	2,22	0,02	0,00	0,00	2,24
2003	6,01	0,00	0,00	0,00	6,02
2004	3,05	0,03	0,00	0,00	3,09
2005	5,47	0,22	0,00	0,00	5,69
2006	5,07	0,16	0,00	0,00	5,23
2007	0,30	0,43	0,00	0,00	0,73
2008	0,03	0,57	0,00	0,00	0,61
2009	0,02	0,62	0,00	0,00	0,64
2010	1,35	0,58	0,00	0,00	1,93
2011	6,66	0,33	0,00	0,00	6,99

Evaluated N_2O emissions from waste incineration are provided in Table 8-42.

Table 8-42. N_2O emissions from waste incineration

Year	N_2O emissions from waste incineration (Gg)
1990	0,0006
1991	0,0006
1992	0,0002
1993	0,0006
1994	0,0002
1995	0,0006

1996	0,0002
1997	0,0002
1998	0,0002
1999	0,0001
2000	0,0003
2001	0,0003
2002	0,0003
2003	0,0008
2004	0,0004
2005	0,0008
2006	0,0007
2007	0,0002
2008	0,0002
2009	0,0002
2010	0,0003
2011	0,0010

8.4.2 Methodological issues

In 1990-2005 small amounts of waste were incinerated in various combustion installations not meant specifically for waste incineration.

Hospital waste incineration facility with nominal capacity 200 kg per hour was put in operation in 2006 in Vilnius. The facility includes rotary kiln, secondary combustion chamber and flue gas treatment unit. Temperature in the secondary combustion chamber can be raised up to 1100 ^{o}C. Flue gas is treated by injecting soda ash and activated carbon into the gas stream and then separating them in bag filter.

Construction of the hazardous waste incineration facility with nominal capacity 1000 kg per hour was completed in 2010 and test burning of hazardous waste started in November. Only about 820 tonnes of waste were incinerated in 2010 and about 4 thou. tonne in 2011.

The hazardous waste incineration facility comprises waste feeding unit, rotary kiln, secondary combustion chamber and flue gas treatment installation. Hazardous waste is incinerated at the minimum temperature 850 ^{o}C with at least 2 seconds residence time. If halogenated compounds are present, temperature is raised to 1100 ^{o}C. Flue gas treatment unit includes semi dry scrubber with activated carbon injection, bag filter and wet scrubber for finishing.

Energy (both heat and electricity) recovery is foreseen in hazardous waste incineration plant but only small amount of hazardous waste was incinerated in 2010-2011 during limited test runs supervised by equipment supplier and energy production was not recorded. There was no energy recovery in hospital waste incineration plant.

Hospital waste incinerator was closed in 2010 and is not operating since.

In previous years when there was no dedicated incinerator in Lithuania, waste was incinerated in various existing combustion facilities. Incinerated waste included calorific waste such as spent oils used, for example, for heating garages, etc.
The data on waste incineration are reported in the framework of overall waste reporting obligations.
The data were reported in accordance with the national waste classification in 1991-1999 and EU Waste List from 2000. As data on waste management were not collected in 1990, it was assumed that the amount of waste incinerated in 1990 was the same as incinerated in 1991.

Waste incinerators are obliged to report data split into categories of the EU Waste List. Reported data include waste received, waste treated, waste handed over to other treatment facilities, and waste stored by the end of the year.

Activity data of incinerated amounts of waste were obtained from Environment Protection Agency (EPA) waste database (Table 8-43). Data collection and validation procedures are described in chapter 1.2.1.1.

Table 8-43. Amounts of incinerated waste 1990-2010, (Gg)

Year	Hazardous	Clinical Health care	Sewage sludge	Municipal	Total
1990	2,63	0,01	0,01	0,00	2,65
1991	2,63	0,01	0,01	0,00	2,65
1992	0,73	0,01	0,32	0,00	1,06
1993	2,12	0,00	0,30	0,18	2,61
1994	0,64	0,01	0,05	0,09	0,79
1995	2,48	0,01	0,00	0,01	2,50
1996	0,83	0,02	0,00	0,00	0,85
1997	0,81	0,04	0,00	0,00	0,85
1998	0,78	0,17	0,00	0,03	0,98
1999	0,34	0,07	0,00	0,01	0,42
2000	1,12	0,00	0,00	0,00	1,12
2001	1,43	0,11	0,00	0,00	1,54
2002	1,35	0,02	0,00	0,00	1,37
2003	3,66	0,00	0,00	0,00	3,67
2004	1,86	0,04	0,00	0,00	1,90
2005	3,33	0,26	0,00	0,00	3,59
2006	3,09	0,19	0,00	0,00	3,28
2007	0,18	0,52	0,00	0,00	0,70
2008	0,02	0,69	0,00	0,00	0,71
2009	0,01	0,74	0,00	0,00	0,76
2010	0,82	0,69	0,00	0,00	1,51
2011	4,06	0,39	0,00	0,00	4,45

Carbon dioxide emissions from waste incineration were calculated according to GPG 2000, equation 5.11 (p. 5.25):

$$CO_{emissions} = \sum_i (IW_i \cdot CCW_i \cdot FCF_i \cdot EF_i \cdot 44/12) \text{ (Gg/yr)}$$

where:
i = MSW: municipal solid waste:
HW: hazardous waste
CW: clinical waste
SS: sewage sludge
IW_i is amount of incinerated waste of type i (Gg/yr)
CCW_i is fraction of carbon content in waste of type i
FCF_i is fraction of fossil carbon in waste of type i
EF_i is burn out efficiency of combustion of incinerators for waste of type i (fraction)
44 / 12 is conversion from C to CO_2

Default values, provided in IPCC Good Practice Guidance were used (Table 8-44):

Table 8-44. Default data for estimation of CO_2 emissions from waste incineration (GPG 2000, p. 5.29)

Parameter	MSW	Sewage sludge	Clinical waste	Hazardous waste
C content of waste	40%	30%	60%	50%
Fossil carbon as % of total carbon	40%	0%	40%	90%
Efficiency of combustion	95%	95%	95%	99,5%

The same activity data (waste inputs into incinerator) were used for calculation of emissions from waste of both fossil and biogenic origin. Emissions resulting from incineration of wastes of biogenic origin were calculated by the same formula provided above using the value of biogenic carbon fraction ($1 - FCF_i$) instead of fossil carbon fraction (FCF_i).

N_2O emissions from waste incineration were estimated using methodology provided in IPCC GPG 2000. Average mean of default values range (225 kg/N_2O/Gg waste) for rotating plants was used. N_2O emissions from waste of biogenic origin were not separated from the total emissions.

8.4.3 Uncertainties and time-series consistency

Activity data uncertainty for waste incineration was assumed to be the same as for solid waste disposal on land, i.e. 30%, as data source is the same.

Uncertainty of emission factors was assumed to be 30% for CO_2 and 100% for N_2O.

Combined uncertainties for GHG emissions from waste incineration calculated using equation 6.4 (GPG 2000, p. 6.12) are the following:

CO_2 - 42%
N_2O - 104%

8.4.4 Source-specific QA/QC and verification

Data collection and calculations were performed in accordance with the requirements outlined in Section 6 of the Quality Assurance and Quality Control Plan[181].

Tier 1 General Inventory Level QC was performed based on recommendations provided in IPCC 2000. Table 8.1 and outlined in the QA/QC plan:

Consistency of data between NIR and CRF has been checked.
Documentation on activity data and emission factors was crosschecked with the corresponding data in calculation model.
In case of large fluctuations in data, other experts or data providers were consulted to either provide the explanation or to identify a possible inconsistency or an error.
Explanations for recalculations were checked to ensure that they are clearly documented.
After the calculation is finished, EPA waste experts not directly involved in the emissions calculation of that year have reviewed the final report and CRF data checking the applied parameters, calculation methodology, as well as trend description in the NIR..

8.4.5 Source specific recalculations

No recalculations were made.

8.4.6 Planned improvements

No improvements are planned for the next submission.

[181] National Greenhouse Gas Emission Inventory of the Republic of Lithuania. Quality Assurance and Quality control Plan 2011-2012. Vilnius, 2011.

9 OTHER (CRF 7)

Not applicable.

10 RECALCULATIONS AND IMPROVEMENTS

List of improvements made in response to ERT recommendations in the 2012 ARR is provided in the Annex VII.

Major changes in methodological descriptions compared to the previous year are summarizied in the Table 10.1.

Table 10-1. Major changes in methodological descriptions compared to the previous year

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	RECALCULATIONS Please tick where this is also reflected in recalculations compared to the previous year CRF	REFERENCE If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
Total (Net Emissions)			
1. Energy			
A. Fuel Combustion (Sectoral Approach)	√	√	CO_2, CH_4, N_2O from Fuel combustion – sectoral approach CRF 1.AA (Chapter 3.2)
1. Energy Industries	√	√	CO_2, CH_4, N_2O from Energy industries CRF 1.AA.1 (Chapter 3.2.6)
2. Manufacturing Industries and Construction	√	√	CO_2, CH_4, N_2O from Manufacturing Industries and Construction CRF 1.AA.2(Chapter 3.3)
3. Transport	√	√	CO_2, CH_4, N_2O from Transport CRF 1.AA.3 (Chapter 3.4)
4. Other Sectors	√	√	CO_2, CH_4, N_2O from Other sector CRF 1.AA.4 (Chapter 3.5)
5. Other			
B. Fugitive Emissions from Fuels		√	CO_2, CH_4, N_2O from Fugitive emissions from fuels CRF 1.B (Chapter 3.6)
1. Solid Fuels			
2. Oil and Natural Gas			
2. Industrial Processes			
A. Mineral Products	√	√	CO_2 from Lime production CRF 2.A.2 (Chapter 4.2.2) CO_2 from Soda ash use CRF 2.A.4.2 (Chapter 4.2.4) CO_2 from Glass production CRF 2.A.7.1 (Chapter 4.2.6)
B. Chemical Industry	√	√	CO_2 from Ammonia production CRF 2.B.1 (Chapter 4.3.1)
C. Metal Production			
D. Other Production			
E. Production of Halocarbons and SF_6			
F. Consumption of Halocarbons and SF_6	√	√	HFC and SF_6 CRF 2.F (Chapter 4.7)
G. Other			
3. Solvent and Other Product Use		√	CO_2 from CRF 3 (Chapter 5)
4. Agriculture			
A. Enteric Fermentation	√	√	CH_4 from CRF 4.A (Chapter 6.2)
B. Manure Management	√	√	CH_4, N_2O from CRF 4.B (Chapter 6.3)
C. Rice Cultivation			
D. Agricultural Soils	√	√	N_2O from CRF 4.D (Chapter 6.5)
E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			
5. Land Use, Land-Use Change and Forestry			
A. Forest Land	√	√	CO_2, CH_4, N_2O from Forest Land CRF 5.A (Chapter 7.2)
B. Cropland	√	√	CO_2 and N_2O from Cropland CRF 5.B (Chapter 7.3)
C. Grassland	√	√	CO_2 from Grassland CRF 5.C (Chapter 7.4)
D. Wetlands	√	√	CO_2 and N_2O from Wetland CRF 5.D (Chapter 7.5)
E. Settlements	√	√	CO_2 from Land converted to Settlements CRF 5.E.2

			(Chapter 7.6.2)
F. Other Land	√	√	CO_2 from Other land CRF 5.F (Chapter 7.7)
G. Other			
6. Waste			
A. Solid Waste Disposal on Land	√	√	CH_4 from CRF 6.A (Chapter 8.2)
B. Waste-water Handling		√	CH_4, N_2O from CRF 6.B (Chapter 8.3)
C. Waste Incineration			
D. Other			
7. Other (as specified in Summary 1.A)			
Memo Items:			
International Bunkers	√	√	CO_2, CH_4, N_2O from International bunkers CRF 1.C.1 (Chapter 3.2.2)
Aviation	√	√	CH_4 and N_2O from Aviation CRF 1.C.1.A (Chapter 3.2.2)
Marine	√	√	CO_2 and CH_4 from Marine CRF 1.C.1.B (Chapter 3.2.2)
Multilateral Operations			
CO2 Emissions from Biomass			

NIR Chapter	DESCRIPTION Please tick where the latest NIR includes major changes in descriptions compared to the previous year NIR		REFERENCE If ticked please provide some more detailed information for example reference to pages in the NIR
Chapter 1.2 Institutional arrangements			
Chapter 1.6 QA/QC plan			

10.1 Source specific recalculations

Energy sector

Energy subsectors (except transport)

Following recalculations has been done taking into account the ERT recommendations for all subsectors of Energy sector (except transport):

- Correction/addition of activity data of liquid (residual fuel oil, LPG, orimulsion, gasoil, and diesel oil, oil production, oil transportation and oil refined), solid (peat, coking coal, charcoal, coke and other solid biomass), and gaseous (natural gas, biogas) fuels consumption based on the newest information provided by Lithuanian Statistics in November 2012;
- removal of waste oil, shale oil consumption and addition of emulsified vacuum residue consumption based on the newest information provided by Lithuanian Statistics in November 2012 and addition of used tires consumption based on EU ETS data;
- correction of CO_2 emission factor for crude oil, shale oil, residual fuel oil, non liquefied petroleum gas, orimulsion, peat, coking coal, natural gas, wood/wood waste, other solid biomass and biogas based on the country specific values that are provided in the study "Determination of national GHG emission factors for Lithuanian energy sector";
- correction of CH_4 emission factor for LPG, motor gasoline, residual fuel oil, gasoil, shale oil, petroleum coke and non liquefied petroleum gas based on default value provided in 1996 IPCC;
- correction of N_2O emission factor for LPG, jet kerosene and lignite based on default value provided in 1996 IPCC;
- correction of N_2O emission factor for peat based on the country specific value that is provided in the study "Determination of national GHG emission factors for Lithuanian energy sector".

In this submission GHG emissions from Non-Ferrous Metals industry are accounted for the first time.

Transport

For this year submission in *Transport* subsector the emissions from *Civil Aviation* have been recalculated for the entire time-series and the default EF for aviation gasoline CO_2 and CH_4 provided in 1996 IPCC was applied. Additionally, the changes with respect to the 2012 report year include recalculation of CH_4 and N_2O at new Tier 2 method in the time period of 2006-2011.

Emissions from *Road Transportation* have been recalculated for the entire time-series for this year submission, using the software COPERT IV version 10.0 (November, 2012). Changes with respect to the 2012 report year include recalculation of LPG CH_4 and N_2O at new Tier 3 method.

N_2O emissions from *Railways* were recalculated according to the default EF provided in 1996 IPCC and new activity data based on Statistics Lithuania.

Following in-country review ERT 2012 recommendations default EF for *Water-borne navigation* CH_4 provided in *1996 IPCC* was applied and the activity data for the years 1990-2011 have been revised according to Statistics Lithuania.

Following ERT 2012 recommendations for Off-road transportation and Military aviation the default EF for CH_4 and N_2O provided in *1996 IPCC* were applied. Additionally, the country specific EF for avgas CO_2 from *Military aviation* provided in "Greenhouse gas emissions characteristics of national energy sector" study was used.

Industrial processes sector

Lime production

CO_2 emissions from lime production were revised in 2012 to take into account the lime production in sugar industry. Emissions were recalculated for the whole reporting period.

Soda ash use

Soda ash use was recalculated for the whole time series due to recalculations related to glass industry:

- Use of plant specific data on consumption of soda ash when available;
- For other periods plant specific average soda ash consumption per tonne of glass was used.

Glass production

In glass production CO_2 emissions were recalculated for entire time series:

- New data was obtained on use of carbonates for Ekranas production plant in 2005-2006 (bankrupt in 2006);
- Glass production data was revised for Ekranas production plant (1990-2006), after quality assurance of plant specific emission factors.
- Plant specific emission factors were developed and used for calculation of CO_2 emissions from particular production plant (1990-1998 Warta glass, 1990-2003 Kauno stiklas, 1990-2004 Ekranas).
- Cullet used for glass production was excluded from CO_2 emission calculations;
- More precise EF for carbonates were introduced and used consistently for entire time series.

Amonia production

CO_2 emissions from ammonia production were recalculated for the whole time series. The produced has confirmed that carbon content factor used in the previous submissions were calculated back from the estimated CO_2 emissions. Therefore it was decided to use country specific energy sector emission factor. Minor errors in activity data were eliminated.

Iron and steel production

For iron and steel production sector errors in historical data on coke consumption were corrected. CO_2 emissions from Iron and Steel production were recalculated for the years 1995, 2002, 2003 and 2008.

Domestic refrigeration

HFC emissions from domestic refrigeration were recalculated for the period 1995-2010 based on the findings of the 2012 Study on use of HFC in Lithuania:

- Data on HFC-134a emissions from manufacturing of new products (2000-2011) is reported for the first time;
- New activity data was collected and emissions of HFC-134a and HFC-152 from freezers were estimated (1995-2010);
- HFC-152 emissions from domestic refrigeration reported for the first time;
- Average amount of F-gases per refrigeration unit was updated;
- Emission factor for annual leakage rate from domestic refrigeration was updated;
- Number of domestic refrigeration units filled with HFC-134a and HFC-152 prior to 1995 was updated based on data from recycling company.

Commercial refrigeration

HFC emissions from commercial refrigeration were recalculated for the period 1995-2010 based on the findings of the 2012 Study on use of HFC in Lithuania:

- HFC-134a emissions from drink coolers in supermarkets (1996-2011) are reported for the first time;
- HFC-134a, HFC-125 and HFC-143a emissions from refrigeration equipment in hotels, cafés, bars (1995-2011) are reported for the first time.

Transport refrigeration

HFC emissions from transport refrigeration were recalculated for the period 1993-2010 based on the findings of the 2012 Study on use of HFC in Lithuania:

- HFC-134a emissions from refrigerated freight wagons (2006-2011) are reported for the first time;
- Average life time of the transport refrigeration units was updated based on country specific vehicle registration data;
- Emission factor for annual leakage rate from transport refrigeration was updated;
- Average amount of F-gases per refrigeration unit was updated based on country specific data.

Stationary air-conditioning

HFC emissions from stationary air conditioning (1995-2011) are reported for the first time. Estimated emissions from geothermic installations are also reported under this category.

Mobile air-conditioning

HFC emissions from mobile air-conditioning were recalculated for the period 1993-2010 based on the findings of the 2012 Study on use of HFC in Lithuania:

- HFC-134a emissions from air conditioning in passenger carriages (2006-2011) are reported for the first time;
- HFC-125 and HFC-143a emissions from mobile air conditioning reported for the first time;

- Data on number of vehicles was updated (1991-2001);
- Average amount of F-gases per MAC unit (busses) was updated based on country specific data;
- Average life time of the vehicles was updated based on country specific vehicle registration data.

Foam blowing
Emissions of HFC-365mfc, HFC-134a, HFC-245fa, HFC-227ea from foam blowing for the period 2004-2010 were recalculated based on the new activity data obtained by the 2012 Study on use of HFC in Lithuania.

Fire extinguishers
HFC emissions from fire extinguishers were recalculated for the period 1996-2010 based on the findings of the 2012 Study on use of HFC in Lithuania:

- Emissions from fire fighting vehicles (2002-2011) are reported for the first time;
- HFC-236fa emissions (2002-2011) are reported for the first time;
- Emission factor was updated (introduced EF based on 2006 IPCC Guidance).
- New data on use of F gases in automatic fire protection systems.

Semiconductor manufacture
Introduced calculation of SF_6 emission from semiconductor manufacture for the period 2008-2011 based on newly obtained data from UAB Vilniaus Ventos puslaidininkiai.

Electrical equipment
Emissions of SF_6 from electrical equipment for the period 1995-2005 were recalculated based on data provided by AB Litgrid. Typing error in 2010 data was corrected.

Other
Introduced calculation of SF_6 emission from accelerators in radiation therapy facilities for the period 1999-2011 based on newly obtained data from hospitals which apply radiation therapy for cancer treatment.

Solvent and other product use

The following recalculations were done:

- NMVOC and CO_2 emissions from Paint application, Industrial degreasing, Dry cleaning, Graphic arts, Glues and adhesives and Domestic solvent use were recalculated for the period 2001-2010 due to updated population data by Statistics Lithuania;
- Typing error was corrected for CO_2 emission from paint application (1990).

Agriculture sector

Enteric fermentation
In order to increase consistency of used methodologies for calculation of CH_4 emission from enteric fermentation, the following recalculations have been made during this submission:

- Gross energy (GE) intake for dairy cattle for the period 2008-2011 was recalculated;
- Emission from non-dairy cattle, sheep and swine for all-time series were recalculated due to recalculation of CH_4 emission factors for young animals.

Manure management CH_4

In order to ensure consistency of methodologies used to estimate CH_4 emission from manure management the following recalculations have been made:

- Due to update of manure management systems for cattle and swine there were three recalculations made in this submission: emissions of CH_4 from dairy cattle, non-dairy cattle and swine;
- Since the national data of manure management systems for sheep were used emissions of CH_4 from sheep in these categories were recalculated;
- Due to updated gross energy data for dairy cattle for the period 2008-2010 CH_4 emissions were recalculated;
- Due to usage of new methodology (Tier 2) for calculation of emission factors for sheep, CH_4 emissions from sheep were recalculated for the whole time-period.

Manure management N_2O

N_2O emissions were recalculated due to updated gross energy intake and protein consumption for the period 2008-2010 and N retention for dairy cattle calculation according to *IPCC GPG 2000* methodology for entire time series. Recalculations of N_2O emissions were also influenced by updated data of manure management systems.

Agricultural soils

Recalculations of direct N_2O emission from agricultural soils were performed in this submission due to:

- Updated activity data on Synthetic N fertilizers (4.D.1.1), particularly year 2007, 2008 and 2010;
- Recalculations performed in manure management – N_2O subsectors what caused recalculations in subsector animal manure applied to soils. Also re-estimation of national value of $Frac_{GRAZ}$ were performed in this submission (4.D.1.2);
- Recalculations in subsectors N-fixing crops (4.D.1.3) and crop residues (4.D.1.4) because a higher Tier method was used in this submission switching from Tier 1a to Tier 1b;
- Recalculations performed in subsector histosols (4.D.1.5) by adding additional area of organic drained grasslands as previously this area was not included in to calculations (Following the recommendations of ERT during in country review 2012). Also recalculations were caused by harmonization of activity data between Agriculture and LULUCF sector: area of cropland and grassland, percentage of organic soils in each land category.
- N_2O emission calculation from sewage sludge was included in this submission (4.D.16).

N_2O emissions from pasture, range and paddock manure (4.D.2) were recalculated due to recalculations made in subsector manure management – N_2O (4.B.(b)).

Recalculations performed in subsector of Indirect N_2O emissions from agricultural soils are related to N_2O emission recalculations made in manure management subsector and activity data updates for calculation of emission from Synthetic fertilizer use subcategory. Changes in emissions were also caused by sewage sludge nitrogen ($N_{SEWSLUDGE}$) that was included in this submissions calculation.

Land use, Land-Use Change and Forestry sector

Forest Land

Following ERT 2012 recommendations uncertainty values were re-estimated.

Yearly land transition matrixes of conversions from other Land use categories to Forest land were created, based on year of the conversion and the category converted.

For estimations of carbon stock changes in living biomass in lands converted to forest land, growing stock volume of lands converted was estimated using data of NFI permanent sample plots on mean growing stock volume at the year of conversion.

Cropland

Carbon stock changes for conversions from other Land use categories to croplands were estimated in this submission, particularly carbon stock changes in organic soils on lands converted to croplands were estimated in this submission. Also re-estimations of carbon stock changes in organic and mineral soils in Croplands remaining croplands were performed using data presented by NFI.

Grassland

Carbon stock changes for conversions from other land uses to grasslands were estimated in this submission. Carbon stock changes in organic and mineral soils were re-estimated using data presented by NFI.

Wetland

Carbon stock changes in soil during the conversion from Other land to Wetlands were eliminated from calculations, because it was assumed that land areas under Other land category do not contain organic soil layer.

For conversion of Forest land to Wetlands it was assumed that all aboveground and belowground biomass was removed entirely at the time of conversion.

Settlement

Carbon stock changes due to loss of living biomass from conversions of Croplands and Grasslands to Settlements were calculated.

For conversion of Forest land to Settlements carbon stock change it was assumed that all aboveground and belowground biomass was lost at the time of conversion.

Other land

Carbon stock change in soil during the conversion from Other land to Wetlands were eliminated from calculations, because it was assumed that land areas under Other land category do not contain organic soil layer.

For conversions of forest land to other land it was assumed that all aboveground and belowground biomass is lost at the time of conversion.

Waste sector

Solid waste disposal on land

CH_4 emissions were recalculated separately for solid waste disposal on land and for sewage sludge disposal. In addition, data on sewage sludge disposal were upgraded by checking disposal codes used by reporting companies and reporting data (starting from 2006 some companies reported sewage sludge disposal as dry mattes, other companies as wet sludge).

Wastewater Handling

New data on population connected to sewerage networks were obtained from Association of Water Supply Enterprises and methane emissions were recalculated using new data. In additions the Statistics Lithuania recalculated population data which starting from 2001 appeared to be lower than earlier established.

10.2 Planned improvements

Energy sector

Further investigation of the possibility of using data provided in the EU ETS, reported by the operators for the energy sector emission estimates, are planned.
In transport sector the fuel consumption factors for road transport vehicles are planned to be updated by the time when new data becomes available from COPERT model updates. Implementation of COPERT 4 10.0 version with a new subsector for very small (<0.8 l) gasoline and (<1.4 l) diesel passenger cars of Euro 4-6 technologies.

Industrial processes sector

Significant improvements of the data collection practices in the Environmental Protection Agency are planned in order to collect complete and reliable data on import, use and recovery of HFCs, PFCs and SF_6 in Lithuania.

Agriculture sector

Enteric fermentation
The collection of new data of cattle weight is planned for the next submission.

Manure management
Collection of more accurate data on manure utilization and appliance to biogas plants in Lithuania is planned. Additional data should enable better and more reliable judgments on N_2O emissions from manure management.

Land use, land use change and forestry sector

Forest land
Following the recommendations of ERT 2012, Lithuania plans to revise methodology used for estimation of country-specific mass values of available fuel for wildfires, including dead wood and litter.

Cropland and Grassland
Following ERT 2012 recommendations inconsistencies in biomass, dead wood and litter stock changes estimates as well as carbon stock-change factors and assumptions made to ensure comparability between land use changes associated with land use conversions from croplands to grasslands and vice versa will be revised. Uncertainty assessment of emissions from cropland will be improved.

Wetland
Additional studies and information research are planned in order to improve reporting of areas and greenhouse gas emissions/removals under this land use category.

Settlement and Other land

Additional studies and information research are planned in order to improve reporting of areas that are under defined notation keys.

PART II: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

11 KP-LULUCF

11.1 General information

Lithuania provides supplementary information under Article 7 of the Kyoto Protocol for the Land Use, Land-Use Change and Forestry sector. This information requested is further specified in Decision 15/CMP.1, 16/CMP.1 and *IPCC Good Practice Guidance* (*IPCC 2003*) for LULUCF.

Estimation of anthropogenic emissions by sources and removals by sinks since 1990 is associated with Afforestation (A), Reforestation (R) and Deforestation (D) under Article 3.3 and Forest Management (FM) under Article 3.4 of the Kyoto Protocol.

Lithuania reports activities under Article 3.3 and 3.4 including geographic boundaries of areas encompassing units of land or land only subject to a single activity by reporting *Method 2* and *Approach 3* (Table 4.2.2 of the *IPCC 2003*).

Net removals from Article 3.3 activities were -109,62 GgCO_2 eq. in 2011. Afforestation (A) and Reforestation (R) resulted in a net removal of -120,09 GgCO_2 eq. and deforestation (D) a net emission of 10,48 GgCO_2 eq. (Table 11-1).

Table 11-1. Net CO_2 eq. emissions/removals from ARD areas, 2008-2011

Year	Afforestation/ Reforestation	Deforestation	Total
2008	-89,32	9,00	**-80,32**
2009	-107,78	8,61	**-99,17**
2010	-109,11	26,31	**-82,80**
2011	-120,09	10,48	**-109,62**

The area subjected to AR was 27,59 thous. ha in 2011. There could be two moment distinguished in the time series of 1990-2011. The first time period of 1990-2000 is related with the history of the Lithuania. After the restoration of Independency in 1990's forest expansion was the key priority therefore afforested and reforested areas constituted to more than 500 ha annually. But this number was steadily decreasing until 1994. After the spruce dieback which hardly hit the Lithuanian forest in 1994, afforestation and deforestation rates again returned to the 1990's level. Another two hughe increases in AR area were recorded in 2001-2007 (result of the storm damages in 2001) and 2009-2011 (introduction of the EU support for AR). In the beginning of 2012, deforested area since 1st of January 1990 was 1117,7 ha (Table 11-4). Deforstation was mainly caused by the forest area convertions to Settlements (road building, cities expansion etc.), Other lands (quarrys etc.) and Wetlands (flooding etc.) land use categories.

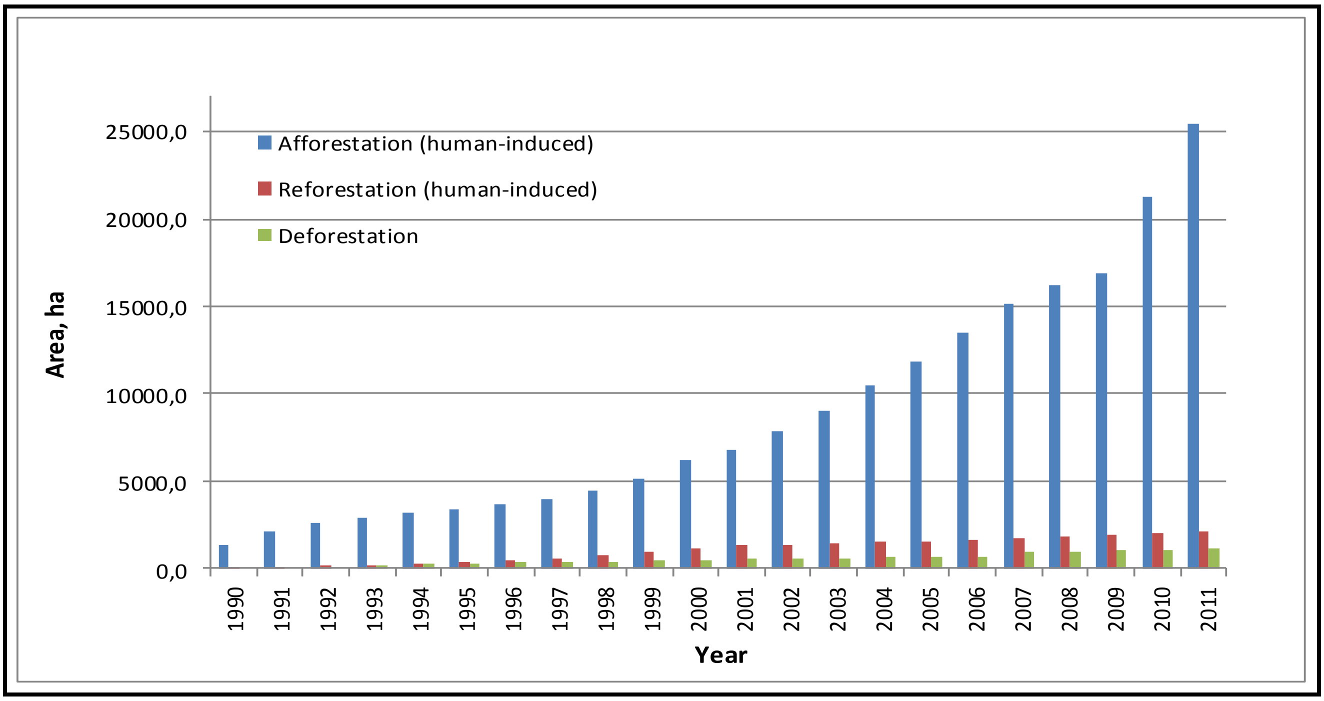

Figure 11-1. Cumulative area of afforestation, reforestation and deforestation, 1990-2011

Additionaly Lithuania has distinguished naturally afforested and reforested areas by using wall-to-wall method (Figure 11-2). Neither emissions nor removals of CO_2 under the requirements of Article 3.3 of the Kyoto Protocol are calculated for these land areas, they are only constantly supplementing areas under Forest management (FM) and are used for consistency purposes by the Party.

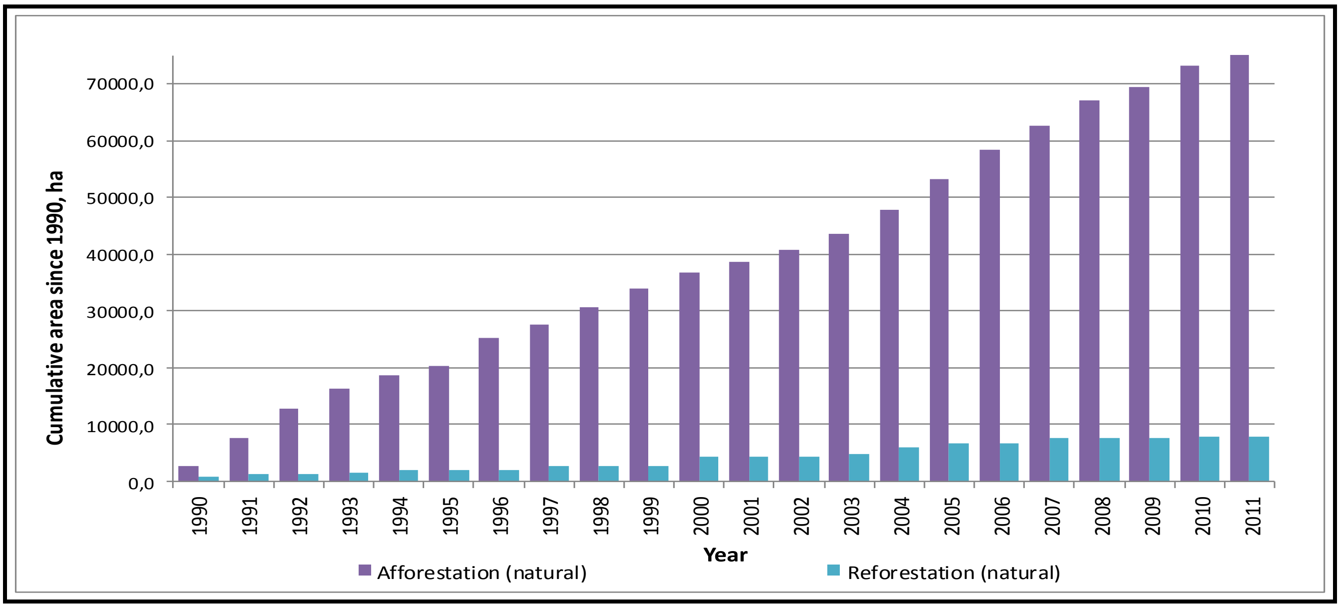

Figure 11-2. Cumulative area of naturally afforest and reforested areas, 1990-2011

Net removals from Article 3.4 activity Forest Management (FM) were -10.849,56 $GgCO_2$ eq. (Table 11-16). The area subjected to FM was 2145,6 thous. ha in the end of the commitment period (Table 11-5).

Lithuania has elected commitment period accounting for KP-LULUCF.

11.1.1 Definition of forest and any other criteria

Forest land is defined according to Forests Law of the Republic of Lithuania: "Forest – a land area not less than 0,1 hectare in size covered with trees, the height of which in a natural site in the maturity age is not less than 5 meters, other forest plants as well as thinned or vegetation-lost forest due to the acts of nature or human activities (cutting areas, burnt areas, clearings). Tree lines up to 10 meters of width in fields, at roadsides, water bodies, in living areas and cemeteries or planted at the railways protection zones as well as single trees and bushes, parks planted and grown by man in urban and rural areas are not defined as forests. The procedures for care, protection and use of these plantings shall be established by the Ministry of Environment. Forest stands with stocking level (approximately equivalent to crown cover) less than 0,3 (or crown cover less than 30%) are not acceptable for high productivity forestry. This threshold is used when including land into forest land areas (Table 11-). The same forest parameters were used in Lithuania's Initial report under the Kyoto protocol. The definition of Forest land is consistent with LULUCF reporting under the UNFCCC.

Table 11-2. Selected parameters defining forest in Lithuania for the reporting

Parameter	Range (FAO)	Values (Lithuania)
Minimum land area	0,05 – 1 ha	0,1 ha
Minimum crown cover	10 – 30 %	30 %
Minimum height at mature age	2 – 5 m	5 m

Table 11-3. Forest land area 1990-2011, thous. ha

Years	Forest land
1990	2061,4
1991	2068,6
1992	2074,6
1993	2079,7
1994	2082,5
1995	2084,9
1996	2090,1
1997	2093,7
1998	2097,3
1999	2100,1
2000	2105,7
2001	2108,9
2002	2113,3
2003	2118,9
2004	2126,9
2005	2134,9
2006	2142,1
2007	2150,4
2008	2157,2
2009	2160,0
2010	2166,4
2011	2173,2

Forest land area was estimated using National definition of forest land, described in Forest Law of the Republic of Lithuania. Land areas which transition to forest land are not over yet, and which are still used as grasslands or croplands are not included in the forest land area.

Area of afforestation, reforestation and deforestation activities is presented in Table 11-4.

Table 11-4. Area of afforestation, reforestation and deforestation, thous. ha

Year	*Afforestation*	*Reforestation*	Total AR	Deforestation
1990	1,33	0,04	**1,37**	**0,00**
1991	0,83	0,07	**0,90**	**0,00**
1992	0,48	0,04	**0,52**	**0,00**
1993	0,31	0,06	**0,37**	**0,19**
1994	0,21	0,04	**0,26**	**0,10**
1995	0,25	0,08	**0,33**	**0,01**
1996	0,25	0,12	**0,37**	**0,05**
1997	0,29	0,13	**0,41**	**0,04**
1998	0,50	0,20	**0,70**	**0,02**
1999	0,73	0,19	**0,92**	**0,05**
2000	1,07	0,21	**1,28**	**0,02**
2001	0,55	0,13	**0,68**	**0,14**
2002	1,10	0,07	**1,18**	**0,00**
2003	1,14	0,09	**1,23**	**0,00**
2004	1,40	0,03	**1,44**	**0,01**
2005	1,43	0,05	**1,48**	**0,05**
2006	1,62	0,07	**1,69**	**0,00**
2007	1,70	0,09	**1,78**	**0,29**
2008	1,03	0,10	**1,13**	**0,02**
2009	0,70	0,10	**0,80**	**0,02**
2010	4,31	0,11	**4,42**	**0,07**
2011	4,24	0,09	**4,33**	**0,03**
Total 1990-2011	**25,47**	**2,11**	**27,59**	**1,12**

11.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

In the first commitment period taking place in 2008-2012 Lithuania has chosen to account emissions and removals from Forest Management under Article 3.4 of the Kyoto Protocol, but did not elect Cropland Management, Grazing Land Management and Revegetation. The decision is supported by the importance of forests to Lithuania and available precise accounting data of forest resources. Regular information on Lithuanian forest resources by Standwise Forest Inventory data is available already since 1922. Lithuania has made essential improvements in data quality on forest resources since 2002, when NFI permanent sample plots net has completely covered all Lithuania's territory.

To estimate areas required by the Article 3.3 and 3.4 of the Kyoto Protocol, additional studies were executed in order to recover ARD activities for the period of 1990 – 2011. Some data sources took back even to 1946. Completed studies recovered required data on ARD areas for the 1990 - 2011 and has made the background for the amendment, supplementation and adption of new relevant legislation (Chapter 7.1), in order to set the rules and also to oblige forest owners and managers to register newly afforested, reforested and deforested areas to State Forest Cadaster, which will now serve as the main data provider for ARD areas identification reported under Kyoto Protocol. Thus, starting already since 2009 every deforestation case, which is under very strict regulation and control by the Forest Law, is recorded in the special database as well as afforestation and reforestation activities.

Lithuania elected reporting Method 2 for lands subject to Article 3.3 and Article 3.4 activities, which is based on spatially explicit and complete geographical identification of all units of land subjected to Article 3.3 activities and all lands subjected to Article 3.4 activities.

ARD areas were assessed using wall-to-wall mapping and FM areas were assessed using sample based (NFI sample plots grid) techniques.

11.1.3 Description on how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

The definitions of Afforestation (A), Reforestation (R) and Deforestation (D) activities are in accordance with the *Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003* (*IPCC 2003*).

ARD definitions presented in *IPCC 2003* under the Kyoto Protocol are followed for KP-LULUCF assessment in Lithuania. It is considered that Afforestation and Reforestation is human-induced artificial planting of croplands, grasslands and wetlands. Separation of afforested and reforested areas requires more effort in studying archive data of SFI and aerial photographies up to 1940's (*Study-1*). Areas of deforestation are under very strict regulation and control legitimated by the Forest Law (original text adopted in 1994) and Lithuanian Republic Governmental Resolution No 1131 dated on Sept 28, 2011. In general forest conversion to other land is very rare i.e. only for road building or settlements establishement and also requires special procedure of compensation. Statutory way of compensation is re-establishment of forest on non-forest land on area up to 3 times larger than used for deforestation.

Forest Law regulates afforestation process on agricultural and other lands (swamps, peatlands, other land) too. Afforestation of these lands could be done by artificial planting as well as by natural regeneration. The legitimated substitution of naturally afforested agricultural and other land to forest is only possible when tree crowns cover attains 30% of the area not less than 0.1 ha and the age of trees exceed 20 years. Natural afforestation is included in area of forest management (FM). All afforested land (human induced and natural) is recorded during SFI and legitimated registration at State Forest Cadastre.

The main data source to identify areas for calculating emissions and removals under Article 3.3 and Article 3.4 of the Kyoto Protocol is study "Forest land changes in Lithuania during 1990-2011" (*Study-1*) (detailed description is provided in Chapter 7.1.1) implemented in 2012.

The main objective of the study was to identify forest land areas and their changes in Lithuania during 1990-2011 following the requirements of Good Practice Guidance for Land Use, Land-Use Change and Forestry, *IPCC 2003*. Study revealed the following Forest land areas and their changes annually in 1990-2011:

- afforested areas with human inducement (AR) – wall-to-wall method used;
- naturally afforested areas which are included in FM – sampling method used;

- deforested areas (D) – wall-to-wall method used;
- forest management areas (FM) – sampling method used.

The *Study-1* object was all Lithuania's forest land territory (or areas, where forest land has been registered at least once) during 1990-2011 years.

The main data sources were used:

- Data from National forest inventory (NFI), which is executed on 16 325 (all Lithuania's territory with non-forest land) systematically distributed permanent sample plots, was used to estimate total land area assigned to Forest Management activity as well as to calculate living biomass and deadwood;
- Lithuanian State Forest Cadastre (LSFC);
- Standwise forest inventory databases and maps (S 1:10 000);
- Orthophoto maps (S 1:10 000);
- National Paying Agency's data of declarations for afforested areas (2010-2011);
- Topographical maps 1973-1990 (S 1:50 000);
- Archive cartographical material backwards to 1946-1949 (S 1:10 000);
- Maps of Lithuanian forest resources (1998-1999) (S 1:50 000).

The *Study-1* resulted in the following outcomes:

- units of land subject to activities under Article 3, paragraph 3, which would otherwise be included in land subject to elected activities under Article 3, paragraph 4, under the provisions of paragraph 8 of the annex to decision 16/CMP.1 were identified and distinguished;
- GIS layers for Afforested, Reforested and Deforested (ARD) areas and areas remaining under Forest Management were prepared;
- report, showing relevant land units changes was prepared;
- proposals on land use definitions harmonization and development of the harmonized methodology for the data evaluation and estimations of emissions and removals for LULUCF sector according to the UNFCCC and the Kyoto Protocol requirements were elaborated.

The definition of Forest Management is in accordance with the *IPCC 2003*. Forest land area under Forest management reported for *KP-LULUCF* calculations is provided in Table 11-4. Data source for determining area under Forest Management activity is *Study-1*, where Forest Management area is assessed using NFI permanent sample plots data. Area of organic soils and drained organic soils is determined using data of NFI. NFI provides data on forest land distribution by forest soils, which are classified by using Forest site tipes classification prepared by M. Vaičys (Chapter 7.2.1). Area of mineral soils amounts to 84,3% and area of organic soils – 15,7% of the total forest area. Drained organic forest soils constitute to 7,9% of the total forest land. The same proportions of organic and mineral soils were also accepted for determination of organic and drained organic soils on Forest management area.

Table 11-5. Area of Forest management*, thous. ha

Year	Total area	Organic soils		
		Not drained	Drained	Total
1990	2060,0	160,7	162,7	323,4
1991	2066,3	161,2	163,2	324,4
1992	2071,8	161,6	163,7	325,3
1993	2076,6	162,0	164,0	326,0
1994	2079,1	162,2	164,3	326,4
1995	2081,2	162,3	164,4	326,7
1996	2086,0	162,7	164,8	327,5
1997	2089,2	163,0	165,0	328,0
1998	2092,1	163,2	165,3	328,5
1999	2094,0	163,3	165,4	328,8
2000	2098,3	163,7	165,8	329,4
2001	2100,8	163,9	166,0	329,8
2002	2104,0	164,1	166,2	330,3
2003	2108,4	164,5	166,6	331,0
2004	2114,9	165,0	167,1	332,0
2005	2121,4	165,5	167,6	333,1
2006	2126,9	165,9	168,0	333,9
2007	2133,5	166,4	168,5	335,0
2008	2139,2	166,9	169,0	335,9
2009	2141,2	167,0	169,2	336,2
2010	2143,2	167,2	169,3	336,5
2011	2145,6	167,4	169,5	336,9

**Natural afforestation and reforestation area is included in Forest management area*

11.1.4 Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified

Lithuania has elected to report only Forest management under Article 3.4 activities, therefore there is no hierarchy among Article 3.4 activities. For the consistency reasons and to be sure that reported forest management activities have occurred on forest land, total land area was splitted into six land use categories as it is required by UNFCCC reporting, and each land area was classified only under one land use category.

11.2 Land-related information

Lithuania implements reporting *Method 2* in combination with *Approach 3* to represent areas under Article 3 of the Kyoto protocol. *Study-1* also elaborated in defining geographical borders of afforested, reforested and deforested areas required by KP-LULUCF reporting (Figure 11-3).

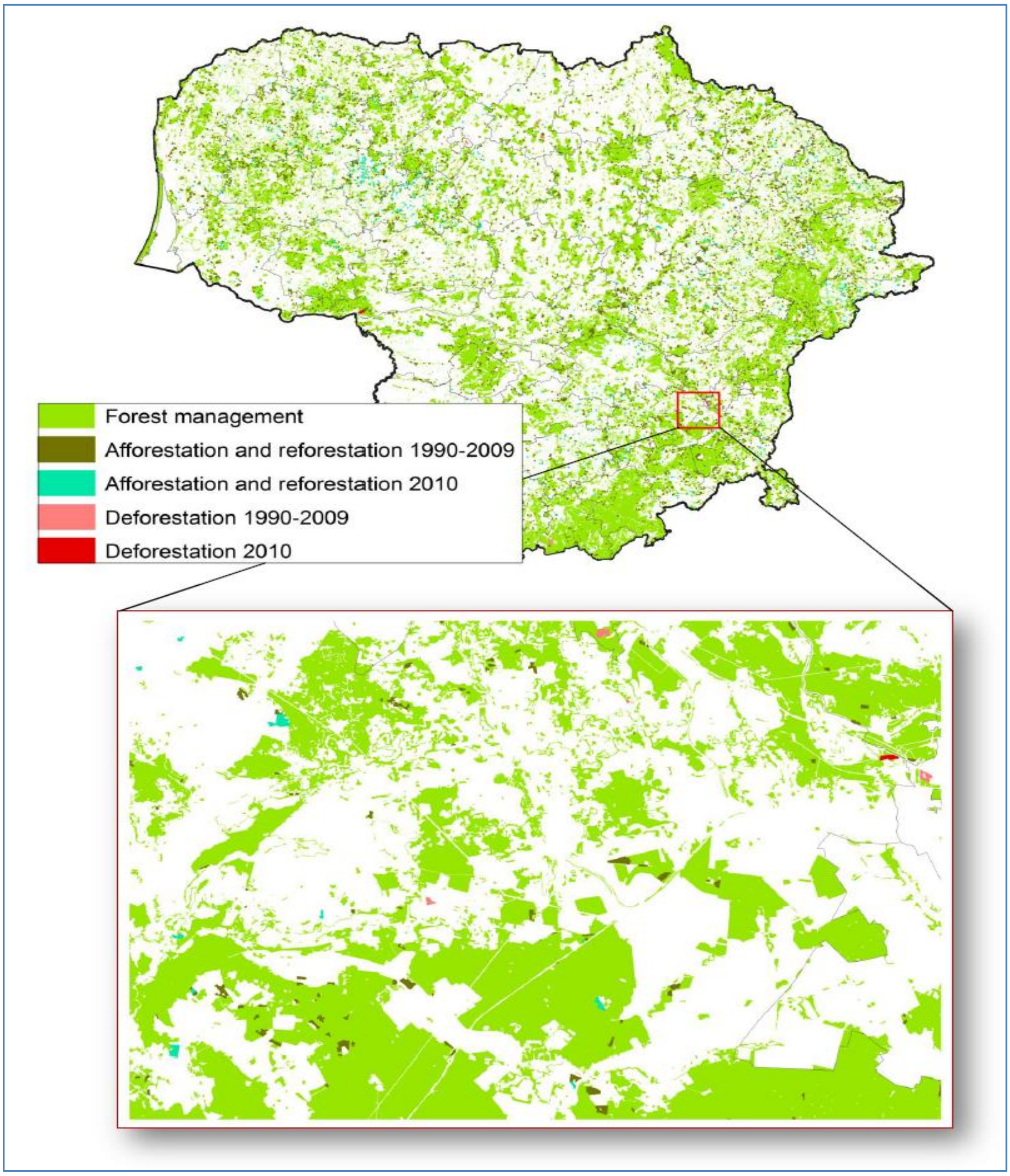

Figure 11-3. Afforestation, reforestation and deforestation activities 1990-2010

To achieve the annual wall-to-wall mapping of forest land areas and to detect the changes several types of source material were used. These were: State Forest Cadastre, National paying agency's information on agricultural land, afforestation of non-agricultural and abandoned land, Lithuanian forest resource database at a scale 1:50 000, all available orthophotos for the country, developed during the analysed period, satellite maps from CORINE, USGS[182] and other projects done by the contractors.

The decision, for allocation of certain land areas to relevant land use categories, has been made by using decision tree with named relevant sources of information, and organizations involved, who were providing necessary data. Such decision tree was prepared and used throughout the land areas allocation process by study executing team experts (Figure 11-4).

[182] *Available from: http://earthexplorer.usgs.gov/*

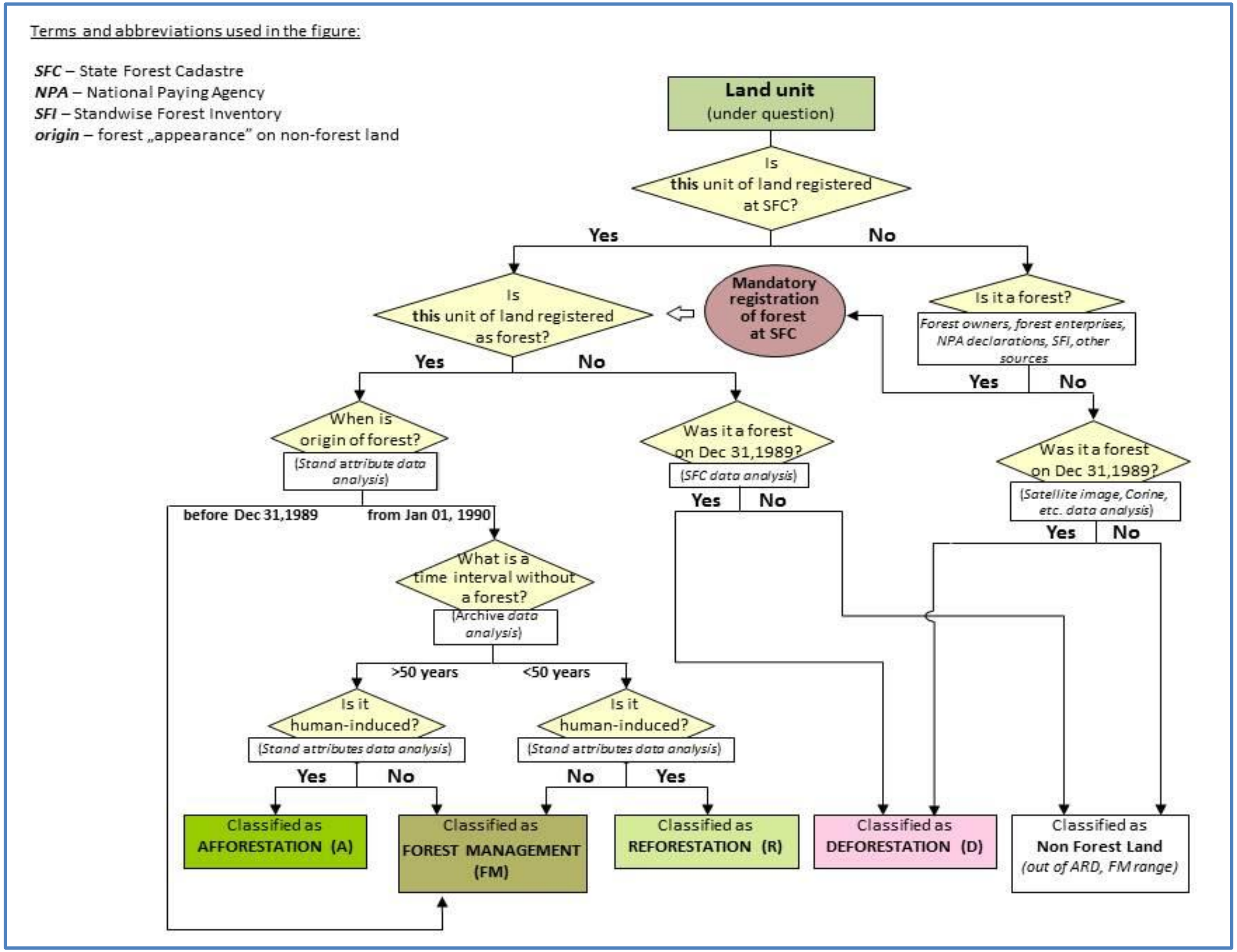

Figure 11-4. Decision tree for land units allocation to relevant land use categories

Codes that were used by Study-1 experts for identification of activities on forest land are presented in Table 11-6.

Table 11-6. Codes to identify Article 3.3 and 3.4 activities

Codes used	Descriptions
FM	*Forest management*
A1	*Afforestation (**human – induced**)*
A2	*Afforestation (**natural**; included in Forest management area)*
R1	*Reforestation (**human – induced**)*
R2	*Reforestation (**natural**; included in Forest management area)*
D	*Deforestation*

As could be seen from the table above, two additional groups were distinguished. A2 and R2 are naturally afforested and reforested land areas that are included into SFC according to Forest Law of the Republic of Lithuania. Such segregation is not required neither by IPCC Good Practice Guidance nor are in compliance for requirements for human induced AR areas under Article 3.3 of the Kyoto Protocol. Therefore, these areas are consistently supplementing FM area and are used for consistency purposes by the Party.

Areas of human – induced afforestation and reforestation were assessed mainly relying on areas of forest plantations registered either by State Forest Cadastre or received as declarations from State Forest Enterprises and private owners. All registered areas have authorizations and certified forest planting projects (Figure 11-5). Projects must be prepared according to Regulations for afforestation and reforestation[183]. Since 2008 most of reforestation cases in Lithuania receive financial support from National Paying Agency and therefore are registered in relevant database.

[183] *Lietuvos Respublikos Seimas. 2012. [Seimas of the Republic of Lithuania]. Miško atkūrimo ir įveisimo nuostatai. [Regulations for afforestation and reforestation]. Nr. D1-1052. Available from: http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=416395&p_query=&p_tr2=2 (In Lithuanian)*

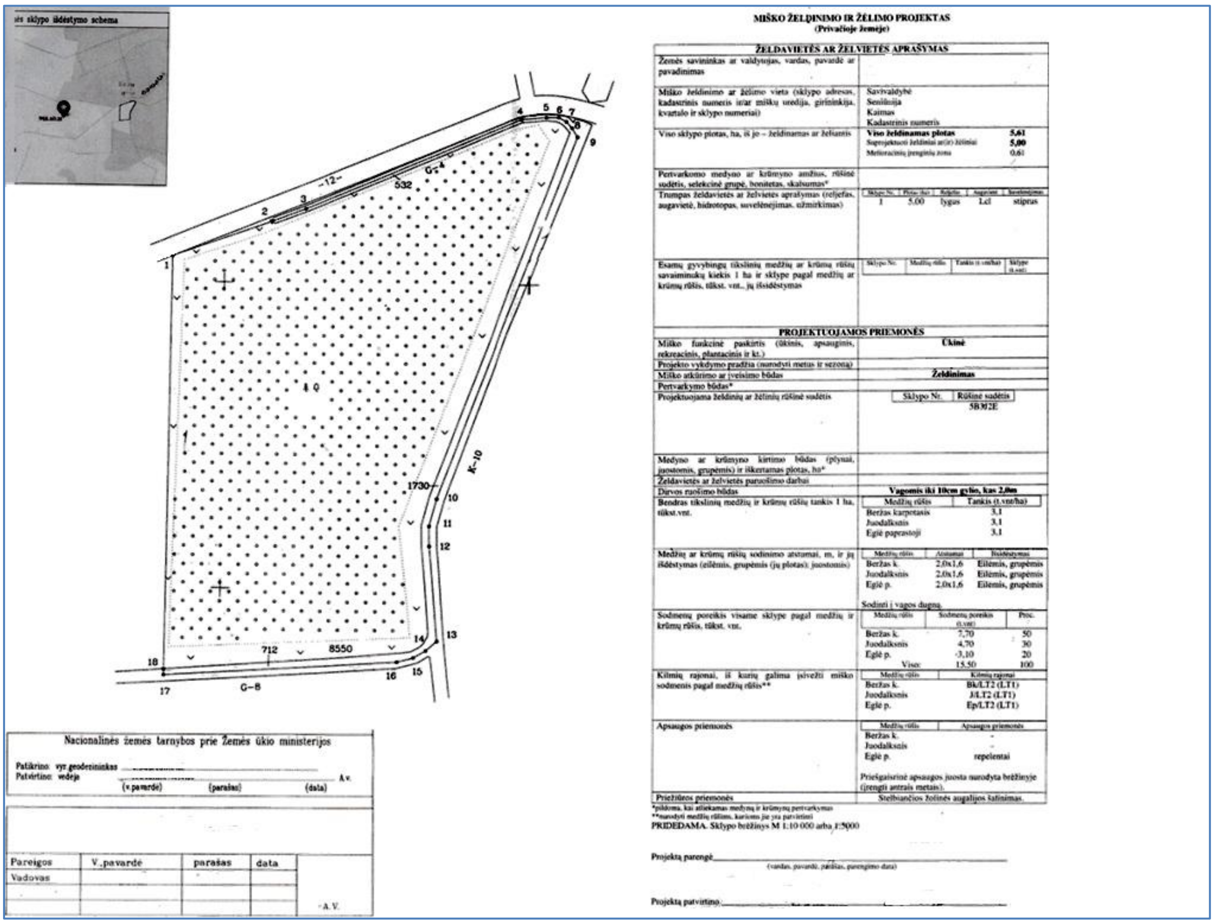

Figure 11-5. Forest planting (afforestation/reforestation) project provided to SFC

The main data source used for identification of AR and D areas was the geographic data from the State Forest Cadastre. These data sets include borders of all forest compartments in the country (around 1.3 mill polygons), and is associated with the data describing stand characteristics of the compartment. Age of all stands was updated to fit defined datum-line – the year 2011. Then, the year of forest stand registration to forest cadastre was estimated, subtracting the age of stand from 2011 (and adding 10 for naturally regenerated forests, as according to national regulations naturally regenerated forest is accounted under forest land at 10 years age). Then, the origin of each compartment was checked to identify whether the forest appeared on forest or other (i.e. non-forest) land.

Two basic and one additional criteria were used to identify the exact appearance of forest: forest was assumed to be grown on non-forest land if it was attributed in a special attribute field as grown on non-forest land. However, such identification was completely dependent on the content and quality of previously executed stand-wise forest inventories and there were numerous forest compartments, actually grown on non-forest land, omitted. Therefore, special spatial overlay and selection techniques were developed and applied to identify forests, which were appearantly existing, but were missing 50 years ago (according to the database developed and referring to the 1950's).

In case of failure ancillary solution how to identify afforestation/reforestation was determined. It was intended to use stand attribute from stand register and posit that forest compartment was first time inventoried during the last stand-wise forest inventory. However, such approach faced some limitations how to reflect the newly established forests, as the State forest cadastre data was based on the information originating from stand-wise forest inventory. Stand-wise forest inventories in Lithuania are carried-out on a 10-years cycle basis, thus, there were some regions with quite outdated information on the compartments and missing the boundaries of stands, established already after the stand-wise inventory. Several solutions were used to fill such information gaps.

First of all, information from the recent Standwise Forest Inventories was acquired from forest inventory contractors, which had not been officially delivered to the State Forest Service yet. Next, all non-forest compartments stored in the State forest cadastre database were checked for the records on potentially established forests there. Simultaneously, State forest enterprises were asked to confirm facts on newly established forests. Data from National paying agency was acquired, to represent borders of afforested areas, which were applied for EU subsidies. Special geo-processing technique was developed to eliminate overlapping in space and time of afforested and reforested areas, resulted by repeated identification of considered areas in independent input data sets.

The decision whether the forest stand, detected to be grown on non-forest land was afforestation or reforestation, was taken based on simple spatial queries testing – verifying presence or absence of the forest land at a certain area in 1950s.

Several techniques were used to detect deforested areas during the last two decades. First of all, deforestation cases that were accounted under the State Forest Cadastre were taken into consideration. There were also records of the officially registred deforestations in State Forest Cadastre, that were also used for this analysis. Recently non-forest land types, identified as forest stands during the previous forest inventories were candidates to be assigned to the deforestation category.

Deforestation was manually mapped using available GIS, orthophoto and satellite image data. It was assumed, that the GIS database of Lithuanian forest resources at a scale of 1:50 000 developed in 1998-1999 represents the year 1990 as it was based on SPOT satellite images from around 1990-1992 and stand-wise forest inventory maps done before 1991. The accuracy of forest cover identification in that database was confirmed by the NFI to be around 95%. Thus, differences between forest covers in the GIS database of Lithuanian forest resources at a scale 1:50 000 and State Forest Cadastre were reasoned by the imperfections of the first data set or the deforestation. All such areas were visually inspected and all deforestations were identified using orthophotos available for Lithuania (referring to 4 dates in the period from 1990). Exact date of deforestation was adjusted using archive satellite data (mainly Landsat, but also coming from SPOT and DMC).

Figure 11-6. Identification of deforestation (D) case using two consecutive orthophotos

Figure 11-7. Identification of human induced afforestation (A1) based on two consecutive orthophotos

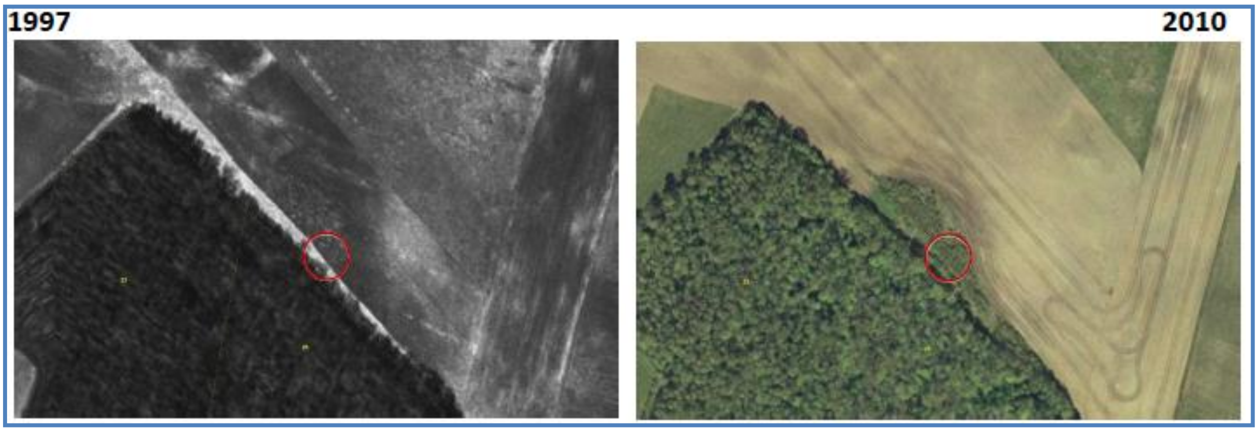

Figure 11-8. Identification of natural afforestation (A2) case using two consecutive orthophotos

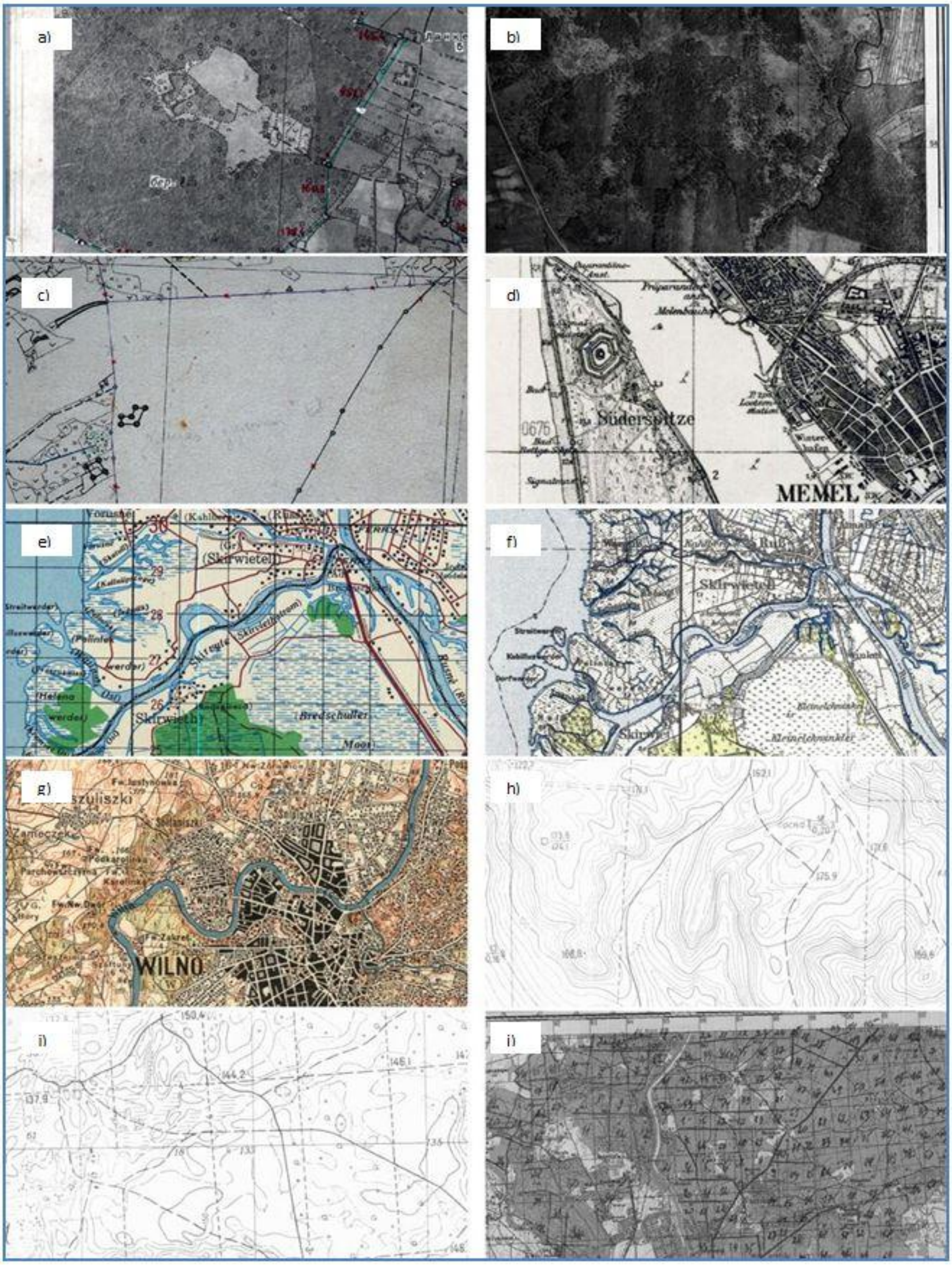

Figure 11-9. Examples of archive cartographical data used for Study-1:

a – scanned orthophotographic map 1949-1952; b – scanned photography negative of orthophotographic map 1949-1952; c – ground survey based map; d – German topographic maps compiled in 4-5th decade of the XX century (d - S 1:25000; f – S1:100000); e – US army cartography department maps compiled in 1944 (S 1:100000); g – Polish army cartography department maps of Vilnius compiled in 1934 (S 1:25000); h – topographical maps of different origin developed in former USSR (h – S 1:10000; i – S 1:25000); j – topographical maps in 1942 coordinate system (S 1:50000).

11.2.1 Spatial assessment unit used for determining the area of the units of land under Article 3.3

The spatial assessment unit for determining the area of land units under Article 3.3 is 0.1 ha, which is the same as the minimum area of forest.

11.2.2 Methodology used to develop the land transition matrix

Figure 11-10 represents total afforestation and reforestation area alterations and differences between LSFC (wall-to-wall method) data, that was used for *Study-1*, and NFI (sampling method) data. As it can be seen fluctuations between these two data sources are minor, and confirms consistency among them. Therefore, NFI data serves for quality assurance as it rather well reitereits AR areas represented by LSFC. NFI data was used to determine total forest land area. Afforestation, reforestation and deforestation area was determined using wall-to-wall method described in chapter 11.2.1. Forest management area was calculated subtracting afforested, reforested, deforested areas from the total forest land.

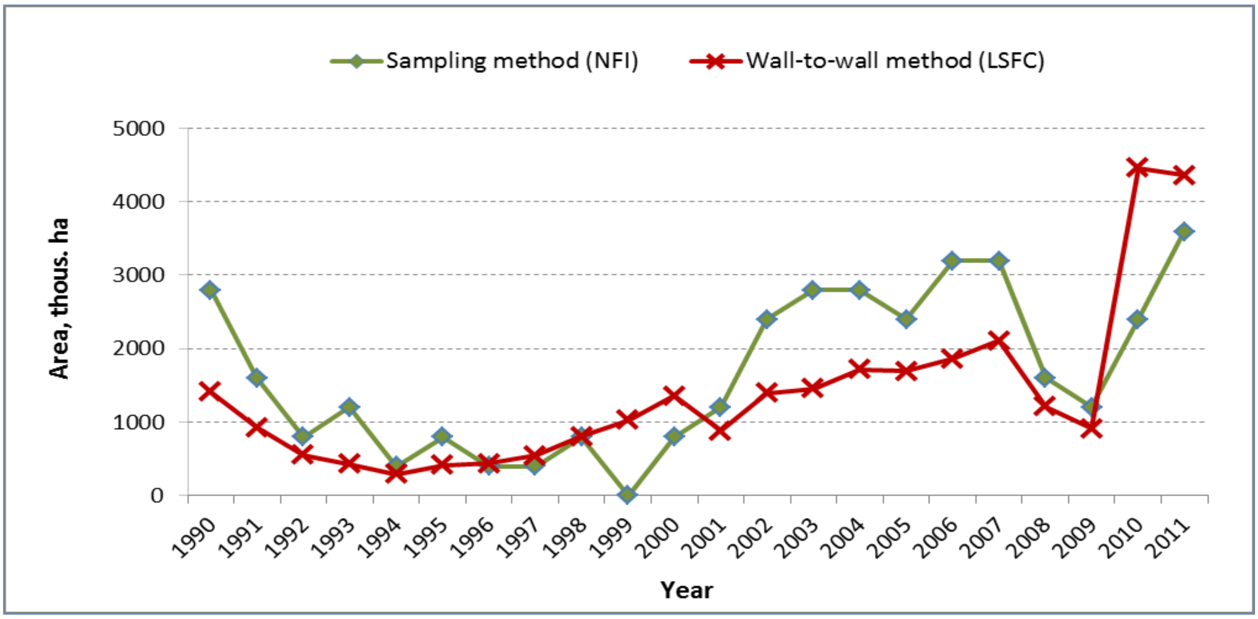

Figure 11-10. Wall-to-wall method quality assurance using NFI data

Decrease in afforestation and reforestation area in 2008-2009 was caused by accounting shortcomings. Data base containing accurate data on afforested and reforested areas was created only in 2009, and some of the areas afforested in 2007-2009 were included in 2010 accounting due to unknown exact establishment date, therefore such a high increase in area in 2010 and decrease in 2008-2009 occurs.

Table 11-7 presents areas and changes in areas between previous and current inventory years.

Table 11-7. Land transition matrix for 2011, thous. ha

From previous inventory year \ To current inventory year		Article 3.3 activities		Article 3.4 activities				Other	Total area at the beginning of the current inventory year
		A/R	D	FM	CM	GLM	REV		
		thous. ha							
Article 3.3 activities	A/R	23,26	0,00						23,26
	D		1,09						1,09
Article 3.4 activities	FM		0,03	2143,13					2143,16
	CM	NA	NA		NA	NA	NA		NA
	GLM	NA	NA		NA	NA	NA		NA
	REV	NA			NA	NA	NA		NA
Other [184]		4,33	0,00	2,49	NA	NA	NA	4355,68	4362,50
Total area at the end of the current inventory year		27,59	1,12	2145,62	NA	NA	NA	4355,68	6530,00

Abbreviations used: A – afforestation, R – reforestation, D – deforestation, FM – forest management, CM – cropland management, GLM – grazing land management, REV – revegetation, NA – not applicable.

11.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

Lithuanian State Forest Cadastre

The total forest land area was estimated using NFI data, but for consistency LSFC maps (S 1:10 000) and database were used.

NFI data was used to determine total forest area and area under Forest management category as well as for estimations of living biomass, deadwood, area of organic soils etc. for forest management and afforestation, reforestation, deforestation activities.

After the *Study-1*, which was used to recover unknown information on ARD areas for the period of 1990-2011, State Forest Cadastre was named as the main data provider for newly afforested, reforested and deforested areas by the Amendment of the Governmental Resolution No 1255 that was adopted in 2012. Several legal acts were also introduced in 2012 setting rules and routines and also obliging forest owners and enterprises to provide information of human induced afforestation, reforestation and deforestation as well as natural AR to State Forest Cadastre:

- **Resolution on forest land conversion to other land and compensation for converted forest land** / *Government resolution* – regulates human induced conversion of forest land to other land (deforestation) and compensation for lost forest land.

[184] "Other" includes the total area of the country that has not been reported under an Article 3.3 or an elected Article 3.4 activity.

- **Rules for afforestation of non-forest land** / *Amendment of the Minister of Environment and Minister of Agriculture* – determines human induced afforestation/reforestation registration routines**.**

- **Inventory and registration of natural afforestation of non-forest land** / *Order of the Minister of Environment and Minister of Agriculture* – determines natural afforestation/reforestation inventory and assessment routines.

Lithuanian State Forest Cadastre (LSFC) database is presented in Figure 11-11. The database:
- covers 100% country's forest land territory, GIS based;
- easy accessible on web for registered users;
- open for forest managers, controllers and other specialists;
- user friendly;
- up to date;
- real time.

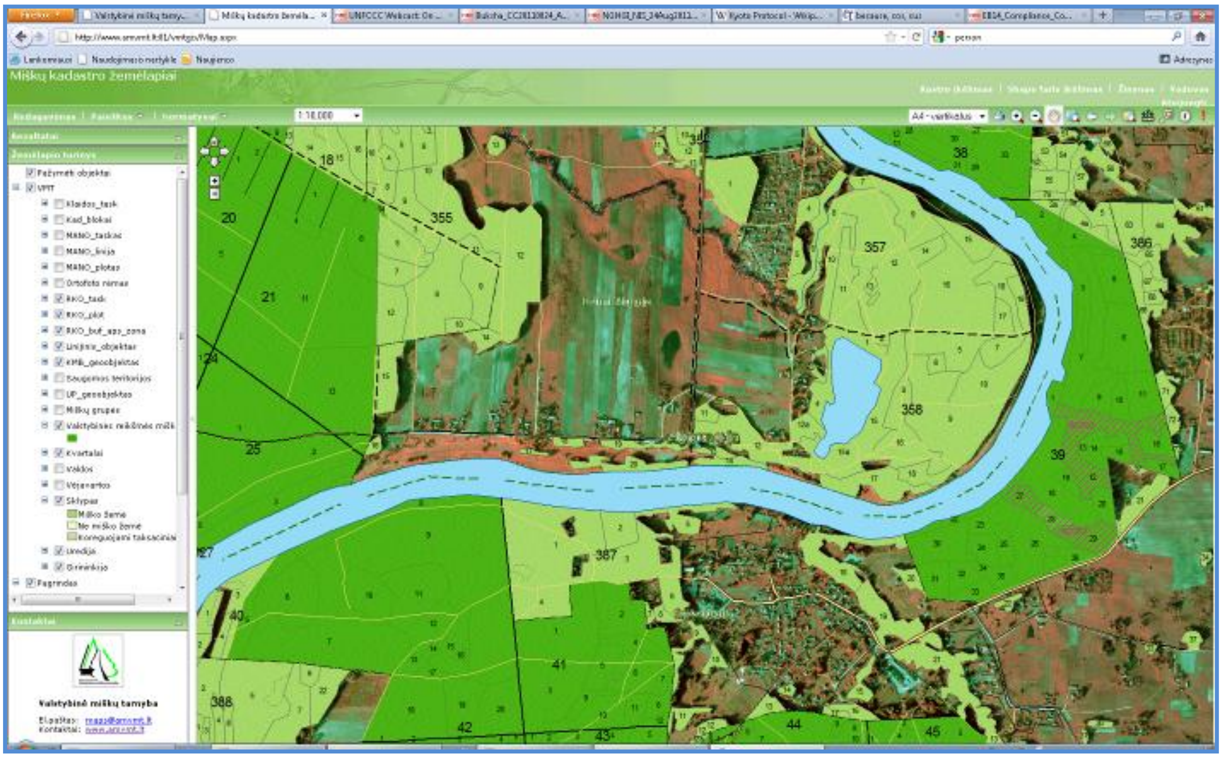

Figure 11-11. Preview of LSFC database

The main object of Lithuanian NFI is forest land area including all forestry related activities taking place on it. Forest Law indicate that State Forest Inventory is carried by sampling method. The purpose of the NFI is strategic planning of the forest sector, control of its efficiency at the national level. Execution of NFI is entrusted to State Forest Service under Ministry of Environment.

National Forest Inventory

NFI is based on continuous, multistage sampling and GIS integrated technology and is organized in the same manner for all forests of Lithuania. Lithuanian NFI was started in 1998. The systematic grid of the NFI of Lithuania covers all land classes (Figure 11-12) including inland waters.

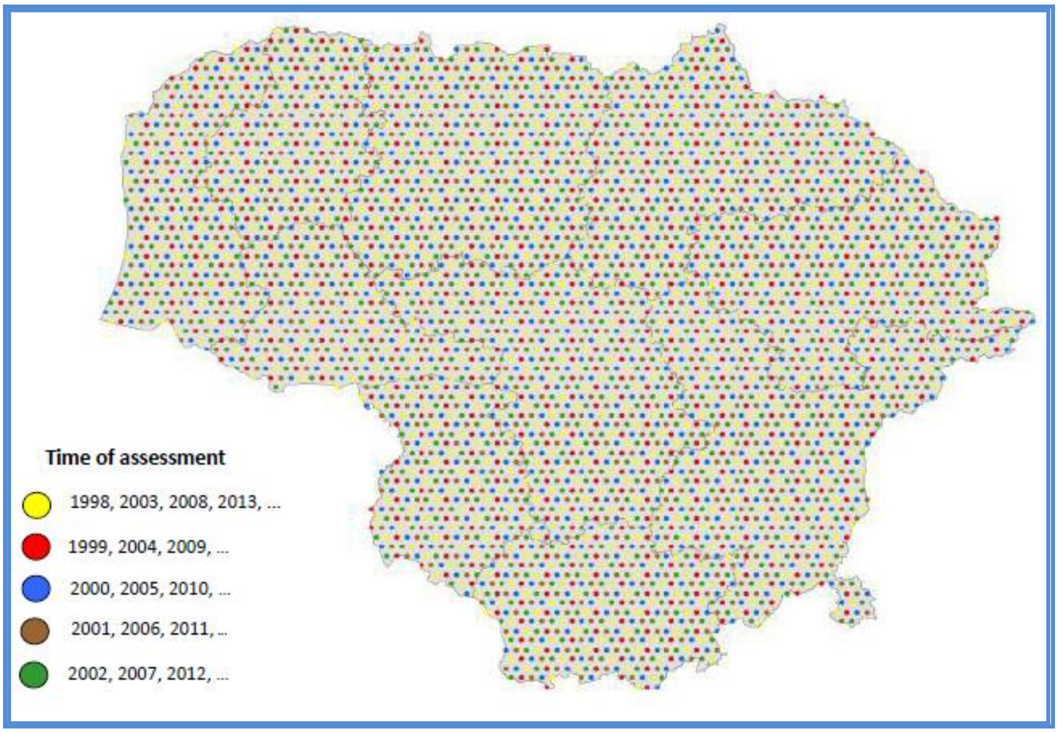

Figure 11-12. Distribution of NFI plots on Lithuania's territory

Sampling is conducted using a 4×4 km systematic grid with a random starting point.

The systematic grid assures a uniform distribution of group of plots over the entire country and regular monitoring of conversion amongst land use categories. The sample units are arranged to square shape clusters and include four permanent, regularly measured plots.

Taking into account the number of homogeneous stands (strata), minimal growing stock volume and increment estimation accuracy, 5600 permanent sample plots were established on forest land over a 5-year period. Approximately 1120 permanent sample plots are re-measured each year. The NFI plots annually to cover the entire country each year with the total number of plots measured over the 5-year inventory cycle reaching a sampling intensity of one sample plot per 400 ha. The inventory cycle is five years.

In 2012, in total around 16 000 permanent sample plotas were established on Lithuanian territory using uniqe NFI sample plots net. 6 000 sample plotas are allocated on forest land and nearly 10 000 sample plots are established on non-forest land. Allocation of each permanent sample plot to relevant land use category is represented in the Figure 11-13. Each sample plot could be allocated to only one land use category according to UNFCCC requirements. NFI net with all permanenet sample plots covers entire Lithuanian territory. Attribution of each permanent sample plot to relevant land use category related to *IPCC 2003* is performed during the inventory, by direct measurements of NFI field measurements team.

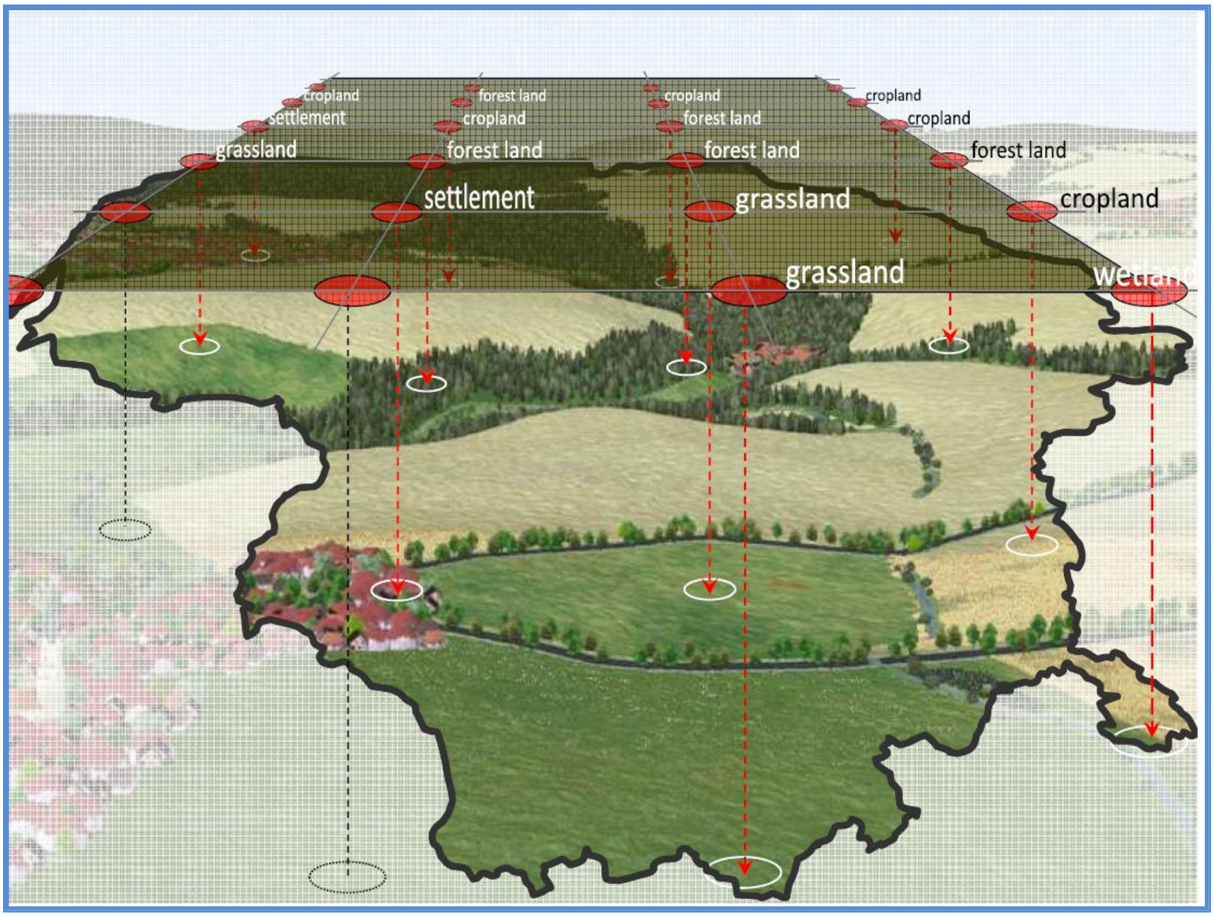

Figure 11-13. Allocation of sample plots to relevant land use category

The aim of establishment of permanent plots is reliably, by direct measurements, to estimate: growing stock volume, gross volume increment, mortality and felled trees, to control the dynamics of forest areas in the country.

11.3 Activity-specific information

11.3.1 Methods for carbon stock change and GHG emission and removal estimates

11.3.1.1 Description of the methodologies and the underlying assumptions used

Living biomass pool in this greenhouse gas inventory refers to aboveground biomass and belowground biomass. For the estimation of carbon stock changes in living biomass in afforested and reforested areas, growing stock volume of afforested and reforested areas estimated using data of NFI permanent sample plots and mean growing stock volume of afforested/reforested areas according to the year of afforestation and reforestation (Table 11-9). 3rd order polynomial trend was used to come up with mean growing stock volume and mean growing stock volume change (Table 11-8) of afforested and reforested areas per hectare.

Growing stock volume change for afforested and reforested areas was estimated by using equation presented below:

$$\Delta V = \sum [A_i (V_{t_2} - V_{t_1})) \quad (11.1)$$

where:
ΔV – GSV change on afforested/reforested land, m^3;
A_i – area according to land use category, ha;
V_{t_1} – GSV at time t_1, m^3;
V_{t_2}- GSV at time t_2, m^3.

Annual change in carbon stocks in living biomass in afforested and reforested areas was calculated by using equation 3.2.25 (p. 3.53) of the *IPCC 2003*:

$$\Delta C_{LFLB} = \Delta C_{LFGROWTH} + \Delta C_{LFCONVERSION} - \Delta C_{LFLOSS} \quad (11.2)$$

where:
$\Delta C_{LF_{LB}}$ – annual change in carbon stocks in living biomass in afforested/reforested land, tonnes C yr^{-1};
$\Delta C_{LF_{GROWTH}}$ – annual increase in carbon stocks in living biomass due to growth in afforested/reforested land, tonnes C yr^{-1};
$\Delta C_{LF_{CONVERSION}}$ – annual change in carbon stocks in living biomass due to afforestation/reforestation, tonnes C yr^{-1};
$\Delta C_{LF_{LOSS}}$ – annual decrease in carbon stocks in living biomass due to losses from harvesting, fuel wood gathering and disturbances in afforested/reforested land, tonnes C yr^{-1}.

Annual change in carbon stocks in living biomass due to afforestation/reforestation was calculated employing equation 3.2.26 (p. 3.53) of the *IPCC 2003*:

$$\Delta C_{LF_{CONVERSION}} = \sum_i [B_{AFTER_i} - B_{BEFORE_i}] \times \Delta A_{TO\_FOREST_i} \times CF \quad (11.3)$$

where:
$\Delta C_{LF_{CONVERSION}}$ – change in carbon stocks in living biomass in land annually afforested/reforested, tonnes C yr^{-1};
B_{BEFORE_i} – biomass stocks on land type *i* immediately before conversion, tonnes d.m. ha^{-1};
B_{AFTER_i} – biomass stocks that are on land immediately after conversion of land type *i*, tonnes d.m. ha^{-1} (in other words, the initial biomass stock after artificial or natural regeneration);
$\Delta A_{TO\_FOREST_i}$ – area of land-use *i* annually afforested/reforested, ha yr^{-1};
CF – carbon fraction of dry matter (default = 0.5), tonnes C (tonnes d.m.)$^{-1}$;
I – represent different types of land converted to forest.

B_{BEFORE} value was taken from the modelled in Figure 11-14 and is equal to zero.

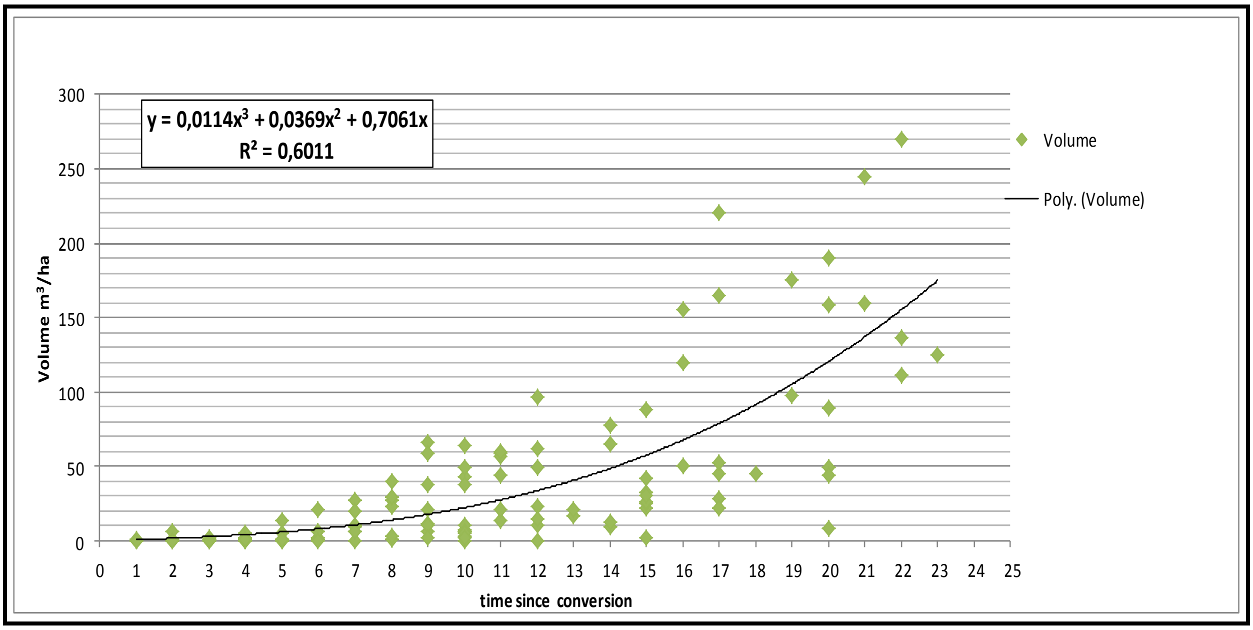

Figure 11-14. NFI data on growing stock volume of afforested and reforested (A1R1) areas

Table 11-8. Mean growings stock volume and mean growing stock volume change in ha for afforested and reforested (A1R1) areas at the time of afforestation/reforestation

Time since conversion	Mean growing stock volume, m^3/ha	Mean growing stock volume change, m^3/ha
1	0,8	0,8
2	1,7	0,9
3	2,8	1,1
4	4,1	1,4
5	5,9	1,7
6	8,0	2,1
7	10,7	2,6
8	13,8	3,2
9	17,7	3,8
10	22,2	4,5
11	27,4	5,3
12	33,5	6,1
13	40,5	7,0
14	48,4	7,9
15	57,4	9,0
16	67,4	10,1
17	78,7	11,2
18	91,2	12,5
19	104,9	13,8
20	120,1	15,2
21	136,7	16,6
22	154,8	18,1
23	174,5	19,7

Table 11-9. Aggregated data for AR areas and growing stock volume at the year of afforestation and reforestation

Time since afforestation /reforestation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Mean volume, m^3/ha	0,8	1,7	2,8	4,1	5,9	8,0	10,7	13,8	17,7	22,2	27,4	33,5	40,5	48,4	57,4	67,4	78,7	91,2	104,9	120,1	136,7	154,8
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
A1R1 area, ha	1373,5	901,0	520,3	369,3	256,2	331,1	367,2	412,5	701,4	920,0	1280,1	680,6	1175,6	1227,7	1435,6	1481,2	1686,8	1781,1	1130,8	803,9	4419,7	4332,2
A1R1 cumulative area, ha	1373,5	2274,5	2794,8	3164,1	3420,3	3751,4	4118,6	4531,2	5232,5	6152,5	7432,6	8113,2	9288,8	10516,5	11952,1	13433,3	15120,1	16901,2	18032,1	18835,9	23255,6	27587,8
ha	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5	1373,5
m3	1036,1	2267,6	3788,3	5692,2	8073,3	11025,4	14642,6	19018,7	24247,8	30423,7	37640,5	45992,0	55572,2	66475,1	78794,6	92624,6	108059,1	125192,0	144117,3	164928,9	187720,8	212587,0
ha		901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0	901,0
m3		679,7	1487,6	2485,2	3734,3	5296,3	7233,0	9606,0	12476,9	15907,3	19958,9	24693,3	30172,2	36457,1	43609,7	51691,7	60764,6	70890,1	82129,9	94545,5	108198,6	123150,8
ha			520,3	520,3	520,3	520,3	520,3	520,3	520,3	520,3	520,3	520,3	520,3	520,3	520,3	520,3	520,3	520,3	520,3	520,3	520,3	520,3
m3			392,5	859,1	1435,2	2156,5	3058,5	4177,0	5547,3	7205,2	9186,2	11526,0	14260,1	17424,0	21053,5	25184,0	29851,2	35090,7	40938,1	47428,9	54598,7	62483,2
ha				369,3	369,3	369,3	369,3	369,3	369,3	369,3	369,3	369,3	369,3	369,3	369,3	369,3	369,3	369,3	369,3	369,3	369,3	369,3
m3				278,6	609,7	1018,5	1530,4	2170,6	2964,3	3936,8	5113,3	6519,2	8179,7	10119,9	12365,3	14941,0	17872,3	21184,5	24902,8	29052,5	33658,8	38747,1
ha					256,2	256,2	256,2	256,2	256,2	256,2	256,2	256,2	256,2	256,2	256,2	256,2	256,2	256,2	256,2	256,2	256,2	256,2
m3					193,3	423,0	706,6	1061,7	1505,8	2056,5	2731,2	3547,4	4522,7	5674,7	7020,8	8578,5	10365,4	12399,1	14696,9	17276,5	20155,4	23351,0
ha						331,1	331,1	331,1	331,1	331,1	331,1	331,1	331,1	331,1	331,1	331,1	331,1	331,1	331,1	331,1	331,1	331,1
m3						249,8	546,7	913,3	1372,3	1946,3	2658,0	3530,0	4585,0	5845,6	7334,4	9074,2	11087,6	13397,1	16025,5	18995,5	22329,6	26050,4
ha							367,2	367,2	367,2	367,2	367,2	367,2	367,2	367,2	367,2	367,2	367,2	367,2	367,2	367,2	367,2	367,2
m3							277,0	606,3	1012,8	1521,9	2158,5	2947,7	3914,8	5084,8	6482,9	8134,0	10063,5	12296,4	14857,7	17772,7	21066,4	24764,0
ha								412,5	412,5	412,5	412,5	412,5	412,5	412,5	412,5	412,5	412,5	412,5	412,5	412,5	412,5	412,5
m3								311,2	681,1	1137,9	1709,7	2424,9	3311,6	4398,1	5712,5	7283,1	9138,1	11305,8	13814,3	16691,8	19966,6	23666,9
ha									701,4	701,4	701,4	701,4	701,4	701,4	701,4	701,4	701,4	701,4	701,4	701,4	701,4	701,4
m3									529,1	1157,9	1934,5	2906,7	4122,5	5630,0	7477,1	9711,8	12381,9	15535,6	19220,8	23485,5	28377,5	33945,0
ha										920,0	920,0	920,0	920,0	920,0	920,0	920,0	920,0	920,0	920,0	920,0	920,0	920,0
m3										694,0	1518,9	2537,5	3812,8	5407,7	7385,1	9808,0	12739,3	16241,9	20378,7	25212,7	30806,8	37223,9
ha											1280,1	1280,1	1280,1	1280,1	1280,1	1280,1	1280,1	1280,1	1280,1	1280,1	1280,1	1280,1
m3											965,7	2113,5	3530,9	5305,4	7524,6	10276,2	13647,5	17726,3	22600,0	28356,3	35082,6	42866,6
ha												680,6	680,6	680,6	680,6	680,6	680,6	680,6	680,6	680,6	680,6	680,6
m3												513,4	1123,6	1877,1	2820,5	4000,3	5463,1	7255,4	9423,8	12014,8	15075,0	18650,9
ha													1175,6	1175,6	1175,6	1175,6	1175,6	1175,6	1175,6	1175,6	1175,6	1175,6
m3													886,9	1941,0	3242,6	4872,3	6910,4	9437,3	12533,5	16279,3	20755,2	26041,6
ha														1227,7	1227,7	1227,7	1227,7	1227,7	1227,7	1227,7	1227,7	1227,7
m3														926,2	2026,9	3386,2	5088,1	7216,4	9855,2	13088,4	17000,1	21674,2
ha															1435,6	1435,6	1435,6	1435,6	1435,6	1435,6	1435,6	1435,6
m3															1083,0	2370,1	3959,6	5949,6	8438,3	11523,9	15304,6	19878,6
ha																1481,2	1481,2	1481,2	1481,2	1481,2	1481,2	1481,2
m3																1117,4	2445,4	4085,4	6138,6	8706,4	11890,1	15791,0
ha																	1686,8	1686,8	1686,8	1686,8	1686,8	1686,8
m3																	1272,5	2785,0	4652,6	6990,9	9915,2	13540,9
ha																		1781,1	1781,1	1781,1	1781,1	1781,1
m3																		1343,7	2940,7	4912,7	7381,7	10469,5
ha																			1130,8	1130,8	1130,8	1130,8
m3																			853,1	1867,0	3119,0	4686,5
ha																				803,9	803,9	803,9
m3																				606,4	1327,2	2217,2
ha																					4419,7	4419,7
m3																					3334,2	7296,9
ha																						4332,2
m3																						3268,2
Total volume, m3	1036,1	2947,3	5668,5	9315,1	14045,6	20169,4	27994,8	37864,7	50337,4	65987,4	85575,4	109251,6	137995,0	172566,7	213933,6	263053,5	321109,8	389332,3	468517,8	559736,6	667064,1	792351,3

The estimation of carbon stock changes in living biomass in areas refering to Forest Management is consistent with the *Method 2* further described in the *IPCC 2003*, which is also called as the *stock change method.* Estimations of carbon stock changes by using this method requires biomass carbon stock inventories for a given forest area in two points in time. Biomass change is the difference between the biomass at $time_2$ and $time_1$, divided by the number of years between the inventories (*IPCC 2003* eq. 3.2.3, p. 3.24):

$$\Delta C_{LB} = (C_{t2} - C_{t1})/(t_2 - t_1) \text{ and } C = (\Delta AGB + \Delta BGB) \times CF \text{ (modified eq. 3.2.3)} \quad (11.4)$$

where:
ΔC_{LB} – annual change in carbon stock in living biomass (includes above- and belowground biomass) in total forest land. t C yr^{-1};
C_{t2} – total carbon in biomass calculated at time t_2, t C;
C_{t1} – total carbon in biomass calculated at time t_1, t C;
ΔAGB – above-ground biomass change, t d. m.;
ΔBGB – below-ground biomass change, t d. m.;
CF – carbon fraction of dry matter (default = 0,5), t C (tonne d.m.)$^{-1}$.

Annual growing stock volume (GSV) change from 2007 for Forest Management estimated based on NFI data by the following steps:

1. Estimation of GSV based on data of re-measured permanent sample plots on the same forest area (for each assessment year separately);
2. First cycle of NFI, when the establishment of permanent sample plots has been completed, has been finished in 1998-2002. First re-measurement of these sample plots has started in 2003 and finished in 2007 (1998 sample plots re-measured in 2003, 1999 sample plots re-measured in 2004, 2000 sample plots re-measured in 2005 etc.). At the same time of re-measurement of old sample plots, new sample plots were measured as well (NFI in details in chapter 7.2.1).
3. Estimation of annual GSV increment, based on new established permanent plots data, on the lost before measuring, and new forest land area (for each assessment year separately);
4. Estimation of annual GSV change in all forest area by the change of GSV on the same area (re-measured permanent sample plots data) plus GSV increment of new measured permanent sample plots;
5. Estimation of annual GSV change on land converted to forest land area (A1R1) by relationship between mean GSV and age of forest in permanent plots of land converted to forest land (A1R1);
6. Estimation of annual GSV change in FM area by difference of all forest annual GSV change (explained in step 3) and annual GSV change of afforested/reforested (A1R1) areas.

The equations presenting calculations on growing stock volume change in Forest Management area are shown below:

$$\Delta FF_t = ((V_{rem_{t2}} - V_{rem_{t1}}) + \Delta V_{new}) - \Delta A1R1 \quad (11.5)$$

where:
ΔFF_t – growing stock volume change for Forest Management for the defined year, m^3;
$V_{rem_{t1}}$ – growing stock volume calculated at time $t_{1,}$ m^3;
$V_{rem_{t2}}$ – growing stock volume calculated at time $t_{2,}$ m^3;

ΔV_{new} – growing stock volume change of the new measured sample plots, m^3;
$\Delta A1R1$ – growing stock volume change of afforested/reforested areas, m^3.

Carbon stock changes in dead wood, litter and soil

Carbon stock changes in dead wood of afforested and reforested areas is assumed to be equal to zero, therefore reported as 'NO'. The accumulation of dead wood was assumed to be marginal on afforested and reforested sites, during 1990-2011, and also dead wood pool can not decrease on those sites, because there is actually no dead wood there before the conversion. The dead wood starts to accumulate when natural mortality or thinnings occur that is nearly at the age of over 20 years.

Annual change in carbon stocks in dead organic matter in Forest Management is calculated following the summarising equation for calculation of changes in dead organic matter carbon pools which is equal to the sum of carbons stock in dead wood (measured available dead wood) and carbon stock in dead wood that is left on site after fellings (*BGB*). Dead wood that is left on site after fellings is assumed to be below-ground biomass which is roots. It is assumed that BGB decays in equal parts in 5 years. Modified equation 3.2.10 (p. 3.32) of *IPCC 2003* has been used to calculate carbon stock change in dead organic matter:

$$\Delta C_{DOM} = C_{DW} + C_{DW_H} \quad (11.6)$$

where:
ΔC_{DOM} – annual change in carbon stocks in dead organic matter, t C yr^{-1};
C_{DW} – change in carbon stocks in dead wood (*measured available dead stems*), t C yr^{-1};
C_{DW_H} – change in carbon stocks in dead wood (*BGB left on site after fellings*), t C yr^{-1}.

Annual change of biomass of dead trees stems is calculated by using stock change method and employing equation 3.2.12, p. 3.34 of *IPCC 2003*.

It was assumed that carbon stock in litter in afforested and reforested areas accumulates in 20 years period and then it remains stable. The average value of carbon stock in litter is 24 t per ha per 20 years. This value was accepted for Forest land, using values for cold temperate dry and moist region from Table 3.2.1 of *IPCC* 2003. Average value accumulated in litter in AR areas equal to 1,2 t/ha/year (24 t/ha / 20 years). Change in carbon stock in litter in AR areas was calculated using area from annual AR conversion matrix (Table 11-10).

Table 11-10. Aggregated data of carbon stock changes in litter of afforested and reforested areas at the year of afforestation or reforestation

Time since afforestation/reforestation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Annual carbon stock in litter, t/ha/year	1,2	2,4	3,6	4,8	6	7,2	8,4	9,6	10,8	12	13,2	14,4	15,6	16,8	18	19,2	20,4	21,6	22,8	24	24	24
Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
A1R1 area, ha	**1373,5**	**901,0**	**520,3**	**369,3**	**256,2**	**331,1**	**367,2**	**412,5**	**701,4**	**920,0**	**1280,1**	**680,6**	**1175,6**	**1227,7**	**1435,6**	**1481,2**	**1686,8**	**1781,1**	**1130,8**	**803,9**	**4419,7**	**4332,2**
Cumulative A1R1 area, ha	**1373,5**	**2274,5**	**2794,8**	**3164,1**	**3420,3**	**3751,4**	**4118,6**	**4531,2**	**5232,5**	**6152,5**	**7432,6**	**8113,2**	**9288,8**	**10516,5**	**11952,1**	**13433,3**	**15120,1**	**16901,2**	**18032,1**	**18835,9**	**23255,6**	**27587,8**
Annual change in carbon stocks in litter, t	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	1648,2	0,0	0,0
		1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	1081,2	0,0
			624,4	624,4	624,4	624,4	624,4	624,4	624,4	624,4	624,4	624,4	624,4	624,4	624,4	624,4	624,4	624,4	624,4	624,4	624,4	624,4
				443,1	443,1	443,1	443,1	443,1	443,1	443,1	443,1	443,1	443,1	443,1	443,1	443,1	443,1	443,1	443,1	443,1	443,1	443,1
					307,4	307,4	307,4	307,4	307,4	307,4	307,4	307,4	307,4	307,4	307,4	307,4	307,4	307,4	307,4	307,4	307,4	307,4
						397,3	397,3	397,3	397,3	397,3	397,3	397,3	397,3	397,3	397,3	397,3	397,3	397,3	397,3	397,3	397,3	397,3
							440,7	440,7	440,7	440,7	440,7	440,7	440,7	440,7	440,7	440,7	440,7	440,7	440,7	440,7	440,7	440,7
								495,0	495,0	495,0	495,0	495,0	495,0	495,0	495,0	495,0	495,0	495,0	495,0	495,0	495,0	495,0
									841,6	841,6	841,6	841,6	841,6	841,6	841,6	841,6	841,6	841,6	841,6	841,6	841,6	841,6
										1104,0	1104,0	1104,0	1104,0	1104,0	1104,0	1104,0	1104,0	1104,0	1104,0	1104,0	1104,0	1104,0
											1536,2	1536,2	1536,2	1536,2	1536,2	1536,2	1536,2	1536,2	1536,2	1536,2	1536,2	1536,2
												816,7	816,7	816,7	816,7	816,7	816,7	816,7	816,7	816,7	816,7	816,7
													1410,8	1410,8	1410,8	1410,8	1410,8	1410,8	1410,8	1410,8	1410,8	1410,8
														1473,2	1473,2	1473,2	1473,2	1473,2	1473,2	1473,2	1473,2	1473,2
															1722,7	1722,7	1722,7	1722,7	1722,7	1722,7	1722,7	1722,7
																1777,4	1777,4	1777,4	1777,4	1777,4	1777,4	1777,4
																	2024,2	2024,2	2024,2	2024,2	2024,2	2024,2
																		2137,4	2137,4	2137,4	2137,4	2137,4
																			1357,0	1357,0	1357,0	1357,0
																				964,6	964,6	964,6
																					5303,6	5303,6
																						5198,7
Total carbon stock change in litter, t	**1648,2**	**2729,4**	**3353,8**	**3796,9**	**4104,4**	**4501,7**	**4942,3**	**5437,4**	**6279,0**	**7383,0**	**8919,2**	**9735,8**	**11146,6**	**12619,8**	**14342,5**	**16119,9**	**18144,1**	**20281,5**	**21638,5**	**22603,1**	**26258,5**	**30376,0**
Gg	**1,64816**	**2,72941**	**3,35381**	**3,79694**	**4,10435**	**4,50169**	**4,94234**	**5,43738**	**6,27901**	**7,38299**	**8,91916**	**9,73582**	**11,1466**	**12,6198**	**14,3425**	**16,1199**	**18,1441**	**20,2815**	**21,6385**	**22,6031**	**26,2585**	**30,376**

NFI provides data on forest land distribution by forest soils (Table 7-9, Chapter 7.2.1). According to NFI[185] data, area of mineral soils amounts to 84,3% and area of organic soils – 15,7% of the total forest area. Drained organic forest soils constitute to 7,9% of the total forest land. Due to the lack of accurate data on drained organic soils in afforested and reforested areas, it was assumed that the same proportion of drained organic soils as it is accepted for Forest land remaining Forest land category refers also to afforested and reforsted areas. The proportion was distributed to afforestated/reforestated Croplands, Grasslands and Wetlands. It was also assumed that total area of Wetlands is under organic soils.

Carbon stock change in mineral and organic forest soils in afforested/reforested areas was calculated using area of afforested and reforested land and emission factors estimated by Finland (*Finish NIR, Chapter 7.2.3.2*). Emission factors for mineral soils were applied for Southern Finland considering similar climatic conditions with Lithuania. Carbon stock changes in organic soils were done separetely for forested Croplands, Graslands and Wetlands. Due to the lack of information in forest planting projects at the State Forest Cadastre on the exact land use before afforestation or reforestation, area of afforested/reforested Croplands, Grasslands and Wetlands was estimated by using data of sample plots of NFI on land use areas distribution and assuming the same distribution of Croplands, Grasslands, Wetlands were afforested and reforested. For afforested/reforested Settlements and Other lands it was assumed that carbon stock changes in organic soil are equal to zero, because there is no organic soil layer on those land during the afforestation/reforestation.

Table 11-11. The aggregated annual emission factors for soil organic matter (SOM) and dead organic matter (DOM) stock change on lands converted to forest land on mineral and on organic soils applied by Lithuania, tonnes C per ha (negative is a loss of carbon)

Year after conversion	Cropland mineral	Grassland mineral	Cropland organic	Grassland organic	Wetlands organic
1	-1,32	-2,92	-3,77	-1,90	-1,47
2	-1,15	-2,28	-3,74	-1,90	-1,45
3	-1,05	-1,87	-3,71	-1,90	-1,44
4	-0,96	-1,57	-3,68	-1,90	-1,43
5	-0,89	-1,34	-3,65	-1,90	-1,41
6	-0,83	-1,16	-3,62	-1,90	-1,40
7	-0,78	-1,02	-3,60	-1,90	-1,39
8	-0,74	-0,92	-3,57	-1,90	-1,37
9	-0,70	-0,84	-3,54	-1,90	-1,36
10	-0,67	-0,77	-3,51	-1,90	-1,35
11	-0,64	-0,72	-3,48	-1,90	-1,33
12	-0,61	-0,68	-3,45	-1,90	-1,32
13	-0,58	-0,64	-3,43	-1,90	-1,31
14	-0,55	-0,61	-3,40	-1,90	-1,30
15	-0,53	-0,59	-3,37	-1,90	-1,28
16	-0,51	-0,57	-3,34	-1,90	-1,27
17	-0,49	-0,55	-3,31	-1,90	-1,26
18	-0,46	-0,53	-3,28	-1,90	-1,24

[185] *Lithuanian National Forest Inventory 2003 – 2007. Forest resources and their dynamics*

Year after conversion	Cropland mineral	Grassland mineral	Cropland organic	Grassland organic	Wetlands organic
19	-0,44	-0,52	-3,26	-1,90	-1,23
20	-0,42	-0,50	-3,23	-1,90	-1,22

Carbon stock change in drained organic forest soils for Forest Management was calculated using equation 3.2.15 of the *IPCC 2003*:

$$\Delta C_{FOS} = A_{Drainage} \times EF_{Drainage} \tag{11.7}$$

where:
ΔC_{FOS} - CO_2 emissions from drained organic forest soils, t C yr^{-1};
$A_{Drainage}$ - area of drained organic forest soils, ha;
$EF_{Drainage}$ - emission factor for CO_2 from drained organic forest soils. t C ha^{-1} yr^{-1}.

Default value of emission factor for drained organic soils in managed forests provided in Table 3.2.3 of the *IPCC 2003* (p. 3.42) was used in calculations. Default $EF_{Drainage}$ for temperate forests is 0,68 tonnes C ha^{-1} yr^{-1}.

For calculations on carbon stock changes caused by conversion (deforestation) of forest land to settlements and other lands it was assumed that all above- and below ground forest biomass as well as dead wood and litter – organic matter was removed entirely as a result of conversion. For deforestation which occurred on Forest management area, mean biomass stock that is lost for the year of deforestation was used.

Lithuanian forests since 1990 showed a continuous increase in per hectare density of carbon stocks in the biomass and dead mass carbon pools; same trend is observed over the whole Baltic region. The increased amounts of living biomass and dead mass causes increasingly quantity of organic material being transferred to the litter and soil organic carbon (SOC) pools, so potentially determining an accumulation of organic carbon. Therefore, Poland, Sweden and Finland are accounting for net carbon-stock increases in both pools; while Germany having not found significant changes is not accounting for both.

A study performed by the European Union all over its territory, the Biosoil project[186], shows for the Lithuanian forests a slightly, not significant, increase in soil carbon stocks from 1992 to 2006[187] (Table 11-12).

Table 11-12. Mean carbon stock in forest land according to the soil monitoring in *ICP-Forest* sample plots Level I 1992 and 2006

Year	Mean carbon stock in litter, g/kg	Mean carbon stock in mineral soil (0-10 cm depth), g/kg	Mean carbon stock in mineral soil (10-20 cm depth), g/kg	Research activity
1992*	370,69 ±12,8	29,1 ±4,4	15,6 ±2,8	Soil monitoring in *IPC-Forests* 74 sample plots Level I

[186] *http://ec.europa.eu/dgs/jrc/index.cfm?id=1410&obj_id=10400&dt_code=NWS&lang=en*
[187] *EU-JRC: Evaluation of BioSoil Demonstration Project - Preliminary Data Analysis (http://eusoils.jrc.ec.europa.eu/ESDB_Archive/eusoils_docs/other/EUR24258.pdf) and EU-JRC: Evaluation of BioSoil Demonstration Project - Soil Data Analysis (http://eusoils.jrc.ec.europa.eu/ESDB_Archive/eusoils_docs/other/EUR24729.pdf)*

2006	399,0 ±96,6	29,9 ±18,2	15,8 ±11,6	"Biosoil" project in *IPC-Forests* 62 sample plots Level I

*- *Due to some differences in sampling and analyses methods data adopted with some assumptions*.

Not having proof of significant increases in litter and in soil organic carbon in forest land and having information that these pools are not a source, Lithuania has decided to be conservative and consequently not to account for those pools under Forest management (reported as 'NO').

Biomass burning

Data on areas affected by forest fires is provided by the Directorate General of State Forests (Table 11-13). The Directorate General of State Forests under the Ministry of Environment performs the functions of founder of forest enterprises and coordinator of their activity as well as establishes the mandatory norms for forest enterprises regarding reforestation, protection and management of forests.

Lithuania is one of the few Europe countries that has uniform system of state fire prevention measures, comprising monitoring, preventive and fire control measures, that are established and maintained in forests irrespective of the forest ownership type. Every forest enterprise presents data on forest fires to the Directorate General of State Forests every year.

Since 2012 Directorate General of State Forests will use special methodology for assessment of forest fires prepared by State Forest Service. More accurate data on burnt areas and burnt living biomass percent will be provided in reports.

Prescribed burning of forest biomass is not used in Lithuania.

GHG emissions (CO_2, CH_4, N_2O) resulting from wildfires for Afforestation and Reforestation activities and Forest management were calculated separately in this submission. Data on wildfires occurring on afforested and reforested areas was received from Directorate General of State Forests (DGSF). GIS layer of burnt AR areas, based on DGSF data, was prepared and intersected with *Study-1* GIS layer of afforested and reforested areas (A1R1), to receive complete information on areas for GHG emissions calculations. Burned area of Forest management was calculated by subtracting burnt area of afforested and reforested areas form the total burn forest land area.

Table 11-13. CO_2 emissions from biomass burning

Year	**Afforestation & Reforestation**		**Deforestation**		**Forest Management**	
	Area burned, ha	CO_2, Gg	Area burned, ha	CO_2, Gg	Area burned, ha	CO_2, Gg
2008	1,93	0,06	NO	NO	110,47	3,40
2009	3,06	0,09	NO	NO	312,24	9,62
2010	2,17	0,07	NO	NO	19,33	0,60
2011	2,78	0,09	NO	NO	290,22	8,93

N_2O emissions from disturbances associated with land-use conversion to cropland

Not relevant for Lithuania as there are no conversion of forest land to cropland (*Study-1* and *Study-2* results). Deforestation mainly refers to conversion of forest land to Settlements, Wetlands and Other land use categories.

N_2O emissions from drainage of soils

N_2O emissions were calculated by using methodology used by NFI for distinguishing organic and drained organic soils, which refers to 15,7% of organic soils 7,9% of drained organic soils from the total forest land area. 2,6% infertile and 5,3% of fertile soils contribute to the total area of drained organic forest soils. N_2O emisions were calculated for the total forest land area, thus emisions from AR were also included.

N_2O emissions from drained organic soils were calculated employing equation 3A.2.1 (Appendix 3A.2, *IPCC 2003*). In Tier 1 Equation 3a.2.1 simple disaggregation of drained organic soils into "nutrient rich" and "nutrient poor" areas is applied and default emission factors are used. For „nutrient rich" areas default emission factor of 0,6 and for „nutrient poor" areas default emission factor of 0,1 according to table 3A.2.1 (Appendix 3A.2, *IPCC 2003*) were used.

Regarding assumption that carbon inputs and losses in mineral soil balance is equal one to another and the net changes are close to zero, there is also no N_2O emissions from mineral soils.

Fertilization and liming

Information presented by Directorate General of State Forests indicates that there were no fertilization or liming of forest land in Lithuania since 1990 to 2011.

Fertilization and liming of forest land could be possible by using biofuel ashes, but there are only few studies done in Lithuania, evaluating impact of application of ashes on forest land, but unfortunatelly there is no clear evidence on efficiency of such application[188].

Fertilization of forest land with other mineral fertilizers is still not worth economically due to high prices of fertilizers and unclear benefit for forest growth in our climatic conditions.

Windbrakes and windfalls

Accounting and data collection principles used by State Forest Service, includes all timber from windbreaks and windfalls into round wood or fuel wood removals as this timber is still consumable. Therefore, to avoid double counting, windbreaks and windfalls were not included in calculations of carbon losses due to disturbances.

Information that emissions/removals from Article 3.3 are not accounted under Article 3.4

According to 15/CMP.1 requirements of paragraph 9(c) emissions/removals from living biomass, biomass burning, deadwood etc. under Article 3.4 activities (FM) are not accounted under Article 3.3. (ARD) and are accounted separately.

[188] *Ozolinčius R., Armolaitis K., Mikšys V., Varnagirytė-Kabašinskienė I. 2010. Recommendations for compensating wood ash fertilization (2nd revised edition).*

11.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

Based on NFI 1998-2011 data changes of dead wood are not significant in the afforested and reforested lands. For estimation of carbon stock change of dead wood it was assumed to be zero and reported as 'NO'.

11.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

No factoring out has been performed in the emission and removal estimates.

11.3.1.4 Uncertainty estimates

Uncertainty values for Article 3.3 and Article 3.4 assessment are represented in Table 11-14.

Table 11-14. Uncertainty assessment values

Indicator	Category	Unit	Uncertainty
Growing stock volume	AR	m^3	15,6%
	D	m^3	2,6%
	FM	m^3	2,6%
Dead trees volume	AR	m^3	15,6%
	FM	m^3	2,6%
Area	FL	ha	2,3%
	AR	ha	3,8%
	D	ha	3,8%
	FM	ha	2,2%
Emission factor	AR	$GgCO_2$	39,1%
	D	$GgCO_2$	62%
	FM	$GgCO_2$	34%

11.3.1.5 Information on other methodological issues

In its initial report under the Kyoto protocol Lithuania has chosen to account for the emissions and removals under Articles 3.3 and 3.4 at the end of the commitment period. Lithuania will further develop methods for area estimation as well as methods to estimate removals and emissions of greenhouse gases. Taking into account this, the estimates presented in this submission for period of 2008-2011 may change in the final report at the end of the commitment period.

11.3.1.6 The year of the onset of an activity, if after 2008

After finalizing *Study-1* Lithuania is able to identify areas of Article 3.3 and Article 3.4 under Kyoto Protocol activities since 1990, using wall-to-wall (Article 3.3 activities) and sampling (Article 3.4 activities) methods. The relevant area sizes of Article 3.3 activities that began after 2008 are represented in Table 11-14. The relevant area sizes of Article 3.4 activities that began after 2008 are represented in Table 11-15.

11.4 Article 3.3

11.4.1 Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

Reported deforestation activities are directly human-induced. Areas of deforestation are under very strict regulation and control of forest lands legitimated by the Forest Law and Lithuanian Republic Government Resolution No 1131 dated on Sept 28, 2011. According to these acts forest land can be converted to non-forest land only using special procedure of compensation. Main way of compensation is re-establishment of forest land on non-forest land on area up to 3 times larger as compared with area of land converted to non-forest land.

Reported Afforestation and Reforestation activities are defined only as human-induced activities without natural forest expansion. Forest Law regulates afforestation process in agricultural lands and other lands (swamps, peatlands, other land) too. Afforestation of these lands could be done by artificial way as well as by natural way. The legitimation of changes of agricultural and other land to forest land by natural afforestation are obligatory if trees crown cover attains 30% of an area not less than 0,1 ha and age of trees exceed 20 years. Natural afforestation is included in area of forest management (FM).

Data of Afforestation, Reforestation and Deforestation for period 1990-2011 estimated as the result of the *Study-1*. Special methodology and descriptive codes (Table 11-6) were used to identify natural and human induced activities under Article 3.3.

Using wall-to-wall method (LSFC) together with SFI data, areas of Afforestation, Reforestation and Deforestation were determined. As quality assurance data from NFI was used to compare with results received from *Study-1*. Comparison revealed that differences are minor and the common trend retained over the study period (1990-2011).

11.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

According to Lithuanian Forest Law the clear cut areas should be reforested during 3 years and are under strict control of forest management and State inspection.

Temporarily unstocked areas after harvesting remain forests and are not accounted as deforestation. Every deforestation case must be reported to Lithuanian State Forest Cadastre and is very rare. Any deforested area must follow to the afforestation of tree times larger area than the one was deforested.

All forest land, where forest was growing in 1990 according to Lithuanian State Forest Resources Database (LTDBK50000-V) scale 1:50 000, but was not fixed in Lithuanian State Forest Cadastre (LSFC) were visually checked, simultaneously inspecting LSFC data (MKAD, MKAD_ARCH and MKAD_2012 databases) as well as all orthophotomaps compiled in the last two decades on Lithuania's territory together with satellite images from CORINE land cover database (Figure 11-15).

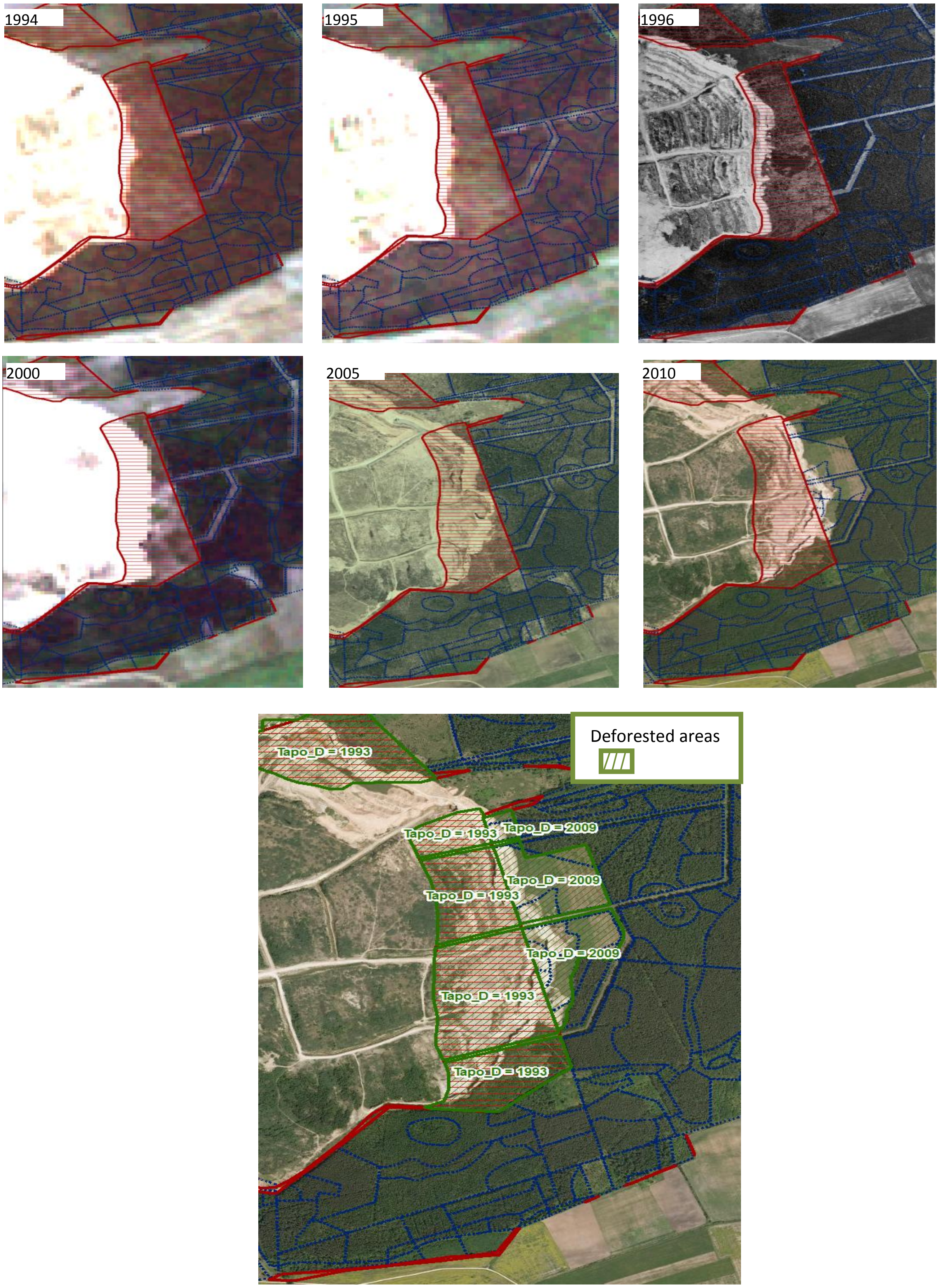

Figure 11-15. Technical procedure of identification of deforested areas 1994 – 2010

11.4.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

Clear-cut area in forests land (temporarily unstocked areas) is not considered as deforestation in Lithuania. In 2008 area of clear fellings was 14909 ha, in 2009 – 13558 ha and in 2011 – 16535 ha. Every clear felling is planned according to forest management plan prepared by forestry expert, and is applied to the area which meets the requirements approved in the Rules for forest fellings[189]. Permission for clear felling is required by forest owner and could be issued at Regional Environmental Protection Agency.

11.4.4 Emissions and removals under Article 3.3

Afforestation and reforestation activities were a net sink of -107,89 GgCO_2 in 2009, -109,18 GgCO_2 in 2010 and -120,19 GgCO_2 in 2011 (Table 11-15). For afforestation and reforestation it was assumed that carbon inputs and losses in dead wood balance are equal and net change is close to zero (NO). The deforestation activities were a continuous net source of 8,61 GgCO_2 in 2009, 26,31 GgCO_2 in 2010 and 10,48 GgCO_2 in 2011 (Table 11-16).

Table 11-15. Carbon stock change and emission/removals of CO_2 in Afforestation and Reforestation, Gg

Year	Carbon stock change in living biomass		Carbon stock change in dead organic matter		Carbon stock change in soil		Total carbon stock change	Emission/ removals of CO_2
	Above-ground	Below-ground	Dead wood	Forest litter	Mineral soil	Organic soil		
2008	20,71	4,73	NO	21,64	-16,38	-6,33	24,37	-89,33
2009	23,86	5,45	NO	22,60	-15,90	-6,59	29,42	-107,79
2010	28,07	6,42	NO	26,26	-22,81	-8,16	29,78	-109,12
2011	32,76	7,49	NO	30,38	-28,16	-9,69	32,78	-120,11

Table 11-16. Carbon stock change and emission/removals of CO_2 in Deforestation, Gg

Year	Carbon stock change in living biomass		Carbon stock change in dead organic matter		Carbon stock change in soil		Total carbon stock change	Emission/ removals of CO_2
	Above-ground	Below-ground	Dead wood	Forest litter	Mineral soil	Organic soil		
2008	-1,44	-0,33	-0,07	-0,60	-1,51	-0,28	-4,23	9,00
2009	-1,40	-0,32	-0,07	-0,57	-1,44	-0,27	-4,07	8,61
2010	-4,36	-1,00	-0,23	-1,74	-4,39	-0,82	-12.54	26,31
2011	-1,76	-0,40	-0,09	-0,69	-1,75	-0,33	5.02	10,48

11.5 Article 3.4

11.5.1 Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

Forests in January 1990 were under Forest management category, since Lithuania considers all forest land managed and human-induced.

NFI system ensures data provision of human-induced activities in Lithuanian forest area from 1998. Data for early period is modelled based on *Study-1*.

[189] *Seimas of the Republic of Lithuania. Regulations for forest fellings. Lietuvos Respublikos Seimas: 2010-01-27, Nr. D1-79. Valstybės žinios: 2010-02-03, Nr.14-676. (In Lithuanian).*

11.5.2 Information relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the base year

Lithuania has not chosen to account emissions and removals from Cropland Management, Grazing Land Management and Revegetation under Article 3.4 of the Kyoto Protocol.

11.5.3 Information relating to Forest Management

Objective information related to Forest management is received from NFI. Permanent sample plots are hidden, what means that they can only be identified during NFI measurements and are not visible and known for forest owners or managers, who could subjectively influence forest management results.

Net removals and emissions resulting from Forest management are provided in Table 11-17.

Table 11-17. Net removals and emissions from Forest management in 2008 – 2011, Gg

	2008	2009	2010	2011
Net CO_2 removals	-9046,98	-11666,63	-10615,26	-10873,90
CH_4 emission	0,02	0,05	0,003	0,05
N_2O emission	0,07	0,07	0,07	0,08
Total (CO_2 eq.)	**-9023,53**	**-11642,34**	**-10592,08**	**-10849,56**

11.5.3.1 Information that the definition of forest for this category conforms with the definition in item 11.1 above

In accordance with definitions in item 11.1 above, all forest land is managed and there is no unmanaged forest land in Lithuania. Only for accounting under Kyoto Protocol purposes all forest land is splitted into ARD and FM according to *IPCC 2003*.

11.5.3.2 Information that forest management is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner (paragraph 1 (f) of the annex to decision 16/CMP.1 (Land use, land –use change and forestry)

Forest represents one of the major Lithuanian natural resources serving for the welfare of the state and its citizens, preserving stability of the landscape and environmental quality. Despite the forest ownership form, forest, primarily, is the national property that shall be preserved for the future generations at the same time meeting ecological, economic and social needs of the society. Being a source of supply of timber and other forest products, forest is the essential factor of the ecological balance providing living places for numerous animal and plant species, stopping the soil erosion, absorbing the carbon dioxide and purifying the air, protecting the ground and the surface waters, providing opportunities for recreation of the urban and rural people.

With the purpose of ensuring a sustainable forestry development, satisfying forest-related needs of various groups of the society, and ensuring preservation of forests for further generations, acknowledging a long forest growth duration, and with respect to the differences of the ownership forms and their relationships, by promoting conditions for proper management of forests with the purpose of economic benefits for the country, a long-term forestry policy has been formed in Lithuania in compliance with policies of other branches of the economy of the country, based on the traditions of the country and requirements of the European Union legal norms, international conventions, resolutions, agreements, programmes, and national legal acts.

The following instruments are used for the purpose of implementation of the forestry policy: well-organised, qualified forestry administration independent from any temporal political changes; the Forest Law and other legal acts; taxes revenues and financial support; education and training; management of the forestry information; public relations.

The Lithuanian forestry policy is being formed upon the following principles:

- *responsibility* for the continuous and sustainable use of the forest resources. Considering forests as the major renewable natural resource for the society, forestry policy ensures the responsibility of forest owners, forest governors and users as well as sustainable use of these resources and their restoration. The state, execute state regulation functions on all forests of the country, develop forest infrastructure, forest protection against natural calamities, widespread diseases and pests, provide legal, financial and other preconditions for the preservation of forests, ensure rational use of forest resources, meeting social needs of the society and environmental protection;
- *compliance* to the national legal system and international agreements. Lithuanian forestry policy is formed following the Constitution of the Republic of Lithuania and other legal acts, as well as the Convention on the Conservation of European Wildlife and Natural Habitat, signed in 1979 in Bern, the Biodiversity Convention signed in Rio de Janeiro in 1992, and Forest Protection Principles adopted at the United Nations conference "Environment and Development", the Strasbourg 1990, Helsinki 1993, and Lisbon 1998 resolutions of the Ministerial Conferences on Protection of Forests in Europe , the principles of the European Union forestry strategies, European Union directives on forestry and environmental protection issues;
- *participation* and co-operation of all interested groups of the society. The policy takes into regard the opinion of all interested groups of the society, complies and balances interests of forest owners, forest governors and users, wood processors, environmental protection organisations, and other social groups related to forest and forestry-related economy. All major forestry policy statements shall be in compliance with separate stakeholders and submitted for public consideration of the society;
- *variety* of forest ownership forms and their equality of rights. The equality of rights for economic activities in forests of all ownership forms is implemented. Equal legal and other conditions both for the management and economic activities in private as well as state-owned forests are created. During the development of the Lithuania forestry, the market economy relationship and free competition principles are strengthened at the private as well as in the state-owned forestry sector;
- *complexity* of forestry. Forestry is being developed in a complex manner upon the basis of multiple use taking into regard its significance and relations to the consumers of forest products and services, wood processing industry structures as well as other groups of society having their interests in forests and forestry;
- *continuation* of the forestry traditions. Lithuanian forestry has traditions tested through the course of time, which are taken into consideration while transferring experience of foreign countries. Forestry reforms and reorganisations, implementation of novelties on forestry management and other issues shall be performed consistently, taking into consideration the practical know-how of the specialists, public opinion, and interests of the state.

Mission of the State in forestry development is:

- To form and implement a rational forestry development policy, which would ensure ecologically, economically and socially balanced development of forestry sector;
- To ensure the stability of forest ecosystems, preservation of biodiversity, increase in forest productivity, improve forest quality and healthiness;
- To preserve valuable forest genetic fund by using the national forest genetic resources for the establishment and creation of new objects of forest seed basis;
- To increase forest coverage of Lithuania by planting forests on uncultivated and poor-quality soils as well as other non-used land areas where forest planting would contribute to the formation of Lithuanian natural carcass;
- To ensure the variety of forest ownership forms and the efficiency of state forestry regulation;
- To ensure meeting general forest-related social needs of the society;
- To create a favourable legal, economic and institutional environment for the effective and competitive functioning of the forest economy, wood industry and a variety of forest business enterprises in a free market;
- To encourage innovations, competitiveness, development of markets and establishment of working places;
- To ensure the maintenance of the scientific potential and its rational application as well as preparation of high-qualification forestry specialists.

The main legal acts forming forest policy in Lithuania since 1990:

- Forest Law of the Republic of Lithuania. *Adopted on: 2001.04.10. No IX-240;*
- Land Law of the Republic of Lithuania. *Adopted on: 2004.01.27. No IX-1983;*
- Land reform Law of the Republic of Lithuania. *Adopted on: 1997.07.02. No VIII-370;*
- Law on territory planning of the Republic of Lithuania. *Adopted on: 2004.01.15. No X-1962.*

Recently adopted legal acts to improve KP-LULUCF accounting:

- Order of the Minister of Environment and Minister of Agriculture on Approval of Action plan to improve LULUCF reporting of Lithuania. *Adopted on: 2011.12.16. No D1-987/3D-927;*
- Order of the Minister of Environment on Approval of Harmonised Principles for data collection and reporting on LULUCF. *Adopted on: 2012.01.12. No D1/27;*
- Amendment of the Order of the Minister of Environment No D1-570 on National forest inventory by sampling method. *Adopted on: 2012.01.24. No D1-59;*
- Amendment of the Government Resolution No 1255 on State Forest Cadastre. *Adopted on: 2012.05.23. No 570;*
- Amendment of the Minister of Environment and Minister of Agriculture Order No 3D-130/D1-144 on Rules for afforestation of non-forest land. *Adopted on: 2012.04.03. No 3D-239/D1-285;*
- Order of the Minister of Environment and Minister of Agriculture on Inventory and Registration of natural afforestation of non-forest land. *Adopted on: 2012.05.08. No D1-409/3D-331.*

11.6 Other information

11.6.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

Key category analysis for KP-LULUCF was developed according to section 5.4 of the *IPCC 2003*.

Categories under Articles 3.3 and 3.4 were considered as key if their contribution was greater than the smallest category considered key in the UNFCCC inventory (including LULUCF). The results are presented in Table 11-18.

Table 11-18. Key categories for Article 3.3 and 3.4. activities

Key categories of emissions and removals	**Gas**	**Criteria used for key category identification**	
		Associated category in UNFCCC inventory is key	**Category contribution is greater than the smallest category considered key in the UNFCCC inventory (including LULUCF)**
Forest Management	CO_2	Forest land remaining forest land	Yes
Forest Management	CH_4	Forest land remaining forest land	No
Forest Management	N_2O	Forest land remaining forest land	No
Afforestation and Reforestation	CH_4	Conversion to forest land	No
Afforestation and Reforestation	CO_2	Conversion to forest land	No
Afforestation and Reforestation	N_2O	Conversion to forest land	No
Deforestation	CH_4	Convertion to cropland, settlements and other land	No
Deforestation	CO_2	Convertion to cropland, settlements and other land	No
Deforestation	N_2O	Convertion to cropland, settlements and other land	No

11.7 Information relating to Article 6

No projects in this sector under Article 6 (Joint implementation projects) are implemented in Lithuania.

12 INFORMATION ON ACCOUNTING OF KYOTO UNITS

12.1 Background information

The standard electronic format (SEF) tables are included in the submission (see "SEF_LT_2013_1_14-49-48 8-4-2013.xls" attached to the submission). The SEF tables include information on the AAU, ERU, CER, t-CER, l-CER and RMU in the Lithuania's registry as well as information on transfers of the units in 2012 to and from other Parties of the Kyoto Protocol.

12.2 Summary of information reported in the SEF tables

At the beginning of the 2012 there were 160 163 624 AAUs and 41993 ERUs in the Lithuania's national holding accounts. 6 036 077 AAUs, 2 502 312 ERUs and 755 932 CERs were in entity holding accounts. In the retirement account were 15 443 469 AAUs, 645 015 ERUs and 2 198 905 CERs.

There were no AAUs issued on the basis of the assigned amount pursuant to Article 3, paragraphs 7 and 8. During the reported year there were 2 346 649 ERUs converted from AAUs.

4 076 420 AAUs, 1 165 359 ERUs and 363 494 CERs were surrendered by Lithuania's operators and retired to Lithuania's national retirement account.

At the end of 2012 160 861 894 AAUs and 213 586 ERUs were left in National holding accounts, 2 950 596 ERUs and 392 438 CERs were held in the entity holding accounts.

During the reported year the registry did not contain any RMUs, t-CERs or l-CERs and no units were in the Article 3.3/3.4 net source cancellation accounts and the t-CER and l-CER replacement accounts.

12.3 Discrepancies and notifications

In 2012 177 discrepancies (within 5 transactions) occurred in the Lithuanian registry. Two types of DES response codes occurred – 5061 and 5255. All of the discrepant transactions ended as terminated.

The transactions No. LT28140, LT28147 and LT28149 were terminated due to a data mismatch in the ITL database. All of them are related to the same JI project. This issue has been fixed in January 2013.

Discrepancies of type 5255 occured as a result of the final decision of the Enforcement Branch of the Compliance Committee No. CC-2011-3-8/Lithuania/EB dated 21 December 2011. As a result Lithuania was considered not to meet one of the 6 eligibility criteria – a national system in place – which was required in order to be able to retire CERs. Lithuania has already implemented needed measures to reinstate its eligibility and the suspension has been lifted.

No notifications occurred in 2012.

12.4 Publicly accessible information

All non-confidential information required to be publicly accessible by the decision 13/CMP/1 is available in the public website of the EUTL – http://ec.europa.eu/environment/ets/account.do?languageCode=en&account.registryCodes=LT&identifierInReg=&accountHolder=&search=Search&searchType=account&currentSortSettings=. Some of the publicly available information is also accessible via Registry management office web page on www.laaif.lt.

According to the Article 83 of the Commission Regulation No. 1193/2011, information, including the holdings of all accounts, all transactions made, the unique unit identification code of the allowances and the unique numeric value of the unit serial number of the Kyoto units held or affected by a transaction, held in the EUTL and the Union Registry shall be considered confidential except as otherwise required by Union law, or by provisions of national law that pursue a legitimate objective compatible with this Regulation and are proportionate.

12.5 Updating Commitment period reserve (CPR)

Each Party included in Annex I shall maintain, in its national registry, a commitment period reserve which should not drop below 90 per cent of the Party's assigned amount calculated pursuant to Article 3, paragraphs 7 and 8, of the Kyoto Protocol, or 100 per cent of five times the most recently reviewed inventory, whichever is lowest.

In the case of the Lithuania, the relevant size of the Commitment Period Reserve is five times the most recent inventory (2011), which is calculated below:

$$5 \times 21{,}611{,}695{,}29 = 108{,}058{,}476 \text{ tonnes } CO_2 \text{ eq.}$$

13 INFORMATION ON CHANGES IN NATIONAL SYSTEM

In 2012, after number of measures had been implemented to improve and strengthen National GHG inventory system, Lithuania's question of implementation, which was raised in 2010 ARR was fully resolved and by the decision of Kyoto Protocol Compliance Committee of 24th October 2012, Lithuania became eligible to participate in the mechanisms under Article 6, 12 and 17 of the Kyoto Protocol (Enforcement branch of the Compliance Committee, Decision under paragraph 2 of section X concerning reinstatement, 24th October 2012, CC-2011-3-18/Lithuania/EB). Major GHG inventory system improvement measures, which Lithuania undertook in 2012 are listed below:

- Full Implementation of "Action plan to improve LULUCF reporting" which was developed aiming to improve existing legal, institutional and administrative arrangements in order to improve identification of the land areas subject to the activities under Article 3, paragraph 3, of the Kyoto Protocol (implementation of 2 studies, approval and amendments of several legal acts, in order to improve legislative basis to ensure mandatory registration of areas specific to the activities under Article 3.3 and 3.4 of the Kyoto Protocol, etc.).
- A number of studies to improve GHG inventory estimates were implemented in 2012:
  - National emission factors for energy sector development study.
  - Study to determine the quantity of fluorinated gases (HFCs, PFCs and SF_6) use in Lithuania, development of the methods for emissions calculations and recommendations to improve F-gases data collection system.
  - Study on research and evaluation of methane producing capacity in the Lithuanian manure management systems.
  - Study on research and analyses of methane emissions from wastewater and sludge.

  The results of all of these studies are already incorporated in this NIR submission.
- In 2013 Lithuania was selected as one of the ten countries to participate in EU support project "Assistance to MS with KP reporting". This project is a valuable help to MS enabling to improve their reporting of GHG inventory. The support is provided by experience exchange between Lithuanian sectorial and project experts. Some outcomes of the support project are already reflected in this submission, mainly in cross-cutting issues. Other improvements will be generalized and provided in the next submission.

14 INFORMATION ON CHANGES IN THE NATIONAL GREENHOUSE GAS REGISTRY

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of EU has undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

(1) Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;

(2) Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;

(3) Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;

(4) Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;

(5) The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;

(6) The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;

(7) All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:

    (a) With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);

    (b) The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;

(c) With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;

(d) The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;

(e) In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

The following changes to the national registry of Lithuania have therefore occurred in 2012, as a consequence of the transition to the CSEUR platform:

Reporting Item	**Description**
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	No changes occurred in 2012.

Reporting Item	**Description**
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	The EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went to production on 20 June 2012. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. This description includes: • **Readiness questionnaire** • **Application logging** **Change management procedure** **Disaster recovery** • **Manual Intervention** • **Operational Plan** • **Roles and responsibilities** • **Security Plan** • **Time Validation Plan** • **Version change Management** The documents above are provided as an appendix to this document. A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as 2nd level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk with regards notably to connectivity or reconciliation issues.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	In 2012, the EU registry has undergone a major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU registries (CSEUR). The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and lead to **successful certification on 1 June 2012.**
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	The overall change to a Consolidated System of EU Registries triggered changes the registry software and required new conformance testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and lead to successful certification on 1 June 2012.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated **manual intervention** document and **the operational plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission..

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated **security plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	Information about the representatives of currently open accounts is only accessible if the representatives have chosen so, otherwise this information is not publicly available any more. Information about the total quantity of ERUs, CERs, AAUs and RMUs in each account at the beginning of the year is considered confidential and therefore is not publicly available.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	The new internet address of the Lithuanian registry is: https://ets-registry.webgate.ec.europa.eu/euregistry/LT/index.xhtml
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated **disaster recovery plan.** The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	On 2 October 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into Production. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted.
The previous Annual Review recommendations	The only recommendation by the assessor was related to the reporting of discrepancies. The R-2 table is submitted as a part of this NIR.

Please note that the documents submitted that are marked as **"ETS Limited"** are not public, they cannot be transmitted in clear and **cannot be made publicly available**.

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

Lithuania continues to finance the projects to minimize the adverse social, environmental and economic impacts of the developing countries. It continued to provide financing under the Fast Start Financing. During the period of 2010-2012, Lithuania contributed to the financing of developing countries both providing finance to mitigation and adaptation projects. Overall contribution from Lithuania to fast start financing was around 64 000 USD. In addition to the contribution of 26 711, 44 USD to the Energy Sector Management Assistance Programme (ESMAP) through the World Bank in 2010, Lithuania continued to provide financing to this fund, additionally contributing the amount of 30 000 USD and further amount of 100 000 LTL, respectively for the year 2011 and 2012.

In 2012 Lithuania has adopted the Strategy for National Climate Change Management Policy by 2050. Currently the draft Action Plan on the Implementation of the Goals and Objectives of the Strategy of National Climate Change Management Policy for the Period 2013-2020 is under preparation and will be approved by the Government. Under these policy documents contributions are outlined for the assistance to the developing countries by the year 2020.

Lithuania is currently planning to increase its bilateral project assistance through ODA and additional contributions from its Climate Change Special Programme fund. It has further envisaged to increase its financing to developing countries from 2013.

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ANNEX I. Tier 1 and Tier 2 key source category analysis

Tier 1 key category Level analysis excluding LULUCF: 1990

Key Category	GHG emissions, Gg CO_2 eq.	Level assessment	Cumulative total
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	6021,25	0,12	12%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	5806,05	0,12	24%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	3500,89	0,07	32%
4.A. Enteric Fermentation, cattle, CH_4	3125,88	0,06	38%
1.AA.3.B Road transportation gasoline, CO_2	3053,06	0,06	44%
1.AA.4.A Commercial/Institutional, CO_2	2827,06	0,06	50%
1.AA.4.B Residential, CO_2	2277,12	0,05	55%
1.AA.3.B Road transportation diesel, CO_2	2133,90	0,04	59%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	2048,76	0,04	63%
4.D.3. Indirect Emissions, N_2O	1889,35	0,04	67%
1.AA.3.E Off-road vehicles and machinery, CO_2	1765,35	0,04	71%
2.A.1. Cement Production, CO_2	1668,07	0,03	74%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1496,04	0,03	77%
4.D.1.1. Direct Soil Emissions synthetic N fertilizer, N_2O	1341,59	0,03	80%
2.B.1. Ammonia Production, CO_2	1291,50	0,03	83%
2.B.2. Nitric Acid Production, N_2O	928,99	0,02	85%
4.B. Manure Management, N_2O	885,94	0,02	86%
6.A. Solid Waste Disposal on Land, CH_4	864,23	0,02	88%
4.B. Manure Management swine, CH_4	636,36	0,01	90%
4.D.1.5. Direct Soil Emissions Cultivation of histosols, N_2O	600,99	0,01	91%
4.D.2. Pasture, Range and Paddock Manure, N_2O	493,81	0,01	92%
4.D.1.2. Direct Soil Emissions manure fertilizers, N_2O	493,43	0,01	93%
4.B. Manure Management, cattle, CH_4	424,59	0,01	94%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	409,63	0,01	95%
1.AA.3.C Railways, CO_2	349,97	0,01	95%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	228,06	0,00	96%
2.A.2. Lime Production, CO_2	217,80	0,00	96%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	189,41	0,00	97%
1.AA.1 Energy industries solid fuel, CO_2	185,11	0,00	97%
6.B. Waste-water Handling, CH_4	173,86	0,00	97%
1.B. Fugitive Emissions from Fuels, CH_4	149,32	0,00	98%
4.D.1.4. Direct Soil Emissions Crop residues, N_2O	144,13	0,00	98%
4.D.1.3. Direct Soil Emissions N-fixing crops, N_2O	121,71	0,00	98%
4.A. Enteric Fermentation others, CH_4	100,67	0,00	98%
3. Solvent and Other Product Use, CO_2	100,42	0,00	99%
3. Solvent and Other Product Use, N_2O	97,11	0,00	99%
1.AA.3.E Natural gas transportation in pipelines, CO_2	88,08	0,00	99%
6.B. Waste-water Handling, N_2O	79,91	0,00	99%
1.AA.4 Other sectors, biomass, CH_4	68,58	0,00	99%
1.AA.3.B Road transportation LPG, CO_2	60,19	0,00	99%

1.AA.3 Transport, N_2O	46,01	0,00	99%
1.AA.3 Transport, CH_4	38,73	0,00	100%
4.B. Manure Management other, CH_4	32,81	0,00	100%
1.AA.4 Other sectors, N_2O	30,39	0,00	100%
1.AA.1 Energy industries, N_2O	23,32	0,00	100%
2.C.1.2 Pig iron, CO_2	21,41	0,00	100%
1.AA.3.D Navigation, CO_2	15,49	0,00	100%
2.A.7 Glass Production, CO_2	11,70	0,00	100%
1.AA.2 Manufacturing and construction, N_2O	11,03	0,00	100%
2D2 Food and drink, CO_2	9,32	0,00	100%
1.AA.3.A Civil aviation, CO_2	9,02	0,00	100%
1.AA.1 Energy industries, CH_4	8,87	0,00	100%
1.AA.2 Manufacturing and construction, CH_4	6,49	0,00	100%
2.A.7 Mineral wool production, CO_2	6,28	0,00	100%
2.A.4. Soda Ash Production and Use, CO_2	5,32	0,00	100%
2.A.3. Limestone and Dolomite Use, CO_2	4,48	0,00	100%
6.C. Waste Incineration, CO_2	4,33	0,00	100%
2.B.5.5 Methanol, CH_4	3,83	0,00	100%
2F1 Refrigeration and Air Conditioning Equipment, HFCs	1,98	0,00	100%
1.B. Fugitive Emissions from Fuels, CO_2	1,03	0,00	100%
4.D.1.5. Direct Soil Emissions Other, N_2O	0,83	0,00	100%
2F4 Aerosols/Metered dose inhalers, HFCs	0,77	0,00	100%
6.C. Waste Incineration, N_2O	0,19	0,00	100%
2F8 Electrical equipment, SF_6	0,05	0,00	100%
2.A.5. Asphalt Roofing, CO_2	0,02	0,00	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,00	0,00	100%
1.AA.5 Other, CH_4		0,00	100%
1.AA.5 Other, CO_2		0,00	100%
1.AA.5 Other, N_2O		0,00	100%
2F2 Foam blowing, HFCs		0,00	100%
2F3 Fire extinguishers, HFCs		0,00	100%
2F7 Semiconductor manufacture, SF_6		0,00	100%
2F9 Other, SF_6		0,00	100%

Tier 1 key category Level analysis including LULUCF: 1990

Key Category	GHG emissions, Gg CO_2 eq.	Level assessment	Cumulative total
5.A.1. Forest Land remaining Forest Land, CO_2	6794,60	0,11	11%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	6021,25	0,09	20%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	5806,05	0,09	29%
5.B. Cropland, CO_2	5772,10	0,09	38%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	3500,89	0,05	43%
4.A. Enteric Fermentation, cattle, CH_4	3125,88	0,05	48%
1.AA.3.B Road transportation gasoline, CO_2	3053,06	0,05	53%
1.AA.4.A Commercial/Institutional, CO_2	2827,06	0,04	57%
5.C. Grassland, CO_2	2362,36	0,04	61%
1.AA.4.B Residential, CO_2	2277,12	0,04	64%
1.AA.3.B Road transportation diesel, CO_2	2133,90	0,03	68%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	2048,76	0,03	71%
4.D.3. Indirect Emissions, N_2O	1889,35	0,03	74%
1.AA.3.E Off-road vehicles and machinery, CO_2	1765,35	0,03	76%
2.A.1. Cement Production, CO_2	1668,07	0,03	79%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1496,04	0,02	81%
4.D.1.1. Direct Soil Emissions synthetic N fertilizer, N_2O	1341,59	0,02	83%
2.B.1. Ammonia Production, CO_2	1291,50	0,02	85%
5.A.2. Land converted to Forest Land, CO_2	1024,87	0,02	87%
2.B.2. Nitric Acid Production, N_2O	928,99	0,01	88%
4.B. Manure Management, N_2O	885,94	0,01	90%
6.A. Solid Waste Disposal on Land, CH_4	864,23	0,01	91%
4.B. Manure Management swine, CH_4	636,36	0,01	92%
4.D.1.5. Direct Soil Emissions Cultivation of histosols, N_2O	600,99	0,01	93%
4.D.2. Pasture, Range and Paddock Manure, N_2O	493,81	0,01	94%
4.D.1.2. Direct Soil Emissions manure fertilizers, N_2O	493,43	0,01	94%
4.B. Manure Management, cattle, CH_4	424,59	0,01	95%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	409,63	0,01	96%
1.AA.3.C Railways, CO_2	349,97	0,01	96%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	228,06	0,00	97%
2.A.2. Lime Production, CO_2	217,80	0,00	97%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	189,41	0,00	97%
1.AA.1 Energy industries solid fuel, CO_2	185,11	0,00	98%
6.B. Waste-water Handling, CH_4	173,86	0,00	98%
1.B. Fugitive Emissions from Fuels, CH_4	149,32	0,00	98%
4.D.1.4. Direct Soil Emissions Crop residues, N_2O	144,13	0,00	98%
4.D.1.3. Direct Soil Emissions N-fixing crops, N_2O	121,71	0,00	98%
4.A. Enteric Fermentation others, CH_4	100,67	0,00	99%
3. Solvent and Other Product Use, CO_2	100,42	0,00	99%
3. Solvent and Other Product Use, N_2O	97,11	0,00	99%
1.AA.3.E Natural gas transportation in pipelines, CO_2	88,08	0,00	99%
6.B. Waste-water Handling, N_2O	79,91	0,00	99%

5.D. Wetlands, CO_2	72,73	0,00	99%
1.AA.4 Other sectors, biomass, CH_4	68,58	0,00	99%
1.AA.3.B Road transportation LPG, CO_2	60,19	0,00	99%
1.AA.3 Transport, N_2O	46,01	0,00	100%
1.AA.3 Transport, CH_4	38,73	0,00	100%
4.B. Manure Management other, CH_4	32,81	0,00	100%
1.AA.4 Other sectors, N_2O	30,39	0,00	100%
1.AA.1 Energy industries, N_2O	23,32	0,00	100%
5.A.1. Forest Land remaining Forest Land, N_2O	22,07	0,00	100%
2.C.1.2 Pig iron, CO_2	21,41	0,00	100%
1.AA.3.D Navigation, CO_2	15,49	0,00	100%
2.A.7 Glass Production, CO_2	11,70	0,00	100%
1.AA.2 Manufacturing and construction, N_2O	11,03	0,00	100%
2D2 Food and drink, CO_2	9,32	0,00	100%
1.AA.3.A Civil aviation, CO_2	9,02	0,00	100%
1.AA.1 Energy industries, CH_4	8,87	0,00	100%
5.B. Cropland, N_2O	7,84	0,00	100%
1.AA.2 Manufacturing and construction, CH_4	6,49	0,00	100%
2.A.7 Mineral wool production, CO_2	6,28	0,00	100%
2.A.4. Soda Ash Production and Use, CO_2	5,32	0,00	100%
2.A.3. Limestone and Dolomite Use, CO_2	4,48	0,00	100%
6.C. Waste Incineration, CO_2	4,33	0,00	100%
2.B.5.5 Methanol, CH_4	3,83	0,00	100%
5.C. Grassland, N_2O	2,40	0,00	100%
2F1 Refrigeration and Air Conditioning Equipment, HFCs	1,98	0,00	100%
5.C. Grassland, CH_4	1,78	0,00	100%
1.B. Fugitive Emissions from Fuels, CO_2	1,03	0,00	100%
4.D.1.5. Direct Soil Emissions Other, N_2O	0,83	0,00	100%
2F4 Aerosols/Metered dose inhalers, HFCs	0,77	0,00	100%
5.A.1. Forest Land remaining Forest Land, CH_4	0,43	0,00	100%
6.C. Waste Incineration, N_2O	0,19	0,00	100%
5.B. Cropland, CH_4	0,07	0,00	100%
2F8 Electrical equipment, SF_6	0,05	0,00	100%
2.A.5. Asphalt Roofing, CO_2	0,02	0,00	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,00	0,00	100%
1.AA.5 Other, CH_4		0,00	100%
1.AA.5 Other, CO_2		0,00	100%
1.AA.5 Other, N_2O		0,00	100%
2F2 Foam blowing, HFCs		0,00	100%
2F3 Fire extinguishers, HFCs		0,00	100%
2F7 Semiconductor manufacture, SF_6		0,00	100%
2F9 Other, SF_6		0,00	100%
5.E Settlements, CO_2		0,00	100%
5.F Other land, CO_2		0,00	100%

Tier 1 key category Level analysis excluding LULUCF: 2011

Key Category	GHG emissions, Gg CO_2 eq.	Level assessment	Cumulative total
1.AA.3.B Road transportation diesel, CO_2	2741,61	0,13	13%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	2651,32	0,12	25%
2.B.1. Ammonia Production, CO_2	2231,08	0,10	35%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1517,80	0,07	42%
4.A. Enteric Fermentation, cattle, CH_4	1137,03	0,05	48%
4.D.3. Indirect Emissions, N_2O	940,32	0,04	52%
2.B.2. Nitric Acid Production, N_2O	885,02	0,04	56%
6.A. Solid Waste Disposal on Land, CH_4	807,75	0,04	60%
4.D.1.1. Direct Soil Emissions synthetic N fertilizer, N_2O	805,61	0,04	64%
1.AA.3.B Road transportation gasoline, CO_2	788,37	0,04	67%
1.AA.4.B Residential, CO_2	733,76	0,03	71%
4.D.1.5. Direct Soil Emissions Cultivation of histosols, N_2O	698,19	0,03	74%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	635,92	0,03	77%
1.AA.3.B Road transportation LPG, CO_2	475,21	0,02	79%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	431,22	0,02	81%
1.AA.4.A Commercial/Institutional, CO_2	389,75	0,02	83%
2.A.1. Cement Production, CO_2	319,84	0,01	84%
4.B. Manure Management, N_2O	268,31	0,01	86%
1.B. Fugitive Emissions from Fuels, CH_4	260,71	0,01	87%
4.B. Manure Management, cattle, CH_4	250,13	0,01	88%
4.B. Manure Management swine, CH_4	216,22	0,01	89%
2F1 Refrigeration and Air Conditioning Equipment, HFCs	204,77	0,01	90%
4.D.2. Pasture, Range and Paddock Manure, N_2O	199,18	0,01	91%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	198,60	0,01	92%
1.AA.3.C Railways, CO_2	193,01	0,01	93%
4.D.1.4. Direct Soil Emissions Crop residues, N_2O	186,67	0,01	94%
4.D.1.2. Direct Soil Emissions manure fertilizers, N_2O	176,03	0,01	94%
1.AA.3.E Off-road vehicles and machinery, CO_2	164,81	0,01	95%
1.AA.4 Other sectors, biomass, CH_4	158,87	0,01	96%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	105,70	0,00	96%
6.B. Waste-water Handling, CH_4	102,04	0,00	97%
3. Solvent and Other Product Use, CO_2	82,29	0,00	97%
6.B. Waste-water Handling, N_2O	73,23	0,00	98%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	67,27	0,00	98%
1.AA.3.E Natural gas transportation in pipelines, CO_2	49,05	0,00	98%
4.A. Enteric Fermentation others, CH_4	48,55	0,00	98%
1.AA.3 Transport, N_2O	39,81	0,00	99%
2.A.2. Lime Production, CO_2	38,52	0,00	99%
1.AA.4 Other sectors, N_2O	34,34	0,00	99%
4.D.1.3. Direct Soil Emissions N-fixing crops, N_2O	32,48	0,00	99%
1.AA.1 Energy industries solid fuel, CO_2	29,20	0,00	99%
4.B. Manure Management other, CH_4	18,94	0,00	99%
1.AA.1 Energy industries, N_2O	18,57	0,00	99%

1.AA.3.D Navigation, CO_2	16,33	0,00	99%
1.AA.5 Other, CO_2	12,79	0,00	99%
1.AA.3 Transport, CH_4	11,65	0,00	100%
2.A.7 Mineral wool production, CO_2	9,12	0,00	100%
1.B. Fugitive Emissions from Fuels, CO_2	9,10	0,00	100%
1.AA.1 Energy industries, CH_4	8,84	0,00	100%
2D2 Food and drink, CO_2	8,82	0,00	100%
6.C. Waste Incineration, CO_2	6,99	0,00	100%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	6,98	0,00	100%
1.AA.2 Manufacturing and construction, N_2O	6,72	0,00	100%
2.A.7 Glass Production, CO_2	6,53	0,00	100%
2F7 Semiconductor manufacture, SF_6	6,21	0,00	100%
2F4 Aerosols/Metered dose inhalers, HFCs	5,96	0,00	100%
2F2 Foam blowing, HFCs	4,39	0,00	100%
1.AA.2 Manufacturing and construction, CH_4	4,33	0,00	100%
2.C.1.2 Pig iron, CO_2	3,72	0,00	100%
3. Solvent and Other Product Use, N_2O	3,66	0,00	100%
4.D.1.5. Direct Soil Emissions Other, N_2O	2,31	0,00	100%
1.AA.3.A Civil aviation, CO_2	1,87	0,00	100%
2F8 Electrical equipment, SF_6	1,61	0,00	100%
2F3 Fire extinguishers, HFCs	1,54	0,00	100%
2.A.4. Soda Ash Production and Use, CO_2	0,47	0,00	100%
6.C. Waste Incineration, N_2O	0,31	0,00	100%
2F9 Other, SF_6	0,29	0,00	100%
2.A.3. Limestone and Dolomite Use, CO_2	0,13	0,00	100%
1.AA.5 Other, N_2O	0,11	0,00	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,03	0,00	100%
2.A.5. Asphalt Roofing, CO_2	0,02	0,00	100%
1.AA.5 Other, CH_4	0,00	0,00	100%
2.B.5.5 Methanol, CH_4		0,00	100%

Tier 1 key category Level analysis including LULUCF: 2011

Key Category	**GHG emissions, Gg CO_2 eq.**	**Level assessment**	**Cumulative total**
5.A.1. Forest Land remaining Forest Land, CO_2	10047,71	0,25	25%
5.B. Cropland, CO_2	3700,05	0,09	35%
5.C. Grassland, CO_2	3138,86	0,08	43%
1.AA.3.B Road transportation diesel, CO_2	2741,61	0,07	50%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	2651,32	0,07	56%
2.B.1. Ammonia Production, CO_2	2231,08	0,06	62%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1517,80	0,04	66%
4.A. Enteric Fermentation, cattle, CH_4	1137,03	0,03	69%
5.A.2. Land converted to Forest Land, CO_2	1096,09	0,03	71%
4.D.3. Indirect Emissions, N_2O	940,32	0,02	74%
2.B.2. Nitric Acid Production, N_2O	885,02	0,02	76%

6.A. Solid Waste Disposal on Land, CH_4	807,75	0,02	78%
4.D.1.1. Direct Soil Emissions synthetic N fertilizer, N_2O	805,61	0,02	80%
1.AA.3.B Road transportation gasoline, CO_2	788,37	0,02	82%
1.AA.4.B Residential, CO_2	733,76	0,02	84%
4.D.1.5. Direct Soil Emissions Cultivation of histosols, N_2O	698,19	0,02	86%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	635,92	0,02	87%
1.AA.3.B Road transportation LPG, CO_2	475,21	0,01	88%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	431,22	0,01	90%
1.AA.4.A Commercial/Institutional, CO_2	389,75	0,01	90%
2.A.1. Cement Production, CO_2	319,84	0,01	91%
4.B. Manure Management, N_2O	268,31	0,01	92%
1.B. Fugitive Emissions from Fuels, CH_4	260,71	0,01	93%
4.B. Manure Management, cattle, CH_4	250,13	0,01	93%
4.B. Manure Management swine, CH_4	216,22	0,01	94%
2F1 Refrigeration and Air Conditioning Equipment, HFCs	204,77	0,01	94%
4.D.2. Pasture, Range and Paddock Manure, N_2O	199,18	0,01	95%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	198,60	0,01	95%
1.AA.3.C Railways, CO_2	193,01	0,00	96%
4.D.1.4. Direct Soil Emissions Crop residues, N_2O	186,67	0,00	96%
4.D.1.2. Direct Soil Emissions manure fertilizers, N_2O	176,03	0,00	97%
1.AA.3.E Off-road vehicles and machinery, CO_2	164,81	0,00	97%
1.AA.4 Other sectors, biomass, CH_4	158,87	0,00	98%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	105,70	0,00	98%
6.B. Waste-water Handling, CH_4	102,04	0,00	98%
3. Solvent and Other Product Use, CO_2	82,29	0,00	98%
6.B. Waste-water Handling, N_2O	73,23	0,00	98%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	67,27	0,00	99%
5.D. Wetlands, CO_2	55,57	0,00	99%
1.AA.3.E Natural gas transportation in pipelines, CO_2	49,05	0,00	99%
4.A. Enteric Fermentation others, CH_4	48,55	0,00	99%
1.AA.3 Transport, N_2O	39,81	0,00	99%
2.A.2. Lime Production, CO_2	38,52	0,00	99%
1.AA.4 Other sectors, N_2O	34,34	0,00	99%
4.D.1.3. Direct Soil Emissions N-fixing crops, N_2O	32,48	0,00	99%
1.AA.1 Energy industries solid fuel, CO_2	29,20	0,00	99%
5.A.1. Forest Land remaining Forest Land, N_2O	23,36	0,00	100%
4.B. Manure Management other, CH_4	18,94	0,00	100%
1.AA.1 Energy industries, N_2O	18,57	0,00	100%
1.AA.3.D Navigation, CO_2	16,33	0,00	100%
1.AA.5 Other, CO_2	12,79	0,00	100%
1.AA.3 Transport, CH_4	11,65	0,00	100%
2.A.7 Mineral wool production, CO_2	9,12	0,00	100%
1.B. Fugitive Emissions from Fuels, CO_2	9,10	0,00	100%
1.AA.1 Energy industries, CH_4	8,84	0,00	100%
2D2 Food and drink, CO_2	8,82	0,00	100%
6.C. Waste Incineration, CO_2	6,99	0,00	100%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	6,98	0,00	100%

1.AA.2 Manufacturing and construction, N_2O	6,72	0,00	100%
2.A.7 Glass Production, CO_2	6,53	0,00	100%
2F7 Semiconductor manufacture, SF_6	6,21	0,00	100%
2F4 Aerosols/Metered dose inhalers, HFCs	5,96	0,00	100%
5.B. Cropland, N_2O	4,90	0,00	100%
2F2 Foam blowing, HFCs	4,39	0,00	100%
1.AA.2 Manufacturing and construction, CH_4	4,33	0,00	100%
2.C.1.2 Pig iron, CO_2	3,72	0,00	100%
3. Solvent and Other Product Use, N_2O	3,66	0,00	100%
4.D.1.5. Direct Soil Emissions Other, N_2O	2,31	0,00	100%
1.AA.3.A Civil aviation, CO_2	1,87	0,00	100%
2F8 Electrical equipment, SF_6	1,61	0,00	100%
2F3 Fire extinguishers, HFCs	1,54	0,00	100%
5.C. Grassland, N_2O	1,25	0,00	100%
5.A.1. Forest Land remaining Forest Land, CH_4	0,93	0,00	100%
5.C. Grassland, CH_4	0,93	0,00	100%
2.A.4. Soda Ash Production and Use, CO_2	0,47	0,00	100%
6.C. Waste Incineration, N_2O	0,31	0,00	100%
2F9 Other, SF_6	0,29	0,00	100%
2.A.3. Limestone and Dolomite Use, CO_2	0,13	0,00	100%
1.AA.5 Other, N_2O	0,11	0,00	100%
5.B. Cropland, CH_4	0,04	0,00	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,03	0,00	100%
2.A.5. Asphalt Roofing, CO_2	0,02	0,00	100%
1.AA.5 Other, CH_4	0,00	0,00	100%
2.B.5.5 Methanol, CH_4		0,00	100%
5.E Settlements, CO_2		0,00	100%
5.F Other land, CO_2		0,00	100%

Tier 1 key category trend assessment excluding LULUCF: 1990 – 2011

Key Category	1990 Gg CO_2 eq.	2011 Gg CO_2 eq.	Level assessment 2011	Trend assessment	% contribution to assessment	Cumulative total
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	6021,25	198,60	0,01	0,26	0,16	16%
1.AA.3.B Road transportation diesel, CO_2	2133,90	2741,61	0,13	0,19	0,11	27%
2.B.1. Ammonia Production, CO_2	1291,50	2231,08	0,10	0,17	0,11	38%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	3500,89	67,27	0,00	0,16	0,09	47%
1.AA.4.A Commercial/Institutional, CO_2	2827,06	389,75	0,02	0,09	0,06	53%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1496,04	1517,80	0,07	0,09	0,05	58%
1.AA.3.E Off-road vehicles and machinery, CO_2	1765,35	164,81	0,01	0,06	0,04	62%
1.AA.3.B Road transportation gasoline, CO_2	3053,06	788,37	0,04	0,06	0,04	66%
2.B.2. Nitric Acid Production, N_2O	928,99	885,02	0,04	0,05	0,03	69%
1.AA.3.B Road transportation LPG, CO_2	60,19	475,21	0,02	0,05	0,03	72%
4.D.1.5. Direct Soil Emissions Cultivation of histosols, N_2O	600,99	698,19	0,03	0,05	0,03	75%
6.A. Solid Waste Disposal on Land, CH_4	864,23	807,75	0,04	0,04	0,03	77%
2.A.1. Cement Production, CO_2	1668,07	319,84	0,01	0,04	0,03	80%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	189,41	431,22	0,02	0,04	0,02	82%
1.AA.4.B Residential, CO_2	2277,12	733,76	0,03	0,03	0,02	84%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	2048,76	635,92	0,03	0,03	0,02	86%
4.A. Enteric Fermentation, cattle, CH_4	3125,88	1137,03	0,05	0,03	0,02	87%
4.D.1.1. Direct Soil Emissions synthetic N fertilizer, N_2O	1341,59	805,61	0,04	0,02	0,01	89%
2F1 Refrigeration and Air Conditioning Equipment, HFCs	1,98	204,77	0,01	0,02	0,01	90%
1.B. Fugitive Emissions from Fuels, CH_4	149,32	260,71	0,01	0,02	0,01	91%
1.AA.4 Other sectors, biomass, CH_4	68,58	158,87	0,01	0,01	0,01	92%
4.B. Manure Management, N_2O	885,94	268,31	0,01	0,01	0,01	93%
4.D.1.4. Direct Soil Emissions Crop residues, N_2O	144,13	186,67	0,01	0,01	0,01	94%
4.D.3. Indirect Emissions, N_2O	1889,35	940,32	0,04	0,01	0,01	94%

2.A.7 Bricks and Tiles (decarbonizing), CO_2	228,06	6,98	0,00	0,01	0,01	95%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	5806,05	2651,32	0,12	0,01	0,01	95%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	409,63	105,70	0,00	0,01	0,00	96%
4.B. Manure Management swine, CH_4	636,36	216,22	0,01	0,01	0,00	96%
4.B. Manure Management, cattle, CH_4	424,59	250,13	0,01	0,01	0,00	97%
2.A.2. Lime Production, CO_2	217,80	38,52	0,00	0,01	0,00	97%
1.AA.1 Energy industries solid fuel, CO_2	185,11	29,20	0,00	0,01	0,00	97%
4.D.1.2. Direct Soil Emissions manure fertilizers, N_2O	493,43	176,03	0,01	0,00	0,00	98%
3. Solvent and Other Product Use, N_2O	97,11	3,66	0,00	0,00	0,00	98%
1.AA.3.C Railways, CO_2	349,97	193,01	0,01	0,00	0,00	98%
6.B. Waste-water Handling, N_2O	79,91	73,23	0,00	0,00	0,00	98%
3. Solvent and Other Product Use, CO_2	100,42	82,29	0,00	0,00	0,00	99%
6.B. Waste-water Handling, CH_4	173,86	102,04	0,00	0,00	0,00	99%
4.D.1.3. Direct Soil Emissions N-fixing crops, N_2O	121,71	32,48	0,00	0,00	0,00	99%
1.AA.4 Other sectors, N_2O	30,39	34,34	0,00	0,00	0,00	99%
4.D.2. Pasture, Range and Paddock Manure, N_2O	493,81	199,18	0,01	0,00	0,00	99%
1.AA.3 Transport, N_2O	46,01	39,81	0,00	0,00	0,00	99%
1.AA.5 Other, CO_2		12,79	0,00	0,00	0,00	99%
1.AA.3.E Natural gas transportation in pipelines, CO_2	88,08	49,05	0,00	0,00	0,00	99%
1.AA.3.D Navigation, CO_2	15,49	16,33	0,00	0,00	0,00	99%
1.B. Fugitive Emissions from Fuels, CO_2	1,03	9,10	0,00	0,00	0,00	99%
1.AA.1 Energy industries, N_2O	23,32	18,57	0,00	0,00	0,00	100%
2.A.7 Mineral wool production, CO_2	6,28	9,12	0,00	0,00	0,00	100%
2F7 Semiconductor manufacture, SF_6		6,21	0,00	0,00	0,00	100%
2.C.1.2 Pig iron, CO_2	21,41	3,72	0,00	0,00	0,00	100%
2F4 Aerosols/Metered dose inhalers, HFCs	0,77	5,96	0,00	0,00	0,00	100%
1.AA.3 Transport, CH_4	38,73	11,65	0,00	0,00	0,00	100%
6.C. Waste Incineration, CO_2	4,33	6,99	0,00	0,00	0,00	100%
1.AA.1 Energy industries, CH_4	8,87	8,84	0,00	0,00	0,00	100%
2D2 Food and drink, CO_2	9,32	8,82	0,00	0,00	0,00	100%

4.B. Manure Management other, CH_4	32,81	18,94	0,00	0,00	0,00	100%
2F2 Foam blowing, HFCs		4,39	0,00	0,00	0,00	100%
4.A. Enteric Fermentation others, CH_4	100,67	48,55	0,00	0,00	0,00	100%
1.AA.3.A Civil aviation, CO_2	9,02	1,87	0,00	0,00	0,00	100%
4.D.1.5. Direct Soil Emissions Other, N_2O	0,83	2,31	0,00	0,00	0,00	100%
2.A.4. Soda Ash Production and Use, CO_2	5,32	0,47	0,00	0,00	0,00	100%
2.A.3. Limestone and Dolomite Use, CO_2	4,48	0,13	0,00	0,00	0,00	100%
1.AA.2 Manufacturing and construction, N_2O	11,03	6,72	0,00	0,00	0,00	100%
2F8 Electrical equipment, SF_6	0,05	1,61	0,00	0,00	0,00	100%
2F3 Fire extinguishers, HFCs		1,54	0,00	0,00	0,00	100%
1.AA.2 Manufacturing and construction, CH_4	6,49	4,33	0,00	0,00	0,00	100%
2.A.7 Glass Production, CO_2	11,70	6,53	0,00	0,00	0,00	100%
2F9 Other, SF_6		0,29	0,00	0,00	0,00	100%
6.C. Waste Incineration, N_2O	0,19	0,31	0,00	0,00	0,00	100%
1.AA.5 Other, N_2O		0,11	0,00	0,00	0,00	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,00	0,03	0,00	0,00	0,00	100%
2.A.5. Asphalt Roofing, CO_2	0,02	0,02	0,00	0,00	0,00	100%
1.AA.5 Other, CH_4		0,00	0,00	0,00	0,00	100%
2.B.5.5 Methanol, CH_4	3,83		0,00	0,00	0,00	100%

Tier 1 key category trend assessment including LULUCF: 1990 – 2011

Key Category	1990 Gg CO_2 eq.	2011 Gg CO_2 eq.	Level assessment 2011	Trend assessment	% contribution to assessment	Cumulative total
5.A.1. Forest Land remaining Forest Land, CO_2	6794,60	10047,71	0,25	0,24	0,21	21%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	6021,25	198,60	0,01	0,14	0,12	33%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	3500,89	67,27	0,00	0,09	0,07	41%
5.C. Grassland, CO_2	2362,36	3138,86	0,08	0,07	0,06	47%
2.B.1. Ammonia Production, CO_2	1291,50	2231,08	0,06	0,06	0,05	52%
1.AA.3.B Road transportation diesel, CO_2	2133,90	2741,61	0,07	0,06	0,05	57%
1.AA.4.A Commercial/Institutional, CO_2	2827,06	389,75	0,01	0,06	0,05	61%
1.AA.3.B Road transportation gasoline, CO_2	3053,06	788,37	0,02	0,04	0,04	65%
1.AA.3.E Off-road vehicles and machinery, CO_2	1765,35	164,81	0,00	0,04	0,03	69%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	5806,05	2651,32	0,07	0,04	0,03	72%
4.A. Enteric Fermentation, cattle, CH_4	3125,88	1137,03	0,03	0,03	0,03	75%
2.A.1. Cement Production, CO_2	1668,07	319,84	0,01	0,03	0,02	77%
1.AA.4.B Residential, CO_2	2277,12	733,76	0,02	0,03	0,02	79%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	2048,76	635,92	0,02	0,03	0,02	82%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1496,04	1517,80	0,04	0,02	0,02	84%
5.A.2. Land converted to Forest Land, CO_2	1024,87	1096,09	0,03	0,02	0,02	85%
1.AA.3.B Road transportation LPG, CO_2	60,19	475,21	0,01	0,02	0,02	87%
4.D.1.5. Direct Soil Emissions Cultivation of histosols, N_2O	600,99	698,19	0,02	0,01	0,01	88%
2.B.2. Nitric Acid Production, N_2O	928,99	885,02	0,02	0,01	0,01	89%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	189,41	431,22	0,01	0,01	0,01	90%
6.A. Solid Waste Disposal on Land, CH_4	864,23	807,75	0,02	0,01	0,01	91%
4.B. Manure Management, N_2O	885,94	268,31	0,01	0,01	0,01	92%
4.D.3. Indirect Emissions, N_2O	1889,35	940,32	0,02	0,01	0,01	93%
2F1 Refrigeration and Air Conditioning Equipment, HFCs	1,98	204,77	0,01	0,01	0,01	94%

4.B. Manure Management swine, CH_4	636,36	216,22	0,01	0,01	0,01	94%
1.B. Fugitive Emissions from Fuels, CH_4	149,32	260,71	0,01	0,01	0,01	95%
5.B. Cropland, CO_2	5772,10	3700,05	0,09	0,01	0,01	96%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	409,63	105,70	0,00	0,01	0,01	96%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	228,06	6,98	0,00	0,01	0,00	96%
4.D.1.2. Direct Soil Emissions manure fertilizers, N_2O	493,43	176,03	0,00	0,01	0,00	97%
1.AA.4 Other sectors, biomass, CH_4	68,58	158,87	0,00	0,00	0,00	97%
4.D.2. Pasture, Range and Paddock Manure, N_2O	493,81	199,18	0,01	0,00	0,00	98%
4.D.1.4. Direct Soil Emissions Crop residues, N_2O	144,13	186,67	0,00	0,00	0,00	98%
2.A.2. Lime Production, CO_2	217,80	38,52	0,00	0,00	0,00	98%
1.AA.1 Energy industries solid fuel, CO_2	185,11	29,20	0,00	0,00	0,00	99%
3. Solvent and Other Product Use, N_2O	97,11	3,66	0,00	0,00	0,00	99%
4.D.1.3. Direct Soil Emissions N-fixing crops, N_2O	121,71	32,48	0,00	0,00	0,00	99%
6.B. Waste-water Handling, N_2O	79,91	73,23	0,00	0,00	0,00	99%
1.AA.3.C Railways, CO_2	349,97	193,01	0,00	0,00	0,00	99%
3. Solvent and Other Product Use, CO_2	100,42	82,29	0,00	0,00	0,00	99%
4.D.1.1. Direct Soil Emissions synthetic N fertilizer, N_2O	1341,59	805,61	0,02	0,00	0,00	99%
1.AA.4 Other sectors, N_2O	30,39	34,34	0,00	0,00	0,00	99%
4.A. Enteric Fermentation others, CH_4	100,67	48,55	0,00	0,00	0,00	99%
1.AA.5 Other, CO_2		12,79	0,00	0,00	0,00	99%
1.AA.3 Transport, CH_4	38,73	11,65	0,00	0,00	0,00	100%
1.AA.3 Transport, N_2O	46,01	39,81	0,00	0,00	0,00	100%
5.D. Wetlands, CO_2	72,73	55,57	0,00	0,00	0,00	100%
4.B. Manure Management, cattle, CH_4	424,59	250,13	0,01	0,00	0,00	100%
5.A.1. Forest Land remaining Forest Land, N_2O	22,07	23,36	0,00	0,00	0,00	100%
2.C.1.2 Pig iron, CO_2	21,41	3,72	0,00	0,00	0,00	100%
1.B. Fugitive Emissions from Fuels, CO_2	1,03	9,10	0,00	0,00	0,00	100%
1.AA.3.D Navigation, CO_2	15,49	16,33	0,00	0,00	0,00	100%
2F7 Semiconductor manufacture, SF_6		6,21	0,00	0,00	0,00	100%
2F4 Aerosols/Metered dose inhalers, HFCs	0,77	5,96	0,00	0,00	0,00	100%

2.A.7 Mineral wool production, CO_2	6,28	9,12	0,00	0,00	0,00	100%
1.AA.3.E Natural gas transportation in pipelines, CO_2	88,08	49,05	0,00	0,00	0,00	100%
6.B. Waste-water Handling, CH_4	173,86	102,04	0,00	0,00	0,00	100%
2F2 Foam blowing, HFCs		4,39	0,00	0,00	0,00	100%
6.C. Waste Incineration, CO_2	4,33	6,99	0,00	0,00	0,00	100%
1.AA.1 Energy industries, N_2O	23,32	18,57	0,00	0,00	0,00	100%
1.AA.3.A Civil aviation, CO_2	9,02	1,87	0,00	0,00	0,00	100%
1.AA.1 Energy industries, CH_4	8,87	8,84	0,00	0,00	0,00	100%
2D2 Food and drink, CO_2	9,32	8,82	0,00	0,00	0,00	100%
2.A.4. Soda Ash Production and Use, CO_2	5,32	0,47	0,00	0,00	0,00	100%
2.A.3. Limestone and Dolomite Use, CO_2	4,48	0,13	0,00	0,00	0,00	100%
4.D.1.5. Direct Soil Emissions Other, N_2O	0,83	2,31	0,00	0,00	0,00	100%
2F8 Electrical equipment, SF_6	0,05	1,61	0,00	0,00	0,00	100%
2F3 Fire extinguishers, HFCs		1,54	0,00	0,00	0,00	100%
4.B. Manure Management other, CH_4	32,81	18,94	0,00	0,00	0,00	100%
5.A.1. Forest Land remaining Forest Land, CH_4	0,43	0,93	0,00	0,00	0,00	100%
2.A.7 Glass Production, CO_2	11,70	6,53	0,00	0,00	0,00	100%
1.AA.2 Manufacturing and construction, CH_4	6,49	4,33	0,00	0,00	0,00	100%
2F9 Other, SF_6		0,29	0,00	0,00	0,00	100%
5.C. Grassland, N_2O	2,40	1,25	0,00	0,00	0,00	100%
6.C. Waste Incineration, N_2O	0,19	0,31	0,00	0,00	0,00	100%
5.C. Grassland, CH_4	1,78	0,93	0,00	0,00	0,00	100%
1.AA.5 Other, N_2O		0,11	0,00	0,00	0,00	100%
5.B. Cropland, N_2O	7,84	4,90	0,00	0,00	0,00	100%
1.AA.2 Manufacturing and construction, N_2O	11,03	6,72	0,00	0,00	0,00	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,00	0,03	0,00	0,00	0,00	100%
5.B. Cropland, CH_4	0,07	0,04	0,00	0,00	0,00	100%
1.AA.5 Other, CH_4		0,00	0,00	0,00	0,00	100%
2.A.5. Asphalt Roofing, CO_2	0,02	0,02	0,00	0,00	0,00	100%
2.B.5.5 Methanol, CH_4	3,83		0,00	0,00	0,00	100%

5.E Settlements, CO_2			0,00	0,00	0,00	100%
5.F Other land, CO_2			0,00	0,00	0,00	100%

Tier 2 key category Level analysis excluding LULUCF: 1990

Key Category	GHG emissions, Gg CO_2 eq.	Level assessment with uncertainty	Cumulative total
4.D.3. Indirect Emissions, N_2O	1889,35	0,04	4%
4.D.1.1. Direct Soil Emissions synthetic N fertilizer, N_2O	1341,59	0,03	7%
6.A. Solid Waste Disposal on Land, CH_4	864,23	0,02	8%
4.A. Enteric Fermentation, cattle, CH_4	3125,88	0,06	15%
4.D.1.5. Direct Soil Emissions Cultivation of histosols, N_2O	600,99	0,01	16%
4.B. Manure Management, N_2O	885,94	0,02	18%
4.D.2. Pasture, Range and Paddock Manure, N_2O	493,81	0,01	19%
4.D.1.2. Direct Soil Emissions manure fertilizers, N_2O	493,43	0,01	20%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	3500,89	0,07	27%
1.AA.4.A Commercial/Institutional, CO_2	2827,06	0,06	33%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	6021,25	0,12	45%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	5806,05	0,12	57%
4.B. Manure Management swine, CH_4	636,36	0,01	59%
1.AA.4.B Residential, CO_2	2277,12	0,05	63%
1.AA.3.E Off-road vehicles and machinery, CO_2	1765,35	0,04	67%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	2048,76	0,04	71%
4.D.1.4. Direct Soil Emissions Crop residues, N_2O	144,13	0,00	71%
6.B. Waste-water Handling, CH_4	173,86	0,00	72%
4.D.1.3. Direct Soil Emissions N-fixing crops, N_2O	121,71	0,00	72%
4.B. Manure Management, cattle, CH_4	424,59	0,01	73%
2.B.2. Nitric Acid Production, N_2O	928,99	0,02	75%
2.A.1. Cement Production, CO_2	1668,07	0,03	78%
1.AA.3.B Road transportation gasoline, CO_2	3053,06	0,06	84%
1.B. Fugitive Emissions from Fuels, CH_4	149,32	0,00	85%
1.AA.3.B Road transportation diesel, CO_2	2133,90	0,04	89%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1496,04	0,03	92%
6.B. Waste-water Handling, N_2O	79,91	0,00	92%
2.B.1. Ammonia Production, CO_2	1291,50	0,03	95%
3. Solvent and Other Product Use, CO_2	100,42	0,00	95%
3. Solvent and Other Product Use, N_2O	97,11	0,00	95%
1.AA.4 Other sectors, biomass, CH_4	68,58	0,00	96%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	409,63	0,01	96%
1.AA.3.C Railways, CO_2	349,97	0,01	97%
1.AA.3 Transport, N_2O	46,01	0,00	97%
4.A. Enteric Fermentation others, CH_4	100,67	0,00	97%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	228,06	0,00	98%
1.AA.3 Transport, CH_4	38,73	0,00	98%
2.A.2. Lime Production, CO_2	217,80	0,00	98%
1.AA.4 Other sectors, N_2O	30,39	0,00	99%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	189,41	0,00	99%
1.AA.1 Energy industries solid fuel, CO_2	185,11	0,00	99%
1.AA.1 Energy industries, N_2O	23,32	0,00	99%

4.B. Manure Management other, CH_4	32,81	0,00	99%
1.AA.3.E Natural gas transportation in pipelines, CO_2	88,08	0,00	100%
1.AA.2 Manufacturing and construction, N_2O	11,03	0,00	100%
1.AA.1 Energy industries, CH_4	8,87	0,00	100%
1.AA.2 Manufacturing and construction, CH_4	6,49	0,00	100%
2.C.1.2 Pig iron, CO_2	21,41	0,00	100%
6.C. Waste Incineration, CO_2	4,33	0,00	100%
1.AA.3.B Road transportation LPG, CO_2	60,19	0,00	100%
2.B.5.5 Methanol, CH_4	3,83	0,00	100%
2.A.7 Glass Production, CO_2	11,70	0,00	100%
1.AA.3.A Civil aviation, CO_2	9,02	0,00	100%
1.AA.3.D Navigation, CO_2	15,49	0,00	100%
4.D.1.5. Direct Soil Emissions Other, N_2O	0,83	0,00	100%
2D2 Food and drink, CO_2	9,32	0,00	100%
2.A.4. Soda Ash Production and Use, CO_2	5,32	0,00	100%
2.A.7 Mineral wool production, CO_2	6,28	0,00	100%
1.B. Fugitive Emissions from Fuels, CO_2	1,03	0,00	100%
2.A.3. Limestone and Dolomite Use, CO_2	4,48	0,00	100%
2F1 Refrigeration and Air Conditioning Equipment, HFCs	1,98	0,00	100%
6.C. Waste Incineration, N_2O	0,19	0,00	100%
2F4 Aerosols/Metered dose inhalers, HFCs	0,77	0,00	100%
2.A.5. Asphalt Roofing, CO_2	0,02	0,00	100%
2F8 Electrical equipment, SF_6	0,05	0,00	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,00	0,00	100%
1.AA.5 Other, CH_4		0,00	100%
1.AA.5 Other, CO_2		0,00	100%
1.AA.5 Other, N_2O		0,00	100%
2F2 Foam blowing, HFCs		0,00	100%
2F3 Fire extinguishers, HFCs		0,00	100%
2F7 Semiconductor manufacture, SF_6		0,00	100%
2F9 Other, SF_6		0,00	100%

Tier 2 key category Level analysis including LULUCF: 1990

Key Category	GHG emissions, Gg CO_2 eq.	Level assessment with uncertainty	Cumulative total
5.B. Cropland, CO_2	5772,10	0,09	9%
5.C. Grassland, CO_2	2362,36	0,04	13%
5.A.1. Forest Land remaining Forest Land, CO_2	6794,60	0,11	23%
4.D.3. Indirect Emissions, N_2O	1889,35	0,03	26%
4.D.1.1. Direct Soil Emissions synthetic N fertilizer, N_2O	1341,59	0,02	28%
6.A. Solid Waste Disposal on Land, CH_4	864,23	0,01	29%
4.A. Enteric Fermentation, cattle, CH_4	3125,88	0,05	34%
4.D.1.5. Direct Soil Emissions Cultivation of histosols, N_2O	600,99	0,01	35%
4.B. Manure Management, N_2O	885,94	0,01	37%
4.D.2. Pasture, Range and Paddock Manure, N_2O	493,81	0,01	37%
4.D.1.2. Direct Soil Emissions manure fertilizers, N_2O	493,43	0,01	38%
5.A.2. Land converted to Forest Land, CO_2	1024,87	0,02	40%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	3500,89	0,05	45%
1.AA.4.A Commercial/Institutional, CO_2	2827,06	0,04	49%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	6021,25	0,09	59%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	5806,05	0,09	68%
4.B. Manure Management swine, CH_4	636,36	0,01	69%
1.AA.4.B Residential, CO_2	2277,12	0,04	72%
1.AA.3.E Off-road vehicles and machinery, CO_2	1765,35	0,03	75%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	2048,76	0,03	78%
4.D.1.4. Direct Soil Emissions Crop residues, N_2O	144,13	0,00	78%
6.B. Waste-water Handling, CH_4	173,86	0,00	79%
4.D.1.3. Direct Soil Emissions N-fixing crops, N_2O	121,71	0,00	79%
4.B. Manure Management, cattle, CH_4	424,59	0,01	79%
2.B.2. Nitric Acid Production, N_2O	928,99	0,01	81%
2.A.1. Cement Production, CO_2	1668,07	0,03	83%
1.AA.3.B Road transportation gasoline, CO_2	3053,06	0,05	88%
1.B. Fugitive Emissions from Fuels, CH_4	149,32	0,00	88%
1.AA.3.B Road transportation diesel, CO_2	2133,90	0,03	92%
5.D. Wetlands, CO_2	72,73	0,00	92%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1496,04	0,02	94%
6.B. Waste-water Handling, N_2O	79,91	0,00	94%
2.B.1. Ammonia Production, CO_2	1291,50	0,02	96%
5.A.1. Forest Land remaining Forest Land, N_2O	22,07	0,00	96%
3. Solvent and Other Product Use, CO_2	100,42	0,00	96%
3. Solvent and Other Product Use, N_2O	97,11	0,00	97%
1.AA.4 Other sectors, biomass, CH_4	68,58	0,00	97%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	409,63	0,01	97%
1.AA.3.C Railways, CO_2	349,97	0,01	98%
1.AA.3 Transport, N_2O	46,01	0,00	98%
4.A. Enteric Fermentation others, CH_4	100,67	0,00	98%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	228,06	0,00	98%

1.AA.3 Transport, CH_4	38,73	0,00	99%
2.A.2. Lime Production, CO_2	217,80	0,00	99%
1.AA.4 Other sectors, N_2O	30,39	0,00	99%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	189,41	0,00	99%
1.AA.1 Energy industries solid fuel, CO_2	185,11	0,00	99%
1.AA.1 Energy industries, N_2O	23,32	0,00	100%
4.B. Manure Management other, CH_4	32,81	0,00	100%
1.AA.3.E Natural gas transportation in pipelines, CO_2	88,08	0,00	100%
1.AA.2 Manufacturing and construction, N_2O	11,03	0,00	100%
5.B. Cropland, N_2O	7,84	0,00	100%
1.AA.1 Energy industries, CH_4	8,87	0,00	100%
1.AA.2 Manufacturing and construction, CH_4	6,49	0,00	100%
2.C.1.2 Pig iron, CO_2	21,41	0,00	100%
6.C. Waste Incineration, CO_2	4,33	0,00	100%
1.AA.3.B Road transportation LPG, CO_2	60,19	0,00	100%
5.C. Grassland, N_2O	2,40	0,00	100%
5.C. Grassland, CH_4	1,78	0,00	100%
2.B.5.5 Methanol, CH_4	3,83	0,00	100%
2.A.7 Glass Production, CO_2	11,70	0,00	100%
1.AA.3.A Civil aviation, CO_2	9,02	0,00	100%
1.AA.3.D Navigation, CO_2	15,49	0,00	100%
4.D.1.5. Direct Soil Emissions Other, N_2O	0,83	0,00	100%
2D2 Food and drink, CO_2	9,32	0,00	100%
2.A.4. Soda Ash Production and Use, CO_2	5,32	0,00	100%
2.A.7 Mineral wool production, CO_2	6,28	0,00	100%
1.B. Fugitive Emissions from Fuels, CO_2	1,03	0,00	100%
2.A.3. Limestone and Dolomite Use, CO_2	4,48	0,00	100%
5.A.1. Forest Land remaining Forest Land, CH_4	0,43	0,00	100%
2F1 Refrigeration and Air Conditioning Equipment, HFCs	1,98	0,00	100%
6.C. Waste Incineration, N_2O	0,19	0,00	100%
2F4 Aerosols/Metered dose inhalers, HFCs	0,77	0,00	100%
5.B. Cropland, CH_4	0,07	0,00	100%
2.A.5. Asphalt Roofing, CO_2	0,02	0,00	100%
2F8 Electrical equipment, SF_6	0,05	0,00	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,00	0,00	100%
1.AA.5 Other, CH_4		0,00	100%
1.AA.5 Other, CO_2		0,00	100%
1.AA.5 Other, N_2O		0,00	100%
2F2 Foam blowing, HFCs		0,00	100%
2F3 Fire extinguishers, HFCs		0,00	100%
2F7 Semiconductor manufacture, SF_6		0,00	100%
2F9 Other, SF_6		0,00	100%
5.E Settlements, CO_2		0,00	100%
5.F Other land, CO_2		0,00	100%

Tier 2 key category Level analysis excluding LULUCF: 2011

Key Category	GHG emissions, Gg CO_2 eq.	Level assessment with uncertainty	Cumulative total
6.A. Solid Waste Disposal on Land, CH_4	807,75	3,7%	4%
4.D.3. Indirect Emissions, N_2O	940,32	4,4%	8%
4.D.1.1. Direct Soil Emissions synthetic N fertilizer, N_2O	805,61	3,7%	12%
4.D.1.5. Direct Soil Emissions Cultivation of histosols, N_2O	698,19	3,2%	15%
4.A. Enteric Fermentation, cattle, CH_4	1137,03	5,3%	20%
4.D.2. Pasture, Range and Paddock Manure, N_2O	199,18	0,9%	21%
4.D.1.4. Direct Soil Emissions Crop residues, N_2O	186,67	0,9%	22%
4.D.1.2. Direct Soil Emissions manure fertilizers, N_2O	176,03	0,8%	23%
4.B. Manure Management, N_2O	268,31	1,2%	24%
1.B. Fugitive Emissions from Fuels, CH_4	260,71	1,2%	25%
2.B.2. Nitric Acid Production, N_2O	885,02	4,1%	30%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	2651,32	12,3%	42%
1.AA.4 Other sectors, biomass, CH_4	158,87	0,7%	43%
1.AA.3.B Road transportation diesel, CO_2	2741,61	12,7%	55%
6.B. Waste-water Handling, CH_4	102,04	0,5%	56%
2.B.1. Ammonia Production, CO_2	2231,08	10,4%	66%
4.B. Manure Management, cattle, CH_4	250,13	1,2%	67%
4.B. Manure Management swine, CH_4	216,22	1,0%	68%
1.AA.4.B Residential, CO_2	733,76	3,4%	72%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1517,80	7,0%	79%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	635,92	3,0%	82%
6.B. Waste-water Handling, N_2O	73,23	0,3%	82%
4.D.1.3. Direct Soil Emissions N-fixing crops, N_2O	32,48	0,2%	82%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	431,22	2,0%	84%
3. Solvent and Other Product Use, CO_2	82,29	0,4%	85%
2F1 Refrigeration and Air Conditioning Equipment, HFCs	204,77	1,0%	86%
1.AA.4.A Commercial/Institutional, CO_2	389,75	1,8%	87%
1.AA.3.B Road transportation gasoline, CO_2	788,37	3,7%	91%
1.AA.3 Transport, N_2O	39,81	0,2%	91%
2.A.1. Cement Production, CO_2	319,84	1,5%	93%
1.AA.4 Other sectors, N_2O	34,34	0,2%	93%
1.AA.3.E Off-road vehicles and machinery, CO_2	164,81	0,8%	94%
1.AA.3.C Railways, CO_2	193,01	0,9%	94%
1.AA.3.B Road transportation LPG, CO_2	475,21	2,2%	97%
4.A. Enteric Fermentation others, CH_4	48,55	0,2%	97%
1.AA.1 Energy industries, N_2O	18,57	0,1%	97%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	105,70	0,5%	97%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	198,60	0,9%	98%
4.B. Manure Management other, CH_4	18,94	0,1%	98%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	67,27	0,3%	99%
1.AA.3 Transport, CH_4	11,65	0,1%	99%

1.B. Fugitive Emissions from Fuels, CO_2	9,10	0,0%	99%
1.AA.1 Energy industries, CH_4	8,84	0,0%	99%
1.AA.3.E Natural gas transportation in pipelines, CO_2	49,05	0,2%	99%
6.C. Waste Incineration, CO_2	6,99	0,0%	99%
1.AA.2 Manufacturing and construction, N_2O	6,72	0,0%	99%
2.A.2. Lime Production, CO_2	38,52	0,2%	99%
4.D.1.5. Direct Soil Emissions Other, N_2O	2,31	0,0%	99%
1.AA.2 Manufacturing and construction, CH_4	4,33	0,0%	99%
1.AA.1 Energy industries solid fuel, CO_2	29,20	0,1%	100%
2F2 Foam blowing, HFCs	4,39	0,0%	100%
3. Solvent and Other Product Use, N_2O	3,66	0,0%	100%
1.AA.3.D Navigation, CO_2	16,33	0,1%	100%
2.A.7 Mineral wool production, CO_2	9,12	0,0%	100%
2D2 Food and drink, CO_2	8,82	0,0%	100%
2.A.7 Glass Production, CO_2	6,53	0,0%	100%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	6,98	0,0%	100%
2F7 Semiconductor manufacture, SF_6	6,21	0,0%	100%
2F3 Fire extinguishers, HFCs	1,54	0,0%	100%
2F4 Aerosols/Metered dose inhalers, HFCs	5,96	0,0%	100%
2.C.1.2 Pig iron, CO_2	3,72	0,0%	100%
1.AA.5 Other, CO_2	12,79	0,1%	100%
6.C. Waste Incineration, N_2O	0,31	0,0%	100%
1.AA.3.A Civil aviation, CO_2	1,87	0,0%	100%
1.AA.5 Other, N_2O	0,11	0,0%	100%
2F8 Electrical equipment, SF_6	1,61	0,0%	100%
2.A.4. Soda Ash Production and Use, CO_2	0,47	0,0%	100%
2F9 Other, SF_6	0,29	0,0%	100%
2.A.3. Limestone and Dolomite Use, CO_2	0,13	0,0%	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,03	0,0%	100%
2.A.5. Asphalt Roofing, CO_2	0,02	0,0%	100%
1.AA.5 Other, CH_4	0,00	0,0%	100%
2.B.5.5 Methanol, CH_4		0,0%	100%

Tier 2 key category Level analysis including LULUCF: 2011

Key Category	**GHG emissions, Gg CO_2 eq.**	**Level assessment with uncertainty**	**Cumulative total**
5.B. Cropland, CO_2	3700,05	0,09	9%
5.A.1. Forest Land remaining Forest Land, CO_2	10047,71	0,25	35%
5.C. Grassland, CO_2	3138,86	0,08	43%
6.A. Solid Waste Disposal on Land, CH_4	807,75	0,02	45%
4.D.3. Indirect Emissions, N_2O	940,32	0,02	47%
4.D.1.1. Direct Soil Emissions synthetic N fertilizer, N_2O	805,61	0,02	49%
4.D.1.5. Direct Soil Emissions Cultivation of histosols, N_2O	698,19	0,02	51%
5.A.2. Land converted to Forest Land, CO_2	1096,09	0,03	54%
4.A. Enteric Fermentation, cattle, CH_4	1137,03	0,03	56%

4.D.2. Pasture, Range and Paddock Manure, N_2O	199,18	0,01	57%
4.D.1.4. Direct Soil Emissions Crop residues, N_2O	186,67	0,00	57%
4.D.1.2. Direct Soil Emissions manure fertilizers, N_2O	176,03	0,00	58%
4.B. Manure Management, N_2O	268,31	0,01	59%
1.B. Fugitive Emissions from Fuels, CH_4	260,71	0,01	59%
2.B.2. Nitric Acid Production, N_2O	885,02	0,02	61%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	2651,32	0,07	68%
1.AA.4 Other sectors, biomass, CH_4	158,87	0,00	69%
1.AA.3.B Road transportation diesel, CO_2	2741,61	0,07	75%
6.B. Waste-water Handling, CH_4	102,04	0,00	76%
2.B.1. Ammonia Production, CO_2	2231,08	0,06	81%
4.B. Manure Management, cattle, CH_4	250,13	0,01	82%
4.B. Manure Management swine, CH_4	216,22	0,01	83%
1.AA.4.B Residential, CO_2	733,76	0,02	84%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1517,80	0,04	88%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	635,92	0,02	90%
5.D. Wetlands, CO_2	55,57	0,00	90%
6.B. Waste-water Handling, N_2O	73,23	0,00	90%
5.A.1. Forest Land remaining Forest Land, N_2O	23,36	0,00	90%
4.D.1.3. Direct Soil Emissions N-fixing crops, N_2O	32,48	0,00	90%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	431,22	0,01	91%
3. Solvent and Other Product Use, CO_2	82,29	0,00	92%
2F1 Refrigeration and Air Conditioning Equipment, HFCs	204,77	0,01	92%
1.AA.4.A Commercial/Institutional, CO_2	389,75	0,01	93%
1.AA.3.B Road transportation gasoline, CO_2	788,37	0,02	95%
1.AA.3 Transport, N_2O	39,81	0,00	95%
2.A.1. Cement Production, CO_2	319,84	0,01	96%
1.AA.4 Other sectors, N_2O	34,34	0,00	96%
1.AA.3.E Off-road vehicles and machinery, CO_2	164,81	0,00	96%
1.AA.3.C Railways, CO_2	193,01	0,00	97%
1.AA.3.B Road transportation LPG, CO_2	475,21	0,01	98%
4.A. Enteric Fermentation others, CH_4	48,55	0,00	98%
1.AA.1 Energy industries, N_2O	18,57	0,00	98%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	105,70	0,00	99%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	198,60	0,01	99%
4.B. Manure Management other, CH_4	18,94	0,00	99%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	67,27	0,00	99%
1.AA.3 Transport, CH_4	11,65	0,00	99%
1.B. Fugitive Emissions from Fuels, CO_2	9,10	0,00	99%
1.AA.1 Energy industries, CH_4	8,84	0,00	99%
1.AA.3.E Natural gas transportation in pipelines, CO_2	49,05	0,00	100%
6.C. Waste Incineration, CO_2	6,99	0,00	100%
5.B. Cropland, N_2O	4,90	0,00	100%
1.AA.2 Manufacturing and construction, N_2O	6,72	0,00	100%
2.A.2. Lime Production, CO_2	38,52	0,00	100%
4.D.1.5. Direct Soil Emissions Other, N_2O	2,31	0,00	100%
1.AA.2 Manufacturing and construction, CH_4	4,33	0,00	100%

1.AA.1 Energy industries solid fuel, CO_2	29,20	0,00	100%
2F2 Foam blowing, HFCs	4,39	0,00	100%
3. Solvent and Other Product Use, N_2O	3,66	0,00	100%
1.AA.3.D Navigation, CO_2	16,33	0,00	100%
5.C. Grassland, N_2O	1,25	0,00	100%
2.A.7 Mineral wool production, CO_2	9,12	0,00	100%
5.A.1. Forest Land remaining Forest Land, CH_4	0,93	0,00	100%
5.C. Grassland, CH_4	0,93	0,00	100%
2D2 Food and drink, CO_2	8,82	0,00	100%
2.A.7 Glass Production, CO_2	6,53	0,00	100%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	6,98	0,00	100%
2F7 Semiconductor manufacture, SF_6	6,21	0,00	100%
2F3 Fire extinguishers, HFCs	1,54	0,00	100%
2F4 Aerosols/Metered dose inhalers, HFCs	5,96	0,00	100%
2.C.1.2 Pig iron, CO_2	3,72	0,00	100%
1.AA.5 Other, CO_2	12,79	0,00	100%
6.C. Waste Incineration, N_2O	0,31	0,00	100%
1.AA.3.A Civil aviation, CO_2	1,87	0,00	100%
1.AA.5 Other, N_2O	0,11	0,00	100%
2F8 Electrical equipment, SF_6	1,61	0,00	100%
2.A.4. Soda Ash Production and Use, CO_2	0,47	0,00	100%
5.B. Cropland, CH_4	0,04	0,00	100%
2F9 Other, SF_6	0,29	0,00	100%
2.A.3. Limestone and Dolomite Use, CO_2	0,13	0,00	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,03	0,00	100%
2.A.5. Asphalt Roofing, CO_2	0,02	0,00	100%
1.AA.5 Other, CH_4	0,00	0,00	100%
2.B.5.5 Methanol, CH_4		0,00	100%
5.E Settlements, CO_2		0,00	100%
5.F Other land, CO_2		0,00	100%

Tier 2 key category trend assessment excluding LULUCF: 1990 – 2011

Key Category	1990 Gg CO_2 eq.	2011 Gg CO_2 eq.	Level assessment 2011	Trend assessment with uncertainty	% contribution to assessment	Cumulative total
6.A. Solid Waste Disposal on Land, CH_4	864,23	807,75	0,04	0,04	0,03	3%
4.D.1.5. Direct Soil Emissions Cultivation of histosols, N_2O	600,99	698,19	0,03	0,05	0,03	5%
4.D.1.1. Direct Soil Emissions synthetic N fertilizer, N_2O	1341,59	805,61	0,04	0,02	0,01	7%
4.D.1.4. Direct Soil Emissions Crop residues, N_2O	144,13	186,67	0,01	0,01	0,01	8%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	3500,89	67,27	0,00	0,16	0,09	17%
4.D.3. Indirect Emissions, N_2O	1889,35	940,32	0,04	0,01	0,01	18%
1.B. Fugitive Emissions from Fuels, CH_4	149,32	260,71	0,01	0,02	0,01	19%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	6021,25	198,60	0,01	0,26	0,16	35%
4.B. Manure Management, N_2O	885,94	268,31	0,01	0,01	0,01	36%
1.AA.4 Other sectors, biomass, CH_4	68,58	158,87	0,01	0,01	0,01	36%
1.AA.4.A Commercial/Institutional, CO_2	2827,06	389,75	0,02	0,09	0,06	42%
1.AA.3.E Off-road vehicles and machinery, CO_2	1765,35	164,81	0,01	0,06	0,04	46%
2.B.1. Ammonia Production, CO_2	1291,50	2231,08	0,10	0,17	0,11	56%
1.AA.3.B Road transportation diesel, CO_2	2133,90	2741,61	0,13	0,19	0,11	68%
4.A. Enteric Fermentation, cattle, CH_4	3125,88	1137,03	0,05	0,03	0,02	70%
2.B.2. Nitric Acid Production, N_2O	928,99	885,02	0,04	0,05	0,03	73%
4.D.1.2. Direct Soil Emissions manure fertilizers, N_2O	493,43	176,03	0,01	0,00	0,00	73%
2F1 Refrigeration and Air Conditioning Equipment, HFCs	1,98	204,77	0,01	0,02	0,01	74%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1496,04	1517,80	0,07	0,09	0,05	80%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	189,41	431,22	0,02	0,04	0,02	82%
2.A.1. Cement Production, CO_2	1668,07	319,84	0,01	0,04	0,03	84%
6.B. Waste-water Handling, N_2O	79,91	73,23	0,00	0,00	0,00	85%
4.D.1.3. Direct Soil Emissions N-fixing crops, N_2O	121,71	32,48	0,00	0,00	0,00	85%
1.AA.4.B Residential, CO_2	2277,12	733,76	0,03	0,03	0,02	87%
4.D.2. Pasture, Range and Paddock Manure, N_2O	493,81	199,18	0,01	0,00	0,00	87%

1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	2048,76	635,92	0,03	0,03	0,02	88%
6.B. Waste-water Handling, CH_4	173,86	102,04	0,00	0,00	0,00	89%
4.B. Manure Management swine, CH_4	636,36	216,22	0,01	0,01	0,00	89%
4.B. Manure Management, cattle, CH_4	424,59	250,13	0,01	0,01	0,00	89%
1.AA.3.B Road transportation gasoline, CO_2	3053,06	788,37	0,04	0,06	0,04	93%
3. Solvent and Other Product Use, N_2O	97,11	3,66	0,00	0,00	0,00	93%
3. Solvent and Other Product Use, CO_2	100,42	82,29	0,00	0,00	0,00	94%
1.AA.3.B Road transportation LPG, CO_2	60,19	475,21	0,02	0,05	0,03	96%
1.AA.4 Other sectors, N_2O	30,39	34,34	0,00	0,00	0,00	97%
1.AA.3 Transport, N_2O	46,01	39,81	0,00	0,00	0,00	97%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	228,06	6,98	0,00	0,01	0,01	97%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	409,63	105,70	0,00	0,01	0,00	98%
1.B. Fugitive Emissions from Fuels, CO_2	1,03	9,10	0,00	0,00	0,00	98%
1.AA.1 Energy industries, N_2O	23,32	18,57	0,00	0,00	0,00	98%
2.A.2. Lime Production, CO_2	217,80	38,52	0,00	0,01	0,00	98%
1.AA.1 Energy industries solid fuel, CO_2	185,11	29,20	0,00	0,01	0,00	99%
1.AA.3.C Railways, CO_2	349,97	193,01	0,01	0,00	0,00	99%
6.C. Waste Incineration, CO_2	4,33	6,99	0,00	0,00	0,00	99%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	5806,05	2651,32	0,12	0,01	0,01	99%
1.AA.1 Energy industries, CH_4	8,87	8,84	0,00	0,00	0,00	99%
1.AA.3 Transport, CH_4	38,73	11,65	0,00	0,00	0,00	99%
4.D.1.5. Direct Soil Emissions Other, N_2O	0,83	2,31	0,00	0,00	0,00	99%
2F2 Foam blowing, HFCs		4,39	0,00	0,00	0,00	99%
4.B. Manure Management other, CH_4	32,81	18,94	0,00	0,00	0,00	99%
1.AA.2 Manufacturing and construction, N_2O	11,03	6,72	0,00	0,00	0,00	100%
1.AA.3.E Natural gas transportation in pipelines, CO_2	88,08	49,05	0,00	0,00	0,00	100%
4.A. Enteric Fermentation others, CH_4	100,67	48,55	0,00	0,00	0,00	100%
1.AA.2 Manufacturing and construction, CH_4	6,49	4,33	0,00	0,00	0,00	100%
2.C.1.2 Pig iron, CO_2	21,41	3,72	0,00	0,00	0,00	100%
1.AA.3.D Navigation, CO_2	15,49	16,33	0,00	0,00	0,00	100%
2.A.7 Mineral wool production, CO_2	6,28	9,12	0,00	0,00	0,00	100%

2F7 Semiconductor manufacture, SF_6		6,21	0,00	0,00	0,00	100%
2F3 Fire extinguishers, HFCs		1,54	0,00	0,00	0,00	100%
2F4 Aerosols/Metered dose inhalers, HFCs	0,77	5,96	0,00	0,00	0,00	100%
1.AA.5 Other, CO_2		12,79	0,00	0,00	0,00	100%
2D2 Food and drink, CO_2	9,32	8,82	0,00	0,00	0,00	100%
6.C. Waste Incineration, N_2O	0,19	0,31	0,00	0,00	0,00	100%
1.AA.3.A Civil aviation, CO_2	9,02	1,87	0,00	0,00	0,00	100%
2.A.4. Soda Ash Production and Use, CO_2	5,32	0,47	0,00	0,00	0,00	100%
2.A.3. Limestone and Dolomite Use, CO_2	4,48	0,13	0,00	0,00	0,00	100%
1.AA.5 Other, N_2O		0,11	0,00	0,00	0,00	100%
2.A.7 Glass Production, CO_2	11,70	6,53	0,00	0,00	0,00	100%
2F8 Electrical equipment, SF_6	0,05	1,61	0,00	0,00	0,00	100%
2F9 Other, SF_6		0,29	0,00	0,00	0,00	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,00	0,03	0,00	0,00	0,00	100%
1.AA.5 Other, CH_4		0,00	0,00	0,00	0,00	100%
2.A.5. Asphalt Roofing, CO_2	0,02	0,02	0,00	0,00	0,00	100%
2.B.5.5 Methanol, CH_4	3,83		0,00		0,00	100%

Tier 2 key category trend assessment including LULUCF: 1990 – 2011

Key Category	1990 Gg CO_2 eq.	2011 Gg CO_2 eq.	Level assessment 2011	Trend assessment with uncertainty	% contribution to assessment	Cumulative total
5.A.1. Forest Land remaining Forest Land, CO_2	6794,60	10047,71	0,25	0,24	0,21	21%
5.C. Grassland, CO_2	2362,36	3138,86	0,08	0,07	0,06	27%
6.A. Solid Waste Disposal on Land, CH_4	864,23	807,75	0,02	0,01	0,01	28%
4.D.1.5. Direct Soil Emissions Cultivation of histosols, N_2O	600,99	698,19	0,02	0,01	0,01	29%
4.D.3. Indirect Emissions, N_2O	1889,35	940,32	0,02	0,01	0,01	30%
5.A.2. Land converted to Forest Land, CO_2	1024,87	1096,09	0,03	0,02	0,02	31%
4.A. Enteric Fermentation, cattle, CH_4	3125,88	1137,03	0,03	0,03	0,03	34%
4.B. Manure Management, N_2O	885,94	268,31	0,01	0,01	0,01	35%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	3500,89	67,27	0,00	0,09	0,07	42%
5.B. Cropland, CO_2	5772,10	3700,05	0,09	0,01	0,01	43%
4.D.1.2. Direct Soil Emissions manure fertilizers, N_2O	493,43	176,03	0,00	0,01	0,00	44%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	6021,25	198,60	0,01	0,14	0,12	56%
4.D.2. Pasture, Range and Paddock Manure, N_2O	493,81	199,18	0,01	0,00	0,00	56%
4.D.1.4. Direct Soil Emissions Crop residues, N_2O	144,13	186,67	0,00	0,00	0,00	57%
1.AA.4.A Commercial/Institutional, CO_2	2827,06	389,75	0,01	0,06	0,05	61%
1.B. Fugitive Emissions from Fuels, CH_4	149,32	260,71	0,01	0,01	0,01	62%
1.AA.3.E Off-road vehicles and machinery, CO_2	1765,35	164,81	0,00	0,04	0,03	65%
1.AA.4 Other sectors, biomass, CH_4	68,58	158,87	0,00	0,00	0,00	66%
1.AA.4.B Residential, CO_2	2277,12	733,76	0,02	0,03	0,02	68%
4.B. Manure Management swine, CH_4	636,36	216,22	0,01	0,01	0,01	69%
2.B.1. Ammonia Production, CO_2	1291,50	2231,08	0,06	0,06	0,05	74%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	2048,76	635,92	0,02	0,03	0,02	76%
4.D.1.3. Direct Soil Emissions N-fixing crops, N_2O	121,71	32,48	0,00	0,00	0,00	76%
1.AA.3.B Road transportation diesel, CO_2	2133,90	2741,61	0,07	0,06	0,05	81%
2.A.1. Cement Production, CO_2	1668,07	319,84	0,01	0,03	0,02	84%

2.B.2. Nitric Acid Production, N_2O	928,99	885,02	0,02	0,01	0,01	85%
1.AA.3.B Road transportation gasoline, CO_2	3053,06	788,37	0,02	0,04	0,04	89%
2F1 Refrigeration and Air Conditioning Equipment, HFCs	1,98	204,77	0,01	0,01	0,01	89%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	5806,05	2651,32	0,07	0,04	0,03	92%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	189,41	431,22	0,01	0,01	0,01	94%
3. Solvent and Other Product Use, N_2O	97,11	3,66	0,00	0,00	0,00	94%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1496,04	1517,80	0,04	0,02	0,02	96%
5.A.1. Forest Land remaining Forest Land, N_2O	22,07	23,36	0,00	0,00	0,00	96%
4.D.1.1. Direct Soil Emissions synthetic N fertilizer, N_2O	1341,59	805,61	0,02	0,00	0,00	96%
6.B. Waste-water Handling, N_2O	79,91	73,23	0,00	0,00	0,00	96%
1.AA.3.B Road transportation LPG, CO_2	60,19	475,21	0,01	0,02	0,02	98%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	409,63	105,70	0,00	0,01	0,01	98%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	228,06	6,98	0,00	0,01	0,00	99%
5.D. Wetlands, CO_2	72,73	55,57	0,00	0,00	0,00	99%
1.AA.4 Other sectors, N_2O	30,39	34,34	0,00	0,00	0,00	99%
3. Solvent and Other Product Use, CO_2	100,42	82,29	0,00	0,00	0,00	99%
2.A.2. Lime Production, CO_2	217,80	38,52	0,00	0,00	0,00	99%
1.AA.1 Energy industries solid fuel, CO_2	185,11	29,20	0,00	0,00	0,00	99%
1.AA.3 Transport, N_2O	46,01	39,81	0,00	0,00	0,00	99%
1.AA.3 Transport, CH_4	38,73	11,65	0,00	0,00	0,00	99%
1.B. Fugitive Emissions from Fuels, CO_2	1,03	9,10	0,00	0,00	0,00	100%
6.B. Waste-water Handling, CH_4	173,86	102,04	0,00	0,00	0,00	100%
4.B. Manure Management, cattle, CH_4	424,59	250,13	0,01	0,00	0,00	100%
4.A. Enteric Fermentation others, CH_4	100,67	48,55	0,00	0,00	0,00	100%
6.C. Waste Incineration, CO_2	4,33	6,99	0,00	0,00	0,00	100%
1.AA.1 Energy industries, N_2O	23,32	18,57	0,00	0,00	0,00	100%
2F2 Foam blowing, HFCs		4,39	0,00	0,00	0,00	100%
4.D.1.5. Direct Soil Emissions Other, N_2O	0,83	2,31	0,00	0,00	0,00	100%
1.AA.1 Energy industries, CH_4	8,87	8,84	0,00	0,00	0,00	100%
1.AA.3.C Railways, CO_2	349,97	193,01	0,00	0,00	0,00	100%
2.C.1.2 Pig iron, CO_2	21,41	3,72	0,00	0,00	0,00	100%

5.A.1. Forest Land remaining Forest Land, CH_4	0,43	0,93	0,00	0,00	0,00	100%
2.A.7 Mineral wool production, CO_2	6,28	9,12	0,00	0,00	0,00	100%
2F7 Semiconductor manufacture, SF_6		6,21	0,00	0,00	0,00	100%
2F3 Fire extinguishers, HFCs		1,54	0,00	0,00	0,00	100%
1.AA.3.E Natural gas transportation in pipelines, CO_2	88,08	49,05	0,00	0,00	0,00	100%
1.AA.3.D Navigation, CO_2	15,49	16,33	0,00	0,00	0,00	100%
2F4 Aerosols/Metered dose inhalers, HFCs	0,77	5,96	0,00	0,00	0,00	100%
1.AA.3.A Civil aviation, CO_2	9,02	1,87	0,00	0,00	0,00	100%
1.AA.5 Other, CO_2		12,79	0,00	0,00	0,00	100%
2.A.4. Soda Ash Production and Use, CO_2	5,32	0,47	0,00	0,00	0,00	100%
4.B. Manure Management other, CH_4	32,81	18,94	0,00	0,00	0,00	100%
2.A.3. Limestone and Dolomite Use, CO_2	4,48	0,13	0,00	0,00	0,00	100%
2D2 Food and drink, CO_2	9,32	8,82	0,00	0,00	0,00	100%
6.C. Waste Incineration, N_2O	0,19	0,31	0,00	0,00	0,00	100%
1.AA.2 Manufacturing and construction, CH_4	6,49	4,33	0,00	0,00	0,00	100%
1.AA.5 Other, N_2O		0,11	0,00	0,00	0,00	100%
5.C. Grassland, N_2O	2,40	1,25	0,00	0,00	0,00	100%
2F8 Electrical equipment, SF_6	0,05	1,61	0,00	0,00	0,00	100%
5.C. Grassland, CH_4	1,78	0,93	0,00	0,00	0,00	100%
5.B. Cropland, N_2O	7,84	4,90	0,00	0,00	0,00	100%
2.A.7 Glass Production, CO_2	11,70	6,53	0,00	0,00	0,00	100%
2F9 Other, SF_6		0,29	0,00	0,00	0,00	100%
1.AA.2 Manufacturing and construction, N_2O	11,03	6,72	0,00	0,00	0,00	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,00	0,03	0,00	0,00	0,00	100%
5.B. Cropland, CH_4	0,07	0,04	0,00	0,00	0,00	100%
1.AA.5 Other, CH_4		0,00	0,00	0,00	0,00	100%
2.A.5. Asphalt Roofing, CO_2	0,02	0,02	0,00	0,00	0,00	100%
2.B.5.5 Methanol, CH_4	3,83		0,00	0,00	0,00	100%
5.E Settlements, CO_2			0,00	0,00	0,00	100%
5.F Other land, CO_2			0,00	0,00	0,00	100%

ANNEX II. Tier 1 Uncertainty evaluation

Table 1a. Uncertainty evaluation excluding LULUCF

IPCC Source category	Gas	Base year (1990) emissions*	Emissions in 2011	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2011	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 eq	Gg CO_2 eq	%	%	%	%	%	%	%	%	%
1A1 Energy Industries: biomass	CO_2			50	50	71	0,00	0,000	0,000	0,00	0,00	0,00
1A1 Energy Industries: biomass	CH_4	0,33	6,26	2	50	50	0,01	0,000	0,000	0,01	0,00	0,01
1A1 Energy Industries: biomass	N_2O	0,65	12,31	2	50	50	0,03	0,000	0,000	0,01	0,00	0,01
1A1 Energy Industries: gaseous fuel	CO_2	5.806,05	2.662,31	2	3	3	0,39	0,002	0,055	0,00	0,15	0,15
1A1 Energy Industries: gaseous fuel	CH_4	2,21	1,01	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A1 Energy Industries: gaseous fuel	N_2O	3,26	1,49	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A1 Energy Industries: liquid fuel	CO_2	7526,62	1.727,55	2	3	3	0,26	-0,033	0,035	-0,08	0,10	0,13
1A1 Energy Industries: liquid fuel	CH_4	6,29	1,57	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A1 Energy Industries: liquid fuel	N_2O	18,56	4,63	2	50	50	0,01	0,000	0,000	0,00	0,00	0,00
1A1 Energy Industries: solid fuel	CO_2	185,11	29,20	2	7	7	0,01	-0,001	0,001	-0,01	0,00	0,01
1A1 Energy Industries: solid fuel	CH_4	0,04	0,01	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A1 Energy Industries: solid fuel	N_2O	0,85	0,13	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A2 Manufacturing Industries	CH_4	6,5	4,3	2	50	50	0,01	0,000	0,000	0,00	0,00	0,00
1A2 Manufacturing Industries	N_2O	11,0	6,7	2	50	50	0,02	0,000	0,000	0,00	0,00	0,00
1A2 Manufacturing Industries	CO_2	5.739,06	1.155,56	2	7	7	0,39	-0,028	0,024	-0,20	0,07	0,21
1A3A Civil aviation	CO_2	9,02	1,87	10	2	10	0,00	0,000	0,000	0,00	0,00	0,00
1A3A Civil aviation	CH_4	0,00	0,00	10	100	100	0,00	0,000	0,000	0,00	0,00	0,00
1A3A Civil aviation	N_2O	0,08	0,02	10	150	150	0,00	0,000	0,000	0,00	0,00	0,00
1A3E Mobile combustion: other transport	CO_2	1.853,43	213,86	5	7	9	0,09	-0,012	0,004	-0,09	0,03	0,09
1A3E Mobile combustion: other transport	CH_4	2,71	0,33	2	40	40	0,00	0,000	0,000	0,00	0,00	0,00

1A3E Mobile combustion: other transport	N_2O	4,55	0,45	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A3B Mobile combustion: road transport	CO_2	5.247,15	4.005,19	2	2	3	0,52	0,034	0,082	0,07	0,23	0,24
1A3B Mobile combustion: road transport	CH_4	35,50	11,02	2	40	40	0,02	0,000	0,000	0,00	0,00	0,00
1A3B Mobile combustion: road transport	N_2O	40,45	38,81	2	50	50	0,09	0,000	0,001	0,02	0,00	0,02
1A3D Navigation	CO_2	15,49	16,33	5	3	6	0,00	0,000	0,000	0,00	0,00	0,00
1A3D Navigation	CH_4	0,02	0,02	2	40	40	0,00	0,000	0,000	0,00	0,00	0,00
1A3D Navigation	N_2O	0,04	0,04	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A3C Railways	CO_2	349,97	193,01	5	5	7	0,06	0,001	0,004	0,00	0,03	0,03
1A3C Railways	CH_4	0,50	0,28	2	40	40	0,00	0,000	0,000	0,00	0,00	0,00
1A3C Railways	N_2O	0,89	0,49	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A4C Agriculture/Forestry/Fishing	CO_2	409,63	105,70	3	7	7	0,04	-0,002	0,002	-0,01	0,01	0,01
1A4C Agriculture/Forestry/Fishing	CH_4	11,57	3,78	2	50	50	0,01	0,000	0,000	0,00	0,00	0,00
1A4C Agriculture/Forestry/Fishing	N_2O	1,24	0,78	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A4A Commercial/Institutional	CO_2	2.827,06	389,75	3	7	7	0,13	-0,018	0,008	-0,12	0,03	0,13
1A4A Commercial/Institutional	CH_4	17,21	9,20	2	50	50	0,02	0,000	0,000	0,00	0,00	0,00
1A4A Commercial/Institutional	N_2O	10,17	2,82	2	50	50	0,01	0,000	0,000	0,00	0,00	0,00
1A4B Residential	CO_2	2.277,12	733,76	3	7	7	0,25	-0,006	0,015	-0,04	0,05	0,07
1A4B Residential	CH_4	155,26	166,41	2	50	50	0,39	0,002	0,003	0,10	0,01	0,10
1A4B Residential	N_2O	18,98	30,75	2	50	50	0,07	0,000	0,001	0,02	0,00	0,02
1A5 Other	CO_2		12,79	2	2	3	0,00	0,000	0,000	0,00	0,00	0,00
1A5 Other	N_2O		0,11	2	150	150	0,00	0,000	0,000	0,00	0,00	0,00
1A5 Other	CH_4		0,00	2	100	100	0,00	0,000	0,000	0,00	0,00	0,00
1B Fugitive Emissions	CH_4	149,32	260,71	5	50	50	0,61	0,004	0,005	0,20	0,04	0,20
1B Fugitive Emissions	CO_2	1,03	9,10	5	50	50	0,02	0,000	0,000	0,01	0,00	0,01
1B Fugitive Emissions	N_2O	0,00	0,03	5	50	50	0,00	0,000	0,000	0,00	0,00	0,00
2A1 Cement Production	CO_2	1.668,07	319,84	2	5	5	0,08	-0,009	0,007	-0,04	0,02	0,05
2A2 Lime Production	CO_2	217,80	38,52	5	5	7	0,01	-0,001	0,001	-0,01	0,01	0,01
2A3 Limestone and dolomite use	CO_2	4,48	0,13	10	5	11	0,00	0,000	0,000	0,00	0,00	0,00
2A4 Soda ash use	CO_2	5,32	0,47	10	5	11	0,00	0,000	0,000	0,00	0,00	0,00

2A5 Asphalt roofing	CO_2	0,02	0,02	5	25	25	0,00	0,000	0,000	0,00	0,00	0,00
2A7.1Glass production	CO_2	11,70	6,53	7	5	9	0,00	0,000	0,000	0,00	0,00	0,00
2A7.2 Mineral wool production	CO_2	6,28	9,12	7	5	9	0,00	0,000	0,000	0,00	0,00	0,00
2A7.3 Bricks and tiles	CO_2	228,06	6,98	5	5	7	0,00	-0,002	0,000	-0,01	0,00	0,01
2B1 Ammonia production	CO_2	1.291,50	2.231,08	2	3	3	0,33	0,034	0,046	0,09	0,13	0,15
2B2 Nitric Acid Production	N_2O	928,99	885,02	2	10	10	0,42	0,010	0,018	0,10	0,05	0,11
2B55 Methanol production	CH_4	3,83		5	30	30	0,00	0,000	0,000	0,00	0,00	0,00
2D2 Food and drink	CO_2	9,32	8,82	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2C12 Pig iron production	CO_2	21,41	3,72	4	10	11	0,00	0,000	0,000	0,00	0,00	0,00
2.IIA.F.1.1 Domestic Refrigeration	HFCs	0,12	0,98	14	28	32	0,00	0,000	0,000	0,00	0,00	0,00
2.IIA.F.1.2Commercial Refrigeration	HFCs	0,96	35,34	36	21	42	0,07	0,001	0,001	0,01	0,04	0,04
2.IIA.F.1.3Transport Refrigeration	HFCs	0,11	59,73	11	21	23	0,06	0,001	0,001	0,03	0,02	0,03
2.IIA.F.1.4 Industrial Refrigeration	HFCs	0,24	9,06	30	15	34	0,01	0,000	0,000	0,00	0,01	0,01
2.IIA.F.1.5 Stationary Air-Conditioning	HFCs	0,12	11,98	36	28	46	0,03	0,000	0,000	0,01	0,01	0,01
2.IIA.F.1.6 Mobile Air-Conditioning	HFCs	0,43	87,76	11	21	23	0,10	0,002	0,002	0,04	0,03	0,05
2F2 Foam blowing	HFCs		12,15	30	30	42	0,02	0,000	0,000	0,01	0,01	0,01
2F3 Fire extinguishers	HFCs	0,04	1,54	20	20	28	0,00	0,000	0,000	0,00	0,00	0,00
2F4 Aerosols/Metered dose inhalers	HFCs	0,77	5,96	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2F7 Semiconductor manufacture	SF_6		6,21	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2F8 Electrical equipment	SF_6	0,05	1,61	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2F9 Other	SF_6		0,29	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
3 Solvent and other product use	CO_2	100,42	82,29	30	20	36	0,14	0,001	0,002	0,02	0,07	0,07
3 Solvent and other product use	N_2O	97,11	3,66	30	20	36	0,01	-0,001	0,000	-0,02	0,00	0,02
4A Enteric Fermentation	CH_4	3.226,55	1.185,58	3	20	20	1,11	-0,005	0,024	-0,10	0,10	0,14
4B Manure Management	CH_4	1.093,75	485,29	18	20	27	0,60	0,000	0,010	0,00	0,25	0,25
4B Manure Management	N_2O	885,94	268,31	28	50	57	0,71	-0,003	0,006	-0,13	0,22	0,25
4D1 Direct Soil Emissions	N_2O	2.702,68	1.901,29	20	100	102	8,97	0,014	0,039	1,44	1,10	1,81
4D2 Pasture Range and Paddock	N_2O	493,81	199,18	20	100	102	0,94	0,000	0,004	-0,04	0,12	0,12
4D3 Indirect Soil Emissions	N_2O	1.889,35	940,32	20	100	102	4,44	0,002	0,019	0,21	0,55	0,58
6A Solid Waste	CH_4	864,23	807,75	30	129	132	4,95	0,009	0,017	1,12	0,70	1,32
6B Wastewater Handling	CH_4	173,86	102,04	30	65	72	0,34	0,001	0,002	0,03	0,09	0,09

6B Wastewater Handling	N_2O	79,91	73,23	30	50	58	0,20	0,001	0,002	0,04	0,06	0,07
6C Waste incineration	CO_2	4,33	6,99	30	42	52	0,02	0,000	0,000	0,00	0,01	0,01
6C Waste incineration	N_2O	0,19	0,31	30	104	108	0,00	0,000	0,000	0,00	0,00	0,00
Total emission		**48.756,71**	**21.619,55**	**Overall uncertainty (%)**			**11,4**	**Trend uncertainty (%)**				**2,4**

* Base year for F-gases is 1995

Table 1b. Uncertainty evaluation including LULUCF

IPCC Source category	Gas	Base year (1990) emissions* Gg CO_2 eq	Emissions in 2011 Gg CO_2 eq	Activity data uncertainty %	Emission factor uncertainty %	Combined uncertainty %	Combined uncertainty as % of total national emissions in 2011 %	Type A sensitivity %	Type B sensitivity %	Uncertainty in trend in national emissions introduced by emission factor uncertainty %	Uncertainty in trend in national emissions introduced by activity data uncertainty %	Uncertainty introduced into the trend in total national emissions %
1A1 Energy Industries: biomass	CO_2			50	50	71	0,00	0,000	0,000	0,00	0,00	0,00
1A1 Energy Industries: biomass	CH_4	0,33	6,26	2	50	50	0,03	0,000	0,000	0,01	0,00	0,01
1A1 Energy Industries: biomass	N_2O	0,65	12,31	2	50	50	0,06	0,000	0,000	0,01	0,00	0,01
1A1 Energy Industries: gaseous fuel	CO_2	5.806,05	2.662,31	2	3	3	0,77	0,027	0,060	0,07	0,17	0,18
1A1 Energy Industries: gaseous fuel	CH_4	2,21	1,01	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A1 Energy Industries: gaseous fuel	N_2O	3,26	1,49	2	50	50	0,01	0,000	0,000	0,00	0,00	0,00
1A1 Energy Industries: liquid fuel	CO_2	7.526,62	1.727,55	2	3	3	0,50	-0,004	0,039	-0,01	0,11	0,11
1A1 Energy Industries: liquid fuel	CH_4	6,29	1,57	2	50	50	0,01	0,000	0,000	0,00	0,00	0,00
1A1 Energy Industries: liquid fuel	N_2O	18,56	4,63	2	50	50	0,02	0,000	0,000	0,00	0,00	0,00
1A1 Energy Industries: solid fuel	CO_2	185,11	29,20	2	7	7	0,02	0,000	0,001	0,00	0,00	0,00
1A1 Energy Industries: solid fuel	CH_4	0,04	0,01	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A1 Energy Industries: solid fuel	N_2O	0,85	0,13	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A2 Manufacturing Industries	CH_4	6,49	4,33	2	50	50	0,02	0,000	0,000	0,00	0,00	0,00
1A2 Manufacturing Industries	N_2O	11,03	6,72	2	50	50	0,03	0,000	0,000	0,00	0,00	0,00
1A2 Manufacturing Industries	CO_2	5.739,06	1.155,56	2	7	7	0,76	-0,006	0,026	-0,04	0,07	0,09
1A3A Civil aviation	CO_2	9,02	1,87	10	2	10	0,00	0,000	0,000	0,00	0,00	0,00
1A3A Civil aviation	CH_4	0,00	0,00	10	100	100	0,00	0,000	0,000	0,00	0,00	0,00

1A3A Civil aviation	N_2O	0,08	0,02	10	150	150	0,00	0,000	0,000	0,00	0,00	0,00
1A3E Mobile combustion: other transport	CO_2	1.853,43	213,86	5	7	9	0,17	-0,006	0,005	-0,04	0,03	0,05
1A3E Mobile combustion: other transport	CH_4	2,71	0,33	2	40	40	0,00	0,000	0,000	0,00	0,00	0,00
1A3E Mobile combustion: other transport	N_2O	4,55	0,45	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A3B Mobile combustion: road transport	CO_2	5.247,15	4.005,19	2	2	3	1,02	0,060	0,090	0,12	0,25	0,28
1A3B Mobile combustion: road transport	CH_4	35,50	11,02	2	40	40	0,04	0,000	0,000	0,00	0,00	0,00
1A3B Mobile combustion: road transport	N_2O	40,45	38,81	2	50	50	0,17	0,001	0,001	0,03	0,00	0,03
1A3D Navigation	CO_2	15,49	16,33	5	3	6	0,01	0,000	0,000	0,00	0,00	0,00
1A3D Navigation	CH_4	0,02	0,02	2	40	40	0,00	0,000	0,000	0,00	0,00	0,00
1A3D Navigation	N_2O	0,04	0,04	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A3C Railways	CO_2	349,97	193,01	5	5	7	0,12	0,002	0,004	0,01	0,03	0,03
1A3C Railways	CH_4	0,50	0,28	2	40	40	0,00	0,000	0,000	0,00	0,00	0,00
1A3C Railways	N_2O	0,89	0,49	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A4C Agriculture/Forestry/Fishing	CO_2	409,63	105,70	3	7	7	0,07	0,000	0,002	0,00	0,01	0,01
1A4C Agriculture/Forestry/Fishing	CH_4	11,57	3,78	2	50	50	0,02	0,000	0,000	0,00	0,00	0,00
1A4C Agriculture/Forestry/Fishing	N_2O	1,24	0,78	2	50	50	0,00	0,000	0,000	0,00	0,00	0,00
1A4A Commercial/Institutional	CO_2	2.827,06	389,75	3	7	7	0,26	-0,007	0,009	-0,05	0,03	0,06
1A4A Commercial/Institutional	CH_4	17,21	9,20	2	50	50	0,04	0,000	0,000	0,01	0,00	0,01
1A4A Commercial/Institutional	N_2O	10,17	2,82	2	50	50	0,01	0,000	0,000	0,00	0,00	0,00
1A4B Residential	CO_2	2.277,12	733,76	3	7	7	0,49	0,004	0,016	0,03	0,06	0,06
1A4B Residential	CH_4	155,26	166,41	2	50	50	0,75	0,003	0,004	0,14	0,01	0,14
1A4B Residential	N_2O	18,98	30,75	2	50	50	0,14	0,001	0,001	0,03	0,00	0,03
1A5 Other	CO_2		12,79	2	2	3	0,00	0,000	0,000	0,00	0,00	0,00
1A5 Other	N_2O		0,11	2	150	150	0,00	0,000	0,000	0,00	0,00	0,00
1A5 Other	CH_4		0,00	2	100	100	0,00	0,000	0,000	0,00	0,00	0,00
1B Fugitive Emissions	CH_4	149,32	260,71	5	50	50	1,18	0,005	0,006	0,25	0,04	0,25
1B Fugitive Emissions	CO_2	1,03	9,10	5	50	50	0,04	0,000	0,000	0,01	0,00	0,01
1B Fugitive Emissions	N_2O	0,00	0,03	5	50	50	0,00	0,000	0,000	0,00	0,00	0,00

2A1 Cement Production	CO_2	1.668,07	319,84	2	5	5	0,15	-0,002	0,007	-0,01	0,02	0,02
2A2 Lime Production	CO_2	217,80	38,52	5	5	7	0,02	0,000	0,001	0,00	0,01	0,01
2A3 Limestone and dolomite use	CO_2	4,48	0,13	10	5	11	0,00	0,000	0,000	0,00	0,00	0,00
2A4 Soda ash use	CO_2	5,32	0,47	10	5	11	0,00	0,000	0,000	0,00	0,00	0,00
2A5 Asphalt roofing	CO_2	0,02	0,02	5	25	25	0,00	0,000	0,000	0,00	0,00	0,00
2A7.1Glass production	CO_2	11,70	6,53	7	5	9	0,01	0,000	0,000	0,00	0,00	0,00
2A7.2 Mineral wool production	CO_2	6,28	9,12	7	5	9	0,01	0,000	0,000	0,00	0,00	0,00
2A7.3 Bricks and tiles	CO_2	228,06	6,98	5	5	7	0,00	-0,001	0,000	-0,01	0,00	0,01
2B1 Ammonia production	CO_2	1.291,50	2.231,08	2	3	3	0,64	0,043	0,050	0,11	0,14	0,18
2B2 Nitric Acid Production	N_2O	928,99	885,02	2	10	10	0,81	0,015	0,020	0,15	0,06	0,16
2B55 Methanol production	CH_4	3,83		5	30	30	0,00	0,000	0,000	0,00	0,00	0,00
2D2 Food and drink	CO_2	9,32	8,82	5	5	7	0,01	0,000	0,000	0,00	0,00	0,00
2C12 Pig iron production	CO_2	21,41	3,72	4	10	11	0,00	0,000	0,000	0,00	0,00	0,00
2.IIA.F.1.1 Domestic Refrigeration	HFCs	0,12	0,98	14	28	32	0,00	0,000	0,000	0,00	0,00	0,00
2.IIA.F.1.2Commercial Refrigeration	HFCs	0,96	35,34	36	21	42	0,13	0,001	0,001	0,02	0,04	0,04
2.IIA.F.1.3Transport Refrigeration	HFCs	0,11	59,73	11	21	23	0,13	0,001	0,001	0,03	0,02	0,03
2.IIA.F.1.4 Industrial Refrigeration	HFCs	0,24	9,06	30	15	34	0,03	0,000	0,000	0,00	0,01	0,01
2.IIA.F.1.5 Stationary Air-Conditioning	HFCs	0,12	11,98	36	28	46	0,05	0,000	0,000	0,01	0,01	0,02
2.IIA.F.1.6 Mobile Air-Conditioning	HFCs	0,43	87,76	11	21	23	0,18	0,002	0,002	0,04	0,03	0,05
2F2 Foam blowing	HFCs		12,15	30	30	42	0,05	0,000	0,000	0,01	0,01	0,01
2F3 Fire extinguishers	HFCs	0,04	1,54	20	20	28	0,00	0,000	0,000	0,00	0,00	0,00
2F4 Aerosols/Metered dose inhalers	HFCs	0,77	5,96	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2F7 Semiconductor manufacture	SF_6		6,21	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2F8 Electrical equipment	SF_6	0,05	1,61	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2F9 Other	SF_6		0,29	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
3 Solvent and other product use	CO_2	100,42	82,29	30	20	36	0,27	0,001	0,002	0,03	0,08	0,08
3 Solvent and other product use	N_2O	97,11	3,66	30	20	36	0,01	0,000	0,000	-0,01	0,00	0,01
4A Enteric Fermentation	CH_4	3.226,55	1.185,58	3	20	20	2,15	0,008	0,027	0,17	0,11	0,20
4B Manure Management	CH_4	1.093,75	485,29	18	20	27	1,17	0,005	0,011	0,10	0,28	0,29
4B Manure Management	N_2O	885,94	268,31	28	50	57	1,38	0,001	0,006	0,05	0,24	0,24
4D1 Direct Soil Emissions	N_2O	2.702,68	1.901,29	20	100	102	17,41	0,028	0,043	2,75	1,21	3,01

4D2 Pasture Range and Paddock	N_2O	493,81	199,18	20	100	102	1,82	0,002	0,004	0,17	0,13	0,21
4D3 Indirect Soil Emissions	N_2O	1.889,35	940,32	20	100	102	8,61	0,011	0,021	1,05	0,60	1,21
5.A.1. Forest Land remaining Forest Land	CO_2	-6794,60	-10047,71	2	31	31	-28,14	-0,188	-0,226	-5,85	-0,73	5,89
5.A.1. Forest Land remaining Forest Land	CH_4	0,43	0,93	35	70	78	0,01	0,000	0,000	0,00	0,00	0,00
5.A.1. Forest Land remaining Forest Land	N_2O	22,07	23,36	11	171	171	0,36	0,000	0,001	0,07	0,01	0,07
5.A.2. Land converted to Forest Land	CO_2	-1024,87	-1096,09	12	38	40	-3,97	-0,019	-0,025	-0,73	-0,43	0,84
5.A.2. Land converted to Forest Land	CH_4	0,02	0,05	35	70	78	0,00	0,000	0,000	0,00	0,00	0,00
5.A.2. Land converted to Forest Land	N_2O	0,00	0,01	11	171	171	0,00	0,000	0,000	0,00	0,00	0,00
5.B. Cropland	CO_2	5772,10	3700,05	2	90	90	29,91	0,051	0,083	4,56	0,26	4,56
5.B. Cropland	CH_4	0,07	0,04	1	70	70	0,00	0,000	0,000	0,00	0,00	0,00
5.B. Cropland	N_2O	7,84	4,90	1	70	70	0,03	0,000	0,000	0,00	0,00	0,00
5.C. Grassland	CO_2	-2362,36	-3138,86	1	90	90	-25,37	-0,057	-0,071	-5,16	-0,12	5,16
5.C. Grassland	CH_4	1,78	0,93	1	70	70	0,01	0,000	0,000	0,00	0,00	0,00
5.C. Grassland	N_2O	2,40	1,25	1	70	70	0,01	0,000	0,000	0,00	0,00	0,00
5.D. Wetlands	CO_2	72,73	55,57	80	20	82	0,41	0,001	0,001	0,02	0,14	0,14
5.D. Wetlands	N_2O	15,81	12,08	1	64	64	0,07	0,000	0,000	0,01	0,00	0,01
6A Solid Waste	CH_4	864,23	807,75	30	129	132	9,61	0,013	0,018	1,72	0,77	1,88
6B Wastewater Handling	CH_4	173,86	102,04	30	65	72	0,66	0,001	0,002	0,09	0,10	0,13
6B Wastewater Handling	N_2O	79,91	73,23	30	50	58	0,38	0,001	0,002	0,06	0,07	0,09
6C Waste incineration	CO_2	4,33	6,99	30	42	52	0,03	0,000	0,000	0,01	0,01	0,01
6C Waste incineration	N_2O	0,19	0,31	30	104	108	0,00	0,000	0,000	0,00	0,00	0,00
Total emission		**44.470,13**	**11.136,06**	**Overall uncertainty (%)**			**53,2**	**Trend uncertainty (%)**				**9,9**

* Base year for F-gases is 1995

Table 2a. Combined uncertainty evaluation excluding LULUCF (reported descending according to combined uncertainty)

IPCC Source category	Base year (1990) emissions*	Emissions in 2011	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2011	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	Gg CO_2 eq	Gg CO_2 eq	%	%	%	%	%	%	%	%	%
6A Solid Waste	864,23	807,75	30	129	132	4,95	0,009	0,017	1,12	0,70	1,32
4D1 Direct Soil Emissions	2.702,68	1.901,29	20	100	102	8,97	0,014	0,039	1,44	1,10	1,81
4D2 Pasture Range and Paddock	493,81	199,18	20	100	102	0,94	0,000	0,004	-0,04	0,12	0,12
4D3 Indirect Soil Emissions	1.889,35	940,32	20	100	102	4,44	0,002	0,019	0,21	0,55	0,58
6C Waste incineration	4,51	7,30	29	40	50	0,02	0,000	0,000	0,00	0,01	0,01
1B Fugitive Emissions	150,35	269,83	5	48	49	0,61	0,004	0,006	0,20	0,04	0,20
6B Wastewater Handling	253,77	175,26	21	43	48	0,39	0,001	0,004	0,06	0,11	0,12
2F2 Foam blowing		12,15	30	30	42	0,02	0,000	0,000	0,01	0,01	0,01
1A1 Energy Industries: biomass	0,99	18,56	1	37	37	0,03	0,000	0,000	0,01	0,00	0,01
3 Solvent and other product use	197,52	85,95	29	19	35	0,14	0,000	0,002	0,00	0,07	0,07
2B55 Methanol production	3,83		5	30	30	0,00	0,000	0,000	0,00	0,00	0,00
2F3 Fire extinguishers	0,04	1,54	20	20	28	0,00	0,000	0,000	0,00	0,00	0,00
4B Manure Management	1.979,69	753,60	15	22	27	0,93	-0,003	0,015	-0,06	0,33	0,34
2A5 Asphalt roofing	0,02	0,02	5	25	25	0,00	0,000	0,000	0,00	0,00	0,00
4A Enteric Fermentation	3.226,55	1.185,58	3	20	20	1,11	-0,005	0,024	-0,10	0,10	0,14
2F1 Refrigeration and Air Conditioning Equipment	1,98	204,86	9	11	14	0,14	0,004	0,004	0,05	0,05	0,07
2A3 Limestone and dolomite use	4,48	0,13	10	5	11	0,00	0,000	0,000	0,00	0,00	0,00
2A4 Soda ash use	5,32	0,47	10	5	11	0,00	0,000	0,000	0,00	0,00	0,00
1A4B Residential	2.451,36	930,91	2	11	11	0,47	-0,003	0,019	-0,03	0,05	0,06
2C12 Pig iron production	21,41	3,72	4	10	11	0,00	0,000	0,000	0,00	0,00	0,00
2B2 Nitric Acid Production	928,99	885,02	2	10	10	0,42	0,010	0,018	0,10	0,05	0,11
1A3 Civil aviation	9,10	1,88	10	2	10	0,00	0,000	0,000	0,00	0,00	0,00
2A7.1Glass production	11,70	6,53	7	5	9	0,00	0,000	0,000	0,00	0,00	0,00
2A7.2 Mineral wool production	6,28	9,12	7	5	9	0,00	0,000	0,000	0,00	0,00	0,00

1A3E Mobile combustion: other transport	1.860,69	214,63	5	7	9	0,09	-0,013	0,004	-0,09	0,03	0,09
1A4C Agriculture/Forestry/Fishing	422,45	110,26	2	7	7	0,04	-0,002	0,002	-0,01	0,01	0,01
1A4A Commercial/Institutional	2.854,44	401,76	2	7	7	0,14	-0,018	0,008	-0,12	0,03	0,13
1A1 Energy Industries: solid fuel	185,99	29,34	2	7	7	0,01	-0,001	0,001	-0,01	0,00	0,01
1A2 Manufacturing Industries	5.756,59	1.166,61	2	7	7	0,39	-0,028	0,024	-0,20	0,07	0,21
2A2 Lime Production	217,80	38,52	5	5	7	0,01	-0,001	0,001	-0,01	0,01	0,01
2A7.3 Bricks and tiles	228,06	6,98	5	5	7	0,00	-0,002	0,000	-0,01	0,00	0,01
2D2 Food and drink	9,32	8,82	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2F4 Aerosols/Metered dose inhalers	0,77	5,96	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2F7 Semiconductor manufacture		6,21	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2F8 Electrical equipment	0,05	1,61	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2F9 Other		0,29	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
1A3C Railways	351,37	193,78	5	5	7	0,06	0,001	0,004	0,00	0,03	0,03
1A3D Navigation	15,55	16,39	5	3	6	0,00	0,000	0,000	0,00	0,00	0,00
2A1 Cement Production	1.668,07	319,84	2	5	5	0,08	-0,009	0,007	-0,04	0,02	0,05
2B1 Ammonia production	1.291,50	2.231,08	2	3	3	0,33	0,034	0,046	0,09	0,13	0,15
1A1 Energy Industries: gaseous fuel	5.811,52	2.664,81	2	2	3	0,39	0,002	0,055	0,00	0,15	0,15
1A1 Energy Industries: liquid fuel	7.551,47	1.733,75	2	2	3	0,26	-0,033	0,036	-0,08	0,10	0,13
1A5 Other	0,00	12,90	2	2	3	0,00	0,000	0,000	0,00	0,00	0,00
1A3B Mobile combustion: road transport	5.323,09	4.055,02	2	2	3	0,53	0,035	0,083	0,07	0,23	0,24
Total emission	**48.756,7**	**21.619,5**	**Overall uncertainty (%)**			**11,4**	**Trend uncertainty (%)**				**2,4**

* Base year for F-gases is 1995

Table 2b. Combined uncertainty evaluation including LULUCF (reported descending according to combined uncertainty)

IPCC Source category	Base year (1990) emissions*	Emissions in 2011	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2011	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
	Gg CO_2 eq	Gg CO_2 eq	%	%	%	%	%	%	%	%	%
6A Solid Waste	864,23	807,75	30	129	132	9,61	0,013	0,018	1,72	0,77	1,88
4D1 Direct Soil Emissions	2.702,68	1.901,29	20	100	102	17,41	0,028	0,043	2,75	1,21	3,01
4D2 Pasture Range and Paddock	493,81	199,18	20	100	102	1,82	0,002	0,004	0,17	0,13	0,21
4D3 Indirect Soil Emissions	1.889,35	940,32	20	100	102	8,61	0,011	0,021	1,05	0,60	1,21
5.C. Grassland	-2.358,18	-3.136,68	-1	-90	90	-25,37	-0,057	-0,071	5,16	0,12	5,16
5.B. Cropland	5.780,01	3.704,99	2,2	89,9	90	29,91	0,051	0,083	4,56	0,26	4,56
5.D. Wetlands	88,54	67,65	66	20	69	0,42	0,001	0,002	0,02	0,14	0,14
6C Waste incineration	4,51	7,30	29	40	50	0,03	0,000	0,000	0,01	0,01	0,01
1B Fugitive Emissions	150,35	269,83	5	48	49	1,18	0,005	0,006	0,25	0,04	0,26
6B Wastewater Handling	253,77	175,26	21	43	48	0,76	0,003	0,004	0,11	0,12	0,16
2F2 Foam blowing		12,15	30	30	42	0,05	0,000	0,000	0,01	0,01	0,01
5.A.2. Land converted to Forest Land	-1.024,84	-1.096,03	-12	-38	40	-3,97	-0,019	-0,025	0,73	0,43	0,84
1A1 Energy Industries: biomass	0,99	18,56	1	37	37	0,06	0,000	0,000	0,02	0,00	0,02
3 Solvent and other product use	197,52	85,95	29	19	35	0,27	0,001	0,002	0,02	0,08	0,08
5.A.1. Forest Land remaining Forest Land	-6.772,11	-10.023,42	-2	-31	31	-28,14	-0,188	-0,225	5,85	0,73	5,89
2B55 Methanol production	3,83		5	30	30	0,00	0,000	0,000	0,00	0,00	0,00
2F3 Fire extinguishers	0,04	1,54	20	20	28	0,00	0,000	0,000	0,00	0,00	0,00
4B Manure Management	1.979,69	753,60	15	22	27	1,81	0,006	0,017	0,13	0,37	0,39
2A5 Asphalt roofing	0,02	0,02	5	25	25	0,00	0,000	0,000	0,00	0,00	0,00
4A Enteric Fermentation	3.226,55	1.185,58	3	20	20	2,15	0,008	0,027	0,17	0,11	0,20
2F1 Refrigeration and Air Conditioning Equipment	1,98	204,86	9	11	14	0,27	0,005	0,005	0,05	0,06	0,08
2A3 Limestone and dolomite use	4,48	0,13	10	5	11	0,00	0,000	0,000	0,00	0,00	0,00
2A4 Soda ash use	5,32	0,47	10	5	11	0,00	0,000	0,000	0,00	0,00	0,00
1A4B Residential	2.451,36	930,91	2	11	11	0,90	0,007	0,021	0,08	0,06	0,10

2C12 Pig iron production	21,41	3,72	4	10	11	0,00	0,000	0,000	0,00	0,00	0,00
2B2 Nitric Acid Production	928,99	885,02	2	10	10	0,81	0,015	0,020	0,15	0,06	0,16
1A3 Civil aviation	9,10	1,88	10	2	10	0,00	0,000	0,000	0,00	0,00	0,00
2A7.1Glass production	11,70	6,53	7	5	9	0,01	0,000	0,000	0,00	0,00	0,00
2A7.2 Mineral wool production	6,28	9,12	7	5	9	0,01	0,000	0,000	0,00	0,00	0,00
1A3E Mobile combustion: other transport	1.860,69	214,63	5	7	9	0,17	-0,006	0,005	-0,04	0,03	0,05
1A4C Agriculture/Forestry/Fishing	422,45	110,26	2	7	7	0,07	0,000	0,002	0,00	0,01	0,01
1A4A Commercial/Institutional	2.854,44	401,76	2	7	7	0,26	-0,007	0,009	-0,05	0,03	0,06
1A1 Energy Industries: solid fuel	185,99	29,34	2	7	7	0,02	0,000	0,001	0,00	0,00	0,00
1A2 Manufacturing Industries	5.756,59	1.166,61	2	7	7	0,76	-0,006	0,026	-0,04	0,07	0,09
2A2 Lime Production	217,80	38,52	5	5	7	0,02	0,000	0,001	0,00	0,01	0,01
2A7.3 Bricks and tiles	228,06	6,98	5	5	7	0,00	-0,001	0,000	-0,01	0,00	0,01
2D2 Food and drink	9,32	8,82	5	5	7	0,01	0,000	0,000	0,00	0,00	0,00
2F4 Aerosols/Metered dose inhalers	0,77	5,96	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2F7 Semiconductor manufacture		6,21	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2F8 Electrical equipment	0,05	1,61	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
2F9 Other		0,29	5	5	7	0,00	0,000	0,000	0,00	0,00	0,00
1A3C Railways	351,37	193,78	5	5	7	0,12	0,002	0,004	0,01	0,03	0,03
1A3D Navigation	15,55	16,39	5	3	6	0,01	0,000	0,000	0,00	0,00	0,00
2A1 Cement Production	1.668,07	319,84	2	5	5	0,15	-0,002	0,007	-0,01	0,02	0,02
2B1 Ammonia production	1.291,50	2.231,08	2	3	3	0,64	0,043	0,050	0,11	0,14	0,18
1A1 Energy Industries: gaseous fuel	5.811,52	2.664,81	2	2	3	0,77	0,027	0,060	0,07	0,17	0,18
1A1 Energy Industries: liquid fuel	7.551,47	1.733,75	2	2	3	0,50	-0,004	0,039	-0,01	0,11	0,11
1A5 Other	0,00	12,90	2	2	3	0,00	0,000	0,000	0,00	0,00	0,00
1A3B Mobile combustion: road transport	5.323,09	4.055,02	2	2	3	1,03	0,061	0,091	0,12	0,25	0,28
Total emission	**44.470,1**	**11.136,1**	**Overall uncertainty (%)**			**53,2**	**Trend uncertainty (%)**				**9,9**

* Base year for F-gases is 1995

ANNEX III. Lithuanian energy balance according to the fuel type

Table 1. Balance of crude oil, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production	502	5358	20081	18504	16307	12872	9217	7718	6595	5465	4918	4909	4892
Biofuel blended													
Import	396707	131189	272070	261120	299997	372149	380035	349532	203786	390555	358659	385276	382015
Export		335	14957	5288	12305	8212	6312	4907	6649	5512	4831	4736	3438
International marine bunkers													
Changes in stocks	2093	-4730	1955	1534	-1167	-7472	9169	-10033	-890	4826	904	-1081	1857
Gross inland consumption	**399302**	**131482**	**279149**	**275870**	**302832**	**369337**	**392109**	**342310**	**202842**	**395334**	**359650**	**384368**	**385326**
Statistical difference		-42	-44										
Transformed in power, heat and other plants:	399302	131440	279101	275870	302815	369309	392101	342307	202835	395334	359631	384357	385326
- in public CHP plant													
- in auto-producer heat plant	84	167	72	28	22								
- in auto-producer CHP plant													
-in public heat plant				21	16								
- in geothermal plants													
- in other industries	399218	131273	279029	275821	302777	369309	392101	342307	202835	395334	359631	384357	385326
Consumed in energy sector, total:						5	3	3	3				
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries						5	3	3	3				
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses			4		17	23	5	..	4	..	19	11	
Final consumption:													
- in industry													
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 2. Balance of motor gasoline, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production	87988	37709	84279	77453	85113	105530	112699	98505	72271	123381	119393	123626	124021
Biofuel blended						3	35	219	471	714	655	445	610
Import	220	14328	1068	36	65	146	1115	3836	376	303	405	2616	1141
Export	42104	23601	69672	61362	68707	90618	95698	89376	54162	104168	105355	114237	114611
International marine bunkers													
Changes in stocks	-2725	-1758	739	-322	-517	111	-3193	2700	275	-1087	982	506	151
Gross inland consumption	**43379**	**26678**	**16414**	**15805**	**15954**	**15172**	**14958**	**15884**	**19231**	**19143**	**16080**	**12956**	**11312**
Statistical difference				132									
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:			9	10	5	3	4	3					
- in peat extraction enterprises				5	3	2	1	1					
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises			9	5	2	1	3	2					
Non-energy use													
Distribution and transmission losses	308	176	51	46	130	45	61	71	33	29	27	22	17
Final consumption:	**43071**	**26502**	**16354**	**15881**	**15819**	**15124**	**14893**	**15810**	**19198**	**19114**	**16053**	**12934**	**11295**
- in industry	44	88	15	16	28	21	31	30	21	28	18	15	17
- in construction	439	176	53	42	42	45	69	56	47	50	34	28	29
- in transport	41840	25887	16169	15710	15662	14973	14721	15652	19058	18965	15948	12841	11201
- in agriculture	440	307	91	93	78	70	53	59	62	52	41	43	38
- in fishing													
- in commercial / public services	308	44	26	20	9	15	19	13	10	19	12	7	10
- in households	87988	37709	84279	77453	85113	105530	112699	98505	72271	123381	119393	123626	124021

Table 3. Balance of aviation gasoline, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production													
Biofuel blended													
Import			22	22	22	22	20	20	22	23	17	18	18
Export													
International marine bunkers													
Changes in stocks											1	0	0
Gross inland consumption			22	22	22	22	20	20	22	23	18	18	18
Statistical difference													
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:			22	22	22	22	20	20	22	23	18	18	18
- in industry													
- in construction													
- in transport			22	22	22	22	20	20	22	23	18	18	18
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 4. Balance of gasoline type jet fuel, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production									-36	-14			
Biofuel blended													
Import			917	637	379	972	3	22	26	5			
Export											5		
International marine bunkers													
Changes in stocks			36	-3	17	16		-22	10	9	5		
Gross inland consumption			953	634	396	988	3						
Statistical difference													
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:			953	634	396	988	3						
- in industry													
- in construction													
- in transport			953	634	396	988	3						
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 5. Balance of kerosene type jet fuel, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production	28125	9088	19886	21183	18163	23874	24705	23467	6495	20850	9668	10352	11862
Biofuel blended													
Import	387	948	198	443	704			584	669		5	837	303
Export	22956	8442	21130	20879	17951	23507	21406	22091	4669	17443	8090	9062	9882
International marine bunkers													
Changes in stocks	86	129	1529	-116	57	287	-1185	419	502	-11	117	115	222
Gross inland consumption	**5642**	**1723**	**483**	**631**	**973**	**654**	**2114**	**2379**	**2997**	**3396**	**1700**	**2242**	**2505**
Statistical difference													
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses					7	13	14	14	4	12	4	5	9
Final consumption:	**5642**	**1723**	**483**	**631**	**966**	**641**	**2100**	**2365**	**2993**	**3384**	**1696**	**2237**	**2496**
- in industry			5	5	5								
- in construction													
- in transport	5642	1723	478	626	961	641	2100	2365	2993	3384	1696	2237	2496
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 6. Balance of transport diesel, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production	107712	42490	88234	86164	99692	120024	127985	103670	78465	135302	134283	150168	156497
Biofuel blended						29	119	589	1748	2127	1597	1478	1600
Import	8923	10198	3020	2127	754	4376	2840	3113	11877	7336	5127	7882	15451
Export	49416	27364	61774	59932	70619	93286	92877	69973	43895	94200	103262	116251	129383
International marine bunkers			894	935									
Changes in stocks	-1997	850	-1048	1226	-1391	1142	-2586	724	-1773	-2979	661	31	178
Gross inland consumption	**65222**	**26174**	**27538**	**28650**	**28436**	**32285**	**35481**	**38123**	**46422**	**47586**	**38406**	**43308**	**44343**
Statistical difference		213											
Transformed in power, heat and other plants:	7521	1742	16	15	7								
- in public CHP plant													
- in auto-producer heat plant		127	12	9	4								
- in auto-producer CHP plant													
-in public heat plant	7521	1615	4	6	3								
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:	128	43	152	176	153	125	194	174	127	140	167	144	150
- in peat extraction enterprises	128	43	56	89	86	83	125	110	93	110	131	109	107
- in crude oil extraction enterprises			46	32	29	27	49	44	24	20	25	23	27
- in refineries			11	11	8			2	2				
- in electricity, gas, steam and air conditioning enterprises			39	44	30	15	20	18	8	10	11	12	16
Non-energy use													
Distribution and transmission losses	297	128	24	24	58	58	122	89	74	80	69	73	81
Final consumption:	**57276**	**24474**	**27346**	**28435**	**28218**	**32102**	**35165**	**37860**	**46221**	**47366**	**38170**	**43091**	**44112**
- in industry	2124	1827	471	321	331	381	499	453	378	263	196	190	191
- in construction	2507	935	534	565	547	495	589	601	615	670	367	382	425
- in transport	34289	14489	24894	25976	25882	29721	32515	35362	43721	44808	36197	41030	41936
- in agriculture	14277	4207	1253	1384	1385	1335	1362	1325	1429	1487	1354	1444	1472
- in fishing							14	7	4	4	7	5	9
- in commercial / public services	2889	2804	194	189	73	170	186	112	74	134	52	40	79
- in households	1190	212											

Table 7. Balance of heating and other gasoil, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production				43	356	609	2125	1824	1033	1155	932	1130	1216
Biofuel blended											3	2	
Import		717		37	905	899	915	818	660	585	617	854	934
Export							985	1075	192	108	9		6
International marine bunkers				12	746	859	770	637	617	617	693	756	867
Changes in stocks		-717	23	-16	-22	-51	-225	-17	-48	-45	28	-7	-59
Gross inland consumption			**23**	**52**	**493**	**598**	**1060**	**913**	**836**	**970**	**878**	**1223**	**1218**
Statistical difference													
Transformed in power, heat and other plants:			8	14	67	44	102	26	33	31	33	55	40
- in public CHP plant												1	
- in auto-producer heat plant			2	3	25	14	38	6	3	4	4	2	2
- in auto-producer CHP plant													
-in public heat plant			6	11	42	30	64	20	30	27	29	52	38
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:												5	3
- in peat extraction enterprises												5	3
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:			**15**	**38**	**426**	**554**	**958**	**879**	**803**	**940**	**845**	**1163**	**1175**
- in industry			6	13	98	127	405	240	198	233	188	220	214
- in construction				5	15	30	25	22	31	33	26	47	49
- in transport					175	230	226	247	235	251	214	235	179
- in agriculture			5	8	43	118	137	122	153	174	167	230	237
- in fishing							59	157	108	101	79	73	65
- in commercial / public services			4	12	68	38	55	53	58	77	57	69	72
- in households					27	11	51	38	20	71	111	289	359

Table 8. Balance of liquefied petroleum gases (LPG), TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production	12006	7636	19104	17662	21146	21046	18812	13254	18439	12679	12720	11507	12006
Biofuel blended													
Import	2208	1056	1858	3433	3319	3110	4182	5621	3725	4008	5024	5202	2208
Export	7038	4646	11286	10171	12460	11596	10235	6928	11363	7183	8114	7526	7038
International marine bunkers													
Changes in stocks	46	230	222	-159	21	163	-59	-44	-74	231	-111	-27	46
Gross inland consumption	**7222**	**4276**	**9898**	**10765**	**12026**	**12723**	**12700**	**11903**	**10727**	**9735**	**9519**	**9156**	**7222**
Statistical difference													
Transformed in power, heat and other plants:	46		60	78	94	90	101	80	78	88	90	79	46
- in public CHP plant										1	3	0	
- in auto-producer heat plant	46		35	50	73	71	82	63	62	70	69	49	46
- in auto-producer CHP plant													
-in public heat plant			25	28	21	19	19	17	16	17	18	30	
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:	552	138	6	5	18	4	2	3					552
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries	552	138			6			2					552
- in electricity, gas, steam and air conditioning enterprises			6	5	12	4	2	1					
Non-energy use													
Distribution and transmission losses	322	92	42	39	42	47	47	38	32	39	26	15	322
Final consumption:	**6302**	**4046**	**9790**	**10643**	**11872**	**12580**	**12550**	**11782**	**10617**	**9608**	**9403**	**9062**	**6302**
- in industry			169	158	176	229	292	324	292	250	273	259	
- in construction	92	46	79	82	95	77	93	94	133	98	122	48	92
- in transport	920	1058	6378	7332	8857	9593	9810	9708	8615	7681	7554	7264	920
- in agriculture	230	46	15	29	37	38	41	43	43	46	41	63	230
- in fishing													
- in commercial / public services	460	92	19	26	22	23	22	22	16	8	6	25	460
- in households	4600	2804	3130	3016	2685	2620	2292	1591	1518	1525	1407	1403	4600

Table 9. Balance of fuel oil – high sulphur (>1%), TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production	133867	33356	53574	49329	55283	66969	71994	77669	55306	72632	61764	65373	67961
Biofuel blended													
Import	293464	47887	2704	3743	3919	5343	5056	4860	3748	3059	6288	7883	1707
Export	277769	8148	25555	29685	39133	53824	56627	66524	44361	68981	56675	60139	6469
International marine bunkers	3894	5780	3031	3290	3330	3564	4712	4471	3622	2878	4017	2801	1281
Changes in stocks	-8951	-11159	-51	2991	-1155	-662	-1824	2202	159	3576	994	-3450	1270
Gross inland consumption	136717	56156	27641	23088	15584	14262	13887	13736	11230	7408	8354	6866	4972
Statistical difference		40		120									
Transformed in power, heat and other plants:	70406	39377	16485	13918	8928	6698	5536	6668	3439	2954	4742	4648	1564
- in public CHP plant	44195	20511	7566	7482	5152	4461	3837	5201	666	2383	4160	4157	942
- in auto-producer heat plant	5379	2047	397	307	171	62	40	36	59	29	1		0
- in auto-producer CHP plant	642	201			4			2	1400				405
-in public heat plant	20190	16618	8522	6129	3600	2176	1659	1429	1314	542	581	491	217
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:	8068	3693	6115	6096	5159	5815	6716	5746	7474	4136	3468	2005	3255
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries	8068	3693	6115	6096	5159	5815	6716	5746	7474	4136	3468	2005	3255
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses	361						38	3	2	4			
Final consumption:	57882	13126	5041	3194	1497	1749	1597	1319	315	314	144	213	153
- in industry	43993	11520	4849	3007	1308	1620	1486	1238	241	245	140	148	79
- in construction	1044	201	22	34	17	13	17	14	9	9			
- in transport			3		4	3	4	10	6	4	4		
- in agriculture	1084	201	97	95	94	78	80	50	44	35		41	40
- in fishing													
- in commercial / public services	11641	1204	70	58	74	35	10	7	15	21		24	34
- in households	120												

Table 10. Balance of fuel oil – low sulphur (<1%), TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production						43			183	4838	5028	4306	2413
Biofuel blended													
Import			1199	950	1052	991	1191	1105	1634	1821	1123	2779	4630
Export						43	23		2		6	40	46
International marine bunkers			187	317	456	269	451	573	705	227	575	2224	3735
Changes in stocks			71	58	-29	-144	-60	23	-449	-585	447	-308	-338
Gross inland consumption			1083	691	567	578	657	555	661	5847	6017	4513	2924
Statistical difference													
Transformed in power, heat and other plants:			778	465	247	293	328	468	296	1547	2090	1232	818
- in public CHP plant										292	377	18	
- in auto-producer heat plant			58	16	5	11	10		22		24		3
- in auto-producer CHP plant										987	1426	1017	602
-in public heat plant			719	449	242	282	318	468	274	268	263	197	213
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:										4022	3697	3042	1787
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries										4022	3697	3042	1787
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses									5				
Final consumption:			305	226	320	285	329	87	360	278	231	239	319
- in industry			166	67	124	188	220	40	241	162	153	147	210
- in construction			44	59	76	66	93	38	87	100	54	75	72
- in transport								4	3	4	7		
- in agriculture			21	9	3	3	2	2	13	5	4	5	22
- in fishing							9						
- in commercial / public services			74	91	117	28	5	3	16	7	13	12	15
- in households													

Table 11. Balance of refinery gas (not liquefied), TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production	11032	5318	10973	12028	12922	14936	15250	12884	9409	14029	13418	14127	13324
Biofuel blended													
Import													
Export													
International marine bunkers													
Changes in stocks													
Gross inland consumption	**11032**	**5318**	**10973**	**12028**	**12922**	**14936**	**15250**	**12884**	**9409**	**14029**	**13418**	**14127**	**13324**
Statistical difference													
Transformed in power, heat and other plants:									71	92	88	109	101
- in public CHP plant													
- in auto-producer heat plant									71	92	88	109	101
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:	11032	5318	10973	12028	12922	14936	15250	12884	9338	13937	13330	14018	13223
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries	11032	5318	10973	12028	12922	14936	15250	12884	9338	13937	13330	14018	13223
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:													
- in industry													
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 12. Balance of bitumen, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production	9534	1108	2646	3989	4344	5578	6804	6421	3957	5829	4576	4938	5158
Biofuel blended													
Import	40	791	626	1176	897	1424	1150	1836	3965	3321	828	1814	2208
Export	1662	356	738	1588	1174	1800	2587	2746	1729	2884	2359	2896	3736
International marine bunkers													
Changes in stocks	40	39	-50	-218	185	-64	28	-35	-155	176	110	-165	162
Gross inland consumption	**7952**	**1582**	**2484**	**3359**	**4252**	**5138**	**5395**	**5476**	**6038**	**6442**	**3155**	**3691**	**3792**
Statistical difference													
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use	7952	1582	2484	3359	4252	5138	5395	5476	6038	6442	3155	3691	3792
Distribution and transmission losses													
Final consumption:													
- in industry													
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 13. Balance of lubricants, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production			659	792	849	816	847	931	1093	1218	1257	1504	1675
Biofuel blended													
Import	413	620	834	1085	910	955	1121	1296	1252	1175	1150	1709	2181
Export			483	580	691	718	843	1113	1352	1444	1711	2350	2950
International marine bunkers								12					
Changes in stocks			4	-168	36	92	-14	-53	16	39	58	-17	-34
Gross inland consumption	**413**	**620**	**1014**	**1129**	**1104**	**1145**	**1111**	**1049**	**1009**	**988**	**754**	**846**	**872**
Statistical difference				42									
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use	413	620	1014	1171	1104	1145	1111	1049	1009	988	754	846	872
Distribution and transmission losses													
Final consumption:													
- in industry													
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 14. Balance of petroleum coke, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production	1962	1393	3422	3039	3144	3831	3940	3345	3199	4113	3892	3856	3882
Biofuel blended													
Import						32	1100			1006		9	
Export													
International marine bunkers													
Changes in stocks						-15	-1054	325	793	-788	685	102	1
Gross inland consumption	**1962**	**1393**	**3422**	**3039**	**3144**	**3848**	**3986**	**3670**	**3992**	**4331**	**4577**	**3967**	**3883**
Statistical difference													
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:	1962	1393	3422	3039	3144	3831	3940	3345	3199	4113	3892	3856	3883
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries	1962	1393	3422	3039	3144	3831	3940	3345	3199	4113	3892	3856	3883
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:						**17**	**46**	**325**	**793**	**218**	**685**	**111**	
- in industry						17	46	325	793	218	685	111	
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 15. Balance of refinery feedstock, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production		8513	493	615	1124	850	1827	1108	34	370	126	0	
Biofuel blended													
Import	1304	17209	9761	5740	3623	1274	3568	13464	44038	13120	12327	12171	18931
Export													
International marine bunkers													
Changes in stocks	-1220	-8470	3584	667	-379	-189	-1121	-1335	663	152	670	614	673
Gross inland consumption	**84**	**17252**	**13838**	**7022**	**4368**	**1935**	**4274**	**13237**	**44735**	**13642**	**13123**	**12785**	**19604**
Statistical difference		-43		-126									
Transformed in power, heat and other plants:	84	17209	13838	6896	4368	1935	4274	13237	44735	13642	13123	12785	19604
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries	84	17209	13838	6896	4368	1935	4274	13237	44735	13642	13123	12785	19604
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:													
- in industry													
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 16. Balance of naphtha, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production			4103	6190	5379	3935	3477	2436	2071	1890	2031		
Biofuel blended													
Import													
Export			4103	6190	5379	3935	3257	2656	2071	1890	2031		
International marine bunkers													
Changes in stocks							-220	220					
Gross inland consumption													
Statistical difference													
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:													
- in industry													
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 17. Balance of orimulsion, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production													
Biofuel blended													
Import		729	1308	664	1661	1727	1681	1655					
Export													
International marine bunkers													
Changes in stocks			-81	787	-1074	-194	700	-461	1508	40			
Gross inland consumption		**729**	**1227**	**1451**	**587**	**1533**	**2381**	**1194**	**1508**	**40**			
Statistical difference													
Transformed in power, heat and other plants:		729	1227	1452	587	1533	2381	1194	1508	40			
- in public CHP plant		729	1227	1452	587	1533	2381	1194	1508	40			
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:													
- in industry													
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 18. Balance of shale oil, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production						-4							
Biofuel blended													
Import						55	73	90	81	172	103	19	
Export										77	36	18	
International marine bunkers													
Changes in stocks						1	-7	-2	-7	-9	-7	31	
Gross inland consumption						**52**	**66**	**88**	**73**	**86**	**60**	**32**	
Statistical difference													
Transformed in power, heat and other plants:						16	9	29	18	8	9	10	
- in public CHP plant													
- in auto-producer heat plant								21	10	8	8	9	
- in auto-producer CHP plant													
-in public heat plant						16	9	8	8		1	1	
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:										7			
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises										7			
Non-energy use													
Distribution and transmission losses													
Final consumption:						**36**	**57**	**59**	**55**	**71**	**51**	**22**	
- in industry						5	13	40	22	27			
- in construction													
- in transport													
- in agriculture						20	23		4	8	15	4	
- in fishing													
- in commercial / public services						11	21	19	29	36	36	18	
- in households													

Table 19. Balance of hard coal, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production													
Biofuel blended													
Import	31752	6506	2656	5589	7401	6642	7374	9891	9089	9611	5402	8027	9898
Export		50				12	41	78	201	216	424	888	605
International marine bunkers													
Changes in stocks	980	2889	245	-299	-596	-26	-186	127	641	-1254	1116	395	-950
Gross inland consumption	**32732**	**9345**	**2901**	**5290**	**6805**	**6604**	**7147**	**9940**	**9529**	**8141**	**6094**	**7534**	**8343**
Statistical difference													
Transformed in power, heat and other plants:	1834	452	323	274	302	287	282	277	246	206	139	166	145
- in public CHP plant													
- in auto-producer heat plant	930	326	54	46	87	76	67	71	74	54	41	61	9
- in auto-producer CHP plant													
-in public heat plant	904	126	269	228	215	211	215	206	172	152	98	105	136
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use		25	10	6	5	2	3						
Distribution and transmission losses		25	11	24	26	9	7	19	13	8	11	9	8
Final consumption:	**30898**	**8843**	**2557**	**4986**	**6472**	**6306**	**6855**	**9644**	**9270**	**7927**	**5944**	**7359**	**8190**
- in industry	1583	703	110	1970	3207	3240	3385	4900	5100	4511	2373	3094	3857
- in construction	226	25	13	14	25	14	20	26	19	12	5	6	12
- in transport													
- in agriculture	1557	50	14	15	39	30	40	55	21	17	15	15	26
- in fishing													
- in commercial / public services	12359	6632	1668	2010	2035	1960	2251	3056	2271	1602	1957	1977	2130
- in households	15173	1433	752	977	1166	1062	1159	1607	1859	1785	1594	2267	2165

Table 20. Balance of coke, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production													
Biofuel blended													
Import			327	415	417	447	440	786	712	456	294	466	517
Export					5								
International marine bunkers													
Changes in stocks			57	-38	7	-42	96	-69	-2	31	27	7	5
Gross inland consumption			**384**	**377**	**419**	**405**	**536**	**717**	**710**	**487**	**321**	**473**	**522**
Statistical difference													
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use			80	60	52	46	2						
Distribution and transmission losses				15	7								
Final consumption:			**304**	**302**	**360**	**359**	**534**	**717**	**710**	**487**	**321**	**473**	**522**
- in industry			304	302	360	359	534	717	710	487	321	473	522
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 21. Balance of lignite/brown coal, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production													
Biofuel blended													
Import			9	4	3	17	40	36		1		14	38
Export													
International marine bunkers													
Changes in stocks			14	5		3	2	4	3			-6	-22
Gross inland consumption			**23**	**9**	**3**	**20**	**42**	**40**	**3**	**1**		**8**	**16**
Statistical difference													
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:			**23**	**9**	**3**	**20**	**42**	**40**	**3**	**1**		**8**	**16**
- in industry													
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services			23	9	3	9	25	28	2	1			8
- in households						11	17	12	1			8	8

Table 22. Balance of peat, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production	580	600	414	584	537	583	825	640	616	790	616	364	492
Biofuel blended													
Import								6					2
Export			73		112	59	1	36	14	59	81	104	142
International marine bunkers													
Changes in stocks	116	222	124	-113	153	26	-235	-60	182	-282	-159	94	140
Gross inland consumption	696	822	465	471	578	550	589	550	784	449	376	354	492
Statistical difference													
Transformed in power, heat and other plants:	445	357	258	288	334	377	299	380	688	345	285	202	248
- in public CHP plant								22	302	6	1		
- in auto-producer heat plant	39	10	30	3	1	2			40				3
- in auto-producer CHP plant													
-in public heat plant	67	96	72	104	108	131	128	133	149	111	135	102	132
- in geothermal plants													
- in other industries	339	251	156	181	225	244	171	225	197	228	149	100	113
Consumed in energy sector, total:		126	48	10	41	5	11	7	3				13
- in peat extraction enterprises			12	9	2	4	11	5	3				
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises		126	36	1	39	1		2					13
Non-energy use													
Distribution and transmission losses	9	10	2		36	22	7		24				0
Final consumption:	242	329	157	173	167	146	272	163	69	104	91	152	231
- in industry	155	174	35	12	13	7	7	3	5	6	5	9	37
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services	87	58					21	15	10	26	24	44	85
- in households		97	122	161	154	139	244	145	54	72	62	99	109

Table 23. Balance of peat briquettes and peat pellets, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production	264	205	138	162	227	226	166	216	198	228	144	95	114
Biofuel blended													
Import		132			39	57	161	217	354	525	600	785	1014
Export								6	2	2	1		25
International marine bunkers													
Changes in stocks	-59	-15	9	4	-2		-39	6	-2	-19	42	-49	-181
Gross inland consumption	205	322	147	166	264	283	288	433	548	732	785	831	922
Statistical difference													
Transformed in power, heat and other plants:			3	4	14	3	11	3		6	15	4	
- in public CHP plant													
- in auto-producer heat plant							8	2		3	12	3	
- in auto-producer CHP plant													
-in public heat plant			3	4	14	3	3	1		3	3	1	
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:			6	3	7								
- in peat extraction enterprises			1	1	1								
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises			5	2	6								
Non-energy use													
Distribution and transmission losses													
Final consumption:	205	322	138	159	243	280	277	429	548	726	770	827	922
- in industry	15	59		1	4	8	9	12	21	18	8	30	31
- in construction									1				
- in transport													
- in agriculture							3	3	11	7	5	18	19
- in fishing													
- in commercial / public services	29	59	3	2		46	32	43	128	176	208	218	269
- in households	161	204	135	156	239	226	233	371	387	525	549	561	603

Table 24. Balance of paraffin and waxes, TJ

	1990	**1995**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Production													
Biofuel blended													
Import			60	60	72	168	176	151	165	249	295	520	857
Export						78	106	101	79	153	204	384	647
International marine bunkers													
Changes in stocks								4	-1		2	3	-46
Gross inland consumption			**60**	**60**	**72**	**90**	**70**	**54**	**85**	**96**	**93**	**139**	**164**
Statistical difference													
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use			60	60	72	90	70	54	85	96	93	139	164
Distribution and transmission losses													
Final consumption:													
- in industry													
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 25. Balance of natural gas, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production													
Biofuel blended													
Import	201957	84929	89806	90787	98605	98083	104363	103830	124570	104651	91655	104017	114115
Export	6102												
International marine bunkers													
Changes in stocks			57	73	-47	225	-671	-1081	-3501	4022	-326	304	-298
Gross inland consumption	**195855**	**84929**	**89863**	**90860**	**98558**	**98308**	**103692**	**102749**	**121069**	**108673**	**91329**	**104321**	**113817**
Statistical difference													
Transformed in power, heat and other plants:	105124	41480	46663	46856	53350	54192	57134	53699	50067	45905	45311	58186	48005
- in public CHP plant	62825	17664	31742	30539	36215	39580	42536	39866	36504	34538	34377	45755	37219
- in auto-producer heat plant	6265	1391	444	356	389	515	667	578	590	746	521	558	568
- in auto-producer CHP plant	1787	473	452	279	315	1149	1160	1053	940	256	990	1003	954
-in public heat plant	34248	21952	13661	14698	15161	11611	11414	11391	11918	10034	8818	10525	8994
- in geothermal plants				531	759	752	819	420	90	30	503	345	270
- in other industries			364	453	511	585	538	391	25	301	102		
Consumed in energy sector, total:			134	134	130	129	130	100	99	98	72	65	199
- in peat extraction enterprises													
- in crude oil extraction enterprises			3	3	3	3	3	3	3	2	2	3	3
- in refineries			28	29	28	27	28	5	5	1	6	4	2
- in electricity, gas, steam and air conditioning enterprises			103	102	99	99	99	92	91	95	64	58	194
Non-energy use	26934	20167	25510	25309	25670	22632	24288	25024	46416	39254	24153	22309	43370
Distribution and transmission losses	1688	1935	1035	635	997	884	420	69	30	..	4	5	4
Final consumption:	**62109**	**21347**	**16521**	**17926**	**18411**	**20471**	**21720**	**23857**	**24457**	**23416**	**21789**	**23756**	**22239**
- in industry	36065	8916	8811	9794	9983	10874	11620	12455	11819	11326	10540	11500	11055
- in construction	1030	219	279	366	410	493	513	611	655	677	424	501	459
- in transport			338	375	322	323	647	1092	1145	1004	1015	1028	862
- in agriculture	2946	1197	1170	1169	1104	1291	1192	1581	1653	1431	1132	1309	1273
- in fishing													
- in commercial / public services	12831	3319	1422	1612	1674	2174	2118	2254	3020	2874	2603	2793	2520
- in households	9237	7696	4501	4610	4918	5316	5630	5864	6165	6104	6075	6625	6070

Table 26. Balance of charcoal, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production						19	18	19	13	13	9	24	19
Biofuel blended													
Import						13	14	25	38	70	69	61	58
Export						21	15	16	16	18	43	38	36
International marine bunkers													
Changes in stocks						3	3	-4	1	-2	5	1	0
Gross inland consumption						**14**	**20**	**24**	**36**	**63**	**40**	**48**	**41**
Statistical difference													
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:						**14**	**20**	**24**	**36**	**63**	**40**	**5**	**41**
- in industry													
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services						14	20	24	36	63	40	5	41
- in households													

Table 27. Balance of wood and wood waste, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production	11930	19632	28388	30517	31702	33523	35293	37650	36839	39022	41787	41734	40955
Biofuel blended													
Import		61	22		45	252	727	1003	957	1227	1972	2008	4603
Export			515	806	984	693	710	1695	1923	2224	4705	5102	5431
International marine bunkers													
Changes in stocks	-14	-381	1507	672	953	349	-498	-503	15	-113	123	444	-2044
Gross inland consumption	11916	19312	29402	30383	31716	33431	34812	36455	35888	37912	39177	39084	38083
Statistical difference				1231	1631	1488	457	225					
Transformed in power, heat and other plants:	527	558	2867	4105	5007	6392	6273	7272	7552	8899	10375	10408	9792
- in public CHP plant							191	784	1597	1864	2331	2472	2359
- in auto-producer heat plant	253	402	495	706	927	1037	1128	939	992	813	680	772	706
- in auto-producer CHP plant			463	833	758	367							
-in public heat plant	274	156	1909	2566	3322	4952	4906	5501	4927	6195	7349	7121	6691
- in geothermal plants													
- in other industries						37	48	48	36	27	15	43	36
Consumed in energy sector, total:			3	4	4	13	13	16	6	2	4	19	12
- in peat extraction enterprises						4	13	9	4		0	4	4
- in crude oil extraction enterprises													
- in refineries								4	1	1	1	1	2
- in electricity, gas, steam and air conditioning enterprises			3	4	4	9		3	1	1	3	14	6
Non-energy use													
Distribution and transmission losses			21	38	38	12	4	17					
Final consumption:	11389	18754	26511	27467	28298	28502	28979	29375	28330	29011	28798	28657	28279
- in industry	453	756	1812	3140	3849	3986	4007	3586	3480	3273	2631	2920	3027
- in construction	51	105	119	196	233	238	185	232	217	177	125	143	145
- in transport													
- in agriculture	187	211	380	418	520	311	253	264	320	371	400	399	463
- in fishing													
- in commercial / public services	1699	1104	1661	1630	1402	1296	1278	1256	1189	1197	1185	1178	1276
- in households	8999	16578	22539	22083	22294	22671	23256	24037	23124	23993	24457	24017	23368

Table 28. Balance of agricultural waste, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production				112	150	186	96	104	150	174	184	228	212
Biofuel blended													
Import													
Export													
International marine bunkers													
Changes in stocks				8	7	-21	16	-31	33	-39	-9	11	-9
Gross inland consumption				120	157	165	112	73	183	135	175	239	203
Statistical difference													
Transformed in power, heat and other plants:				46	53	59	64	60	63	88	109	144	113
- in public CHP plant													
- in auto-producer heat plant						5	9	17	11	11	15	13	13
- in auto-producer CHP plant													
-in public heat plant				46	53	54	55	43	52	77	94	131	100
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:								1			7	3	1
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries											7		
- in electricity, gas, steam and air conditioning enterprises								1				3	1
Non-energy use													
Distribution and transmission losses													
Final consumption:				74	104	106	48	12	120	47	59	92	89
- in industry				47	84	91	41	10	76	19	8	11	7
- in construction													
- in transport													
- in agriculture					3	2	2		44	28	51	56	56
- in fishing													
- in commercial / public services												18	25
- in households				27	17	13	5	2				7	1

Table 29. Balance of bioethanol, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production						69	267	268	402	463	661	1060	565
Biofuel blended													
Import								70	116	250	94	106	234
Export						34	222	115	8	66	106	649	320
International marine bunkers													
Changes in stocks						-32	-10	2	-16	9	-46	-3	-14
Gross inland consumption						**3**	**35**	**225**	**494**	**656**	**603**	**514**	**465**
Statistical difference													
Transformed in power, heat and other plants:								153	294	311	1		
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries								153	294	311	1		
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use										11	18	78	68
Distribution and transmission losses													
Final consumption:						**3**	**35**	**72**	**200**	**334**	**584**	**436**	**397**
- in industry													
- in construction													
- in transport						3	35	72	200	334	584	436	397
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 30. Balance of biodiesel, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production						82	260	383	917	2390	3873	3299	2956
Biofuel blended													
Import								227	1156	1639	1222	527	1273
Export						7	168		235	1955	3434	2538	2726
International marine bunkers													
Changes in stocks						-46	27	-21	-76	-158	-80	166	-22
Gross inland consumption						**29**	**119**	**589**	**1762**	**1916**	**1581**	**1454**	**1481**
Statistical difference													
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:						**29**	**119**	**589**	**1762**	**1916**	**1581**	**1454**	**1481**
- in industry													
- in construction													
- in transport						29	119	589	1762	1916	1581	1454	1481
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 31. Balance of biogas, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production								153	294	311	1		
Biofuel blended													
Import													
Export													
International marine bunkers													
Changes in stocks								-6	-12	11	5		
Gross inland consumption								**147**	**282**	**322**	**6**		
Statistical difference													
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:								**147**	**282**	**322**	**6**		
- in industry													
- in construction													
- in transport								147	282	322	6		
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 32. Balance of sludge biogas, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production				28	30	47	57	62	69	70	89	125	129
Biofuel blended													
Import													
Export													
International marine bunkers													
Changes in stocks													
Gross inland consumption				28	30	47	57	62	69	70	89	125	129
Statistical difference													
Transformed in power, heat and other plants:				28	30	30	33	36	39	35	37	55	56
- in public CHP plant							17	30	33	21	9	8	13
- in auto-producer heat plant													
- in auto-producer CHP plant						7		6	6	14	28	47	43
-in public heat plant				28	30	23	16						
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:						17	24	26	30	35	52	70	73
- in industry													
- in construction													
- in transport													
- in agriculture						4	1						
- in fishing													
- in commercial / public services						13	23	26	30	35	52	70	73
- in households													

Table 33. Balance of landfill biogas, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production										17	56	83	245
Biofuel blended													
Import													
Export													
International marine bunkers													
Changes in stocks													
Gross inland consumption										17	56	83	245
Statistical difference													
Transformed in power, heat and other plants:										17	56	83	237
- in public CHP plant												35	152
- in auto-producer heat plant													
- in auto-producer CHP plant										17	56	48	85
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:												0	8
- in industry													
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services												0	8
- in households													

Table 34. Balance of other biogas, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production				34	48	21	20	21	34	38	50	210	89
Biofuel blended													
Import													
Export													
International marine bunkers													
Changes in stocks													
Gross inland consumption				34	48	21	20	21	34	38	50	210	89
Statistical difference													
Transformed in power, heat and other plants:						5	10	6	9	14	15	91	42
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant						5	10	6	9	14	15	91	42
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:				34	48	16	10	15	25	24	35	119	47
- in industry								6	13	10	18	104	41
- in construction													
- in transport													
- in agriculture					9	16	10	9	12	14	17	15	6
- in fishing													
- in commercial / public services				34	39								
- in households													

Table 35. Balance of emulsified vacuum residue, TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production										557			19
Biofuel blended													
Import													
Export													19
International marine bunkers													
Changes in stocks													
Gross inland consumption										**557**			
Statistical difference													
Transformed in power, heat and other plants:										557			
- in public CHP plant										557			
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use													
Distribution and transmission losses													
Final consumption:													
- in industry													
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

Table 36. Balance of sulphur (from oil), TJ

	1990	1995	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production	703	293	491	542	528	730	808	665	464	2956	2789	2939	3068
Biofuel blended													
Import													
Export			61	153	182	152	42			38	561	49	
International marine bunkers													
Changes in stocks		-205	11	-4	3		-20	21	-25	102	11	6	3
Gross inland consumption	**703**	**88**	**441**	**385**	**349**	**578**	**746**	**686**	**439**	**3020**	**2239**	**2896**	**3071**
Statistical difference		205											
Transformed in power, heat and other plants:													
- in public CHP plant													
- in auto-producer heat plant													
- in auto-producer CHP plant													
-in public heat plant													
- in geothermal plants													
- in other industries													
Consumed in energy sector, total:													
- in peat extraction enterprises													
- in crude oil extraction enterprises													
- in refineries													
- in electricity, gas, steam and air conditioning enterprises													
Non-energy use	703	293	441	385	349	578	746	686	439	3020	2239	2896	3071
Distribution and transmission losses													
Final consumption:													
- in industry													
- in construction													
- in transport													
- in agriculture													
- in fishing													
- in commercial / public services													
- in households													

ANNEX IV. Summary of study on "Determination of national GHG emission factors for energy sector", performed by Lithuanian Energy Institute in August 2012

During combustion a great share of carbon is removed immediately as CO_2, therefore conditions of combustion process practically have not influence on CO_2 emission factors. CO_2 emission factors depend on type of fuel, i.e. on the amount of carbon content in this fuel. After the summarization of performed comparative analysis of applied emission factors in other EU countries, summarization of data provided by the operators under the EU ETS system and aggregation of results provided by the accredited research laboratories, in this chapter of the study determined country specific CO_2 emission factors for energy sector (fuel combustion). Recommended values of country specific CO_2 emission factors are set considering to the results of analysis performed. Besides, determined values of emission factors have to assure low as possible uncertainty of emission factors.

CH_4 and N_2O emission factors are influenced by type of technology, operating conditions, age of equipment and other combustion conditions, therefore values of these emission factors significantly differ between the individual technologies. Seeking to precisely set country specific CH_4 and N_2O emission factors of energy technologies used in Lithuania, it is essential to perform comprehensive and multiplex measurements of emissions by differencing in accordance to the group of equipment and fuel type. However, the measurements have to be long-lasting, therefore in this study recommended values of CH_4 and N_2O emission factors are based in accordance to the results of analysis performed and default IPCC (1996) values.

Recommended CO_2, CH_4 and N_2O emission factors for energy sector are provided in Tables 1–4.

Recommended country specific CO_2 emission factor for natural gas is determined considering to the chemical composition of natural gas that was provided by Central Calibration and Test Laboratory of JSC "Lietuvos dujos", and considering the carbon content in natural gas.

Values of national CO_2 emission factors for coking coal, residual fuel oil, petroleum coke, orimulsion, non liquefied petroleum gas and coke are set on the basis of data provided by the operators under EU ETS and considering to the Tier 3 reliability that ensures the lowest uncertainty of emission factor. Sustaining to data base of EU ETS, in the some cases it is possible to apply emission factors set at the plant-specific level. For example, this can be applied for orimulsion combusted in Lithuania Thermal Power Plant or residual fuel oil combusted in CHP of the JSC "ORLEN Lietuva". For the national GHG inventory preparation it is essential to consider the possibility to apply plant-specific emission factors, because the application of these emission factors enables to use higher Tiers in national GHG inventory.

Values of national CO_2 emission factors for gasoline, diesel, gasoil, jet kerosene and liquefied petroleum gas are determined on the basis of measurement performed by accredited Laboratory of Quality Research Centre of JSC „ORLEN Lietuva".

Value of CO_2 emission factor for shale oil is based on national Estonian emission factor considering to the fact that shale oil is imported to Lithuania from Estonia.

Country specific CO_2 emission factors for crude oil, waste oil and peat are determined taking into consideration results of performed measurements and calculations provided in various national studies.

Country specific CO_2 emission factor for wood and wood waste is specified by performed measurements in Laboratory of Heat Equipment Research and Testing (Lithuanian Energy Institute).

Recommended value of CO_2 emission factor for biogas is chosen in accordance to the results of analysis on applied emission factors in other EU countries and considering to the results of long-lasting research analysis performed in other countries. However, seeking to ensure low uncertainty of emission factor for biogas, it is essential to perform long-lasting measurements for different types of biogas in Lithuania.

Table 1. Recommended GHG emission factors for energy industries

1.AA.1 Energy industries sector	*CO_2, t/TJ*	*CH_4, t/TJ*	*N_2O, t/TJ*
Waste oil	77,11	0,003	0,0006
Gasoline	72,97	0,003	0,0006
Diesel	72,89	0,003	0,0006
Gasoil	72,89	0,003	0,0006
Residual fuel oil	77,60	0,003	0,0006
Petroleum coke	94,06	0,003	0,0006
Non liquefied petroleum gas	55,82	0,003	0,0006
Orimulsion	81,74	0,003	0,0006
Shale oil	77,40	0,003	0,0006
Liquefied petroleum gas	65,42	0,003	0,0006
Crude oil	77,74	0,003	0,0006
Coking coal	94,90	0,001	0,0014
Peat	104,34	0,001	0,0015
Natural gas	55,23	0,001	0,0001
Biogas	58,45	0,001	0,0001
Wood and wood waste	109,90	0,03	0,004

The reliabilities of recommended national CO_2 emission factors are assessed considering to the default IPCC (1996) emission factors and results of the comparative analysis of emission factors applied in other EU countries. The comparison of recommended national CO_2 emission factors with default IPCC (1996) emission factors is presented in Figure 1.

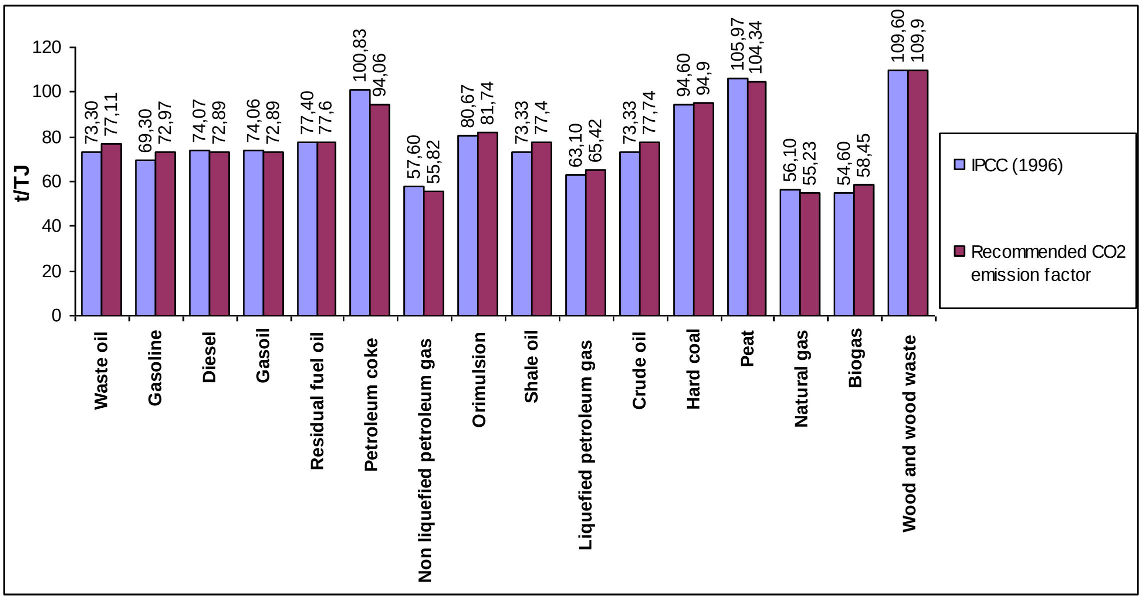

Figure 1. Comparison of recommended national CO_2 emission factors and default IPCC (1996) emission factors: energy industries

As it is seen from Figure 1, recommended values of national CO_2 emission factors are higher than default IPCC (1996) for many types of fuels. Recommended values of national CO_2 emission factors for diesel, gasoil, petroleum coke, non liquefied petroleum gas, peat and natural gas are lower than default IPCC (1996) values. Recommended national CO_2 emission factors of petroleum coke and non liquefied petroleum gas are lower than default values by 6,71% and 3,09%, respectively.

CO_2 emission factors for manufacturing industries and construction are recommended the same as for energy industries sector (Table 2). CH_4 and N_2O emission factors are selected considering to the results of analysis performed and default IPCC (1996) values.

Table 2. Recommended GHG emission factors for manufacturing industries and construction

1.AA.2 Manufacturing industries and construction	*CO_2, t/TJ*	*CH_4, t/TJ*	*N_2O, t/TJ*
Gasoil	72,89	0,002	0,0006
Residual fuel oil	77,60	0,002	0,0006
Petroleum coke	94,06	0,002	0,0006
Shale oil	77,40	0,002	0,0006
Liquefied petroleum gas	65,42	0,002	0,0006
Jet kerosene	72,24	0,002	0,0006
Coking coal	94,90	0,01	0,0015
Peat	104,34	0,002	0,0015
Coke	109,11	0,01	0,0015
Natural gas	55,23	0,005	0,0001
Biogas	58,45	0,001	0,0001
Wood and wood waste	109,9	0,03	0,004

Recommended values of CO_2, CH_4 and N_2O emission factors for transport sector are presented in Table 3. CO_2 emission factors of fuels (except aviation gasoline) used in transport sector are determined on the basis of measurement performed by accredited Laboratory of Quality Research Centre of JSC „ORLEN Lietuva“. Aviation gasoline is not produced in Lithuania. Minor volume of this fuel is imported from Sweden and other EU countries, therefore it is recommended for aviation gasoline to apply average value of emission factors applied in EU countries.

Table 3. Recommended GHG emission factors for transport sector

1.AA.3 Transport	*CO_2, t/TJ*	*CH_4, t/TJ*	*N_2O, t/TJ*
Aviation gasoline	71,62	0,0005	0,002
Gasoline	72,97	0,02	0,0006
Diesel	72,89	0,005	0,0006
Residual fuel oil	77,60	0,005	0,0006
Liquefied petroleum gas	65,42	0,005	0,0006
Jet kerosene	72,24	0,0005	0,002

The comparison of recommended national CO_2 emission factors with default IPCC (1996) emission factors are presented in Figure 2.

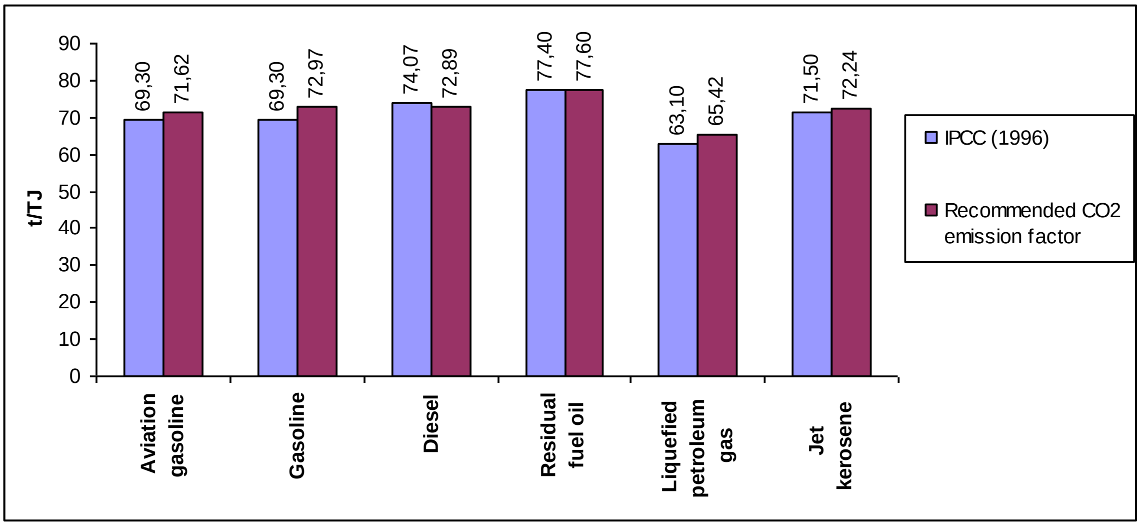

Figure 2. Comparison of recommended national CO_2 emission factors with default IPCC (1996) emission factors: transport sector

As it is seen from Figure 2, only in the case of diesel, recommended value of national CO_2 emission factor is lower than the default value (by 1,59%). In all other cases, recommended values of national CO_2 emission factors exceed default IPCC (1996) values by 0,26% (residual fuel oil) – 5,30% (gasoline).

Recommended values of CO_2, CH_4 and N_2O emission factors for service, household, agriculture and fishing sector are presented in Table 4.

Table 4. Recommended GHG emission factors for commercial/institutional, household, agriculture and fishing sectors

1.AA.3 Other sectors	*Fuel type*	*CO_2, t/TJ*	*CH_4, t/TJ*	*N_2O, t/TJ*
Commercial/ institutional sector	Coking coal	94,9	0,01	0,0014
	Biogas	58,45	0,005	0,0001
	Peat	104,34	0,01	0,0014
	Natural gas	55,23	0,005	0,0001
	Gasoil	72,89	0,01	0,0006
	Lignite	101,2	0,01	0,0014
	Wood and wood waste	109,9	0,3	0,004
	Residual fuel oil	77,6	0,01	0,0006
	Charcoal	109,9	0,2	0,001
	Shale oil	77,4	0,01	0,0006
	Liquefied petroleum gas	65,42	0,01	0,0006
Household sector	Coking coal	94,9	0,3	0,0014
	Peat	104,34	0,3	0,0014
	Natural gas	55,23	0,005	0,0001
	Gasoil	72,89	0,01	0,0006
	Lignite	101,2	0,3	0,0014
	Wood and wood waste	109,9	0,3	0,004
	Residual fuel oil	77,6	0,01	0,0006
	Liquefied petroleum gas	65,42	0,01	0,0006
Agriculture and fishing sector	Coking coal	94,9	0,3	0,0014
	Biogas	58,45	0,005	0,0001
	Peat	104,34	0,3	0,0014
	Natural gas	55,23	0,005	0,0001
	Gasoil	72,89	0,01	0,0006
	Wood and wood waste	109,9	0,3	0,004
	Residual fuel oil	77,6	0,01	0,0006
	Shale oil	77,4	0,01	0,0006
	Liquefied petroleum gas	65,42	0,01	0,0006

Recommended CO_2 emission factors for the main types of fuel are the same as for energy industries sector. Only in the case of lignite it is recommended to apply the default IPCC (1996) value.

Preparing the national GHG inventory, it is essential to evaluate the overall inventory uncertainty. For this purpose it is needed to have uncertainty estimates of emission factors, therefore in this study expert valuations of determined national emission factors uncertainties are performed.

Considering to international practice, uncertainty assessment of CO_2, N_2O and CH_4 emission factors is performed at aggregated sector-specific and fuel type-specific (liquid, solid, gaseous fuel and biomass) levels. Uncertainty estimations of recommended GHG emission factors are presented in Table 5.

Table 5. Uncertainties of recommended GHG emission factors

IPCC source category	*Fuel type*	*CO_2*	*CH_4*	*N_2O*
1.AA.1 Energy industries	Liquid fuel	± 2,5%	± 50%	± 50%
	Solid fuel	± 7%	± 50%	± 50%
	Natural gas	± 2,5%	± 50%	± 50%
	Biomass	± 50%	± 150%	± 150%
1.AA.2 Manufacturing industry and construction	Liquid fuel	± 2,5%	± 50%	± 50%
	Solid fuel	± 7%	± 50%	± 50%
	Natural gas	± 2,5%	± 50%	± 50%
	Biomass	± 50%	± 150%	± 150%
1.AA.3 Transport	Liquid fuel	± 2,5%	± 100%	± 150%
1.AA.3 Other sectors: commercial/institutional, household, agriculture and fishing	Liquid fuel	± 2,5%	± 50%	± 50%
	Solid fuel	± 7%	± 50%	± 50%
	Natural gas	± 2,5%	± 50%	± 50%
	Biomass	± 50%	± 150%	± 150%

Assessment of uncertainty of CO_2 emission factors is performed considering to the fact that carbon share of some types of fuels is relatively stable (for example, in the case of natural gas). Therefore uncertainties of CO_2 emission factors of these type of fuels are fairly small (±2,5%). Emission factors for liquid fuels mainly are identified at the accredited laboratory that satisfies the requirements of LST EN ISO/IEC 17025:2005 standard or are based on data provided by EU ETS applying the Tier 3. This has an influence on low uncertainties of emission factors for liquid fuel (±2,5%). Uncertainties of emission factors for solid fuel are remarkably higher, because, for example, carbon share in peat is variable, therefore uncertainties of emission factors for solid fuels are estimated considering to the recommendations provided in IPCC methodology. Uncertainty of CO_2 emission factor for biomass is the highest and reaches ±50%.

Uncertainties of aggregated CH_4 and N_2O emission factors are very high, since these emission factors highly depend on type of combustion technologies. Assessment of uncertainties of these emission factors are performed considering to IPCC Guidelines for National GHG inventories (2006).

ANNEX V. CO_2 emissions from the installations registered in the GHG Emission Allowance Registry, 2011

No	Company	Installation ID	Name of the installation	EUA Allocations	Verified emissions, t CO2	Corresponding CRF Sector (Fuel combustion)
1	AB Akmenės cementas	LT-1	Boiler house, cement production furnace	985617	662809	1.AA.2.F Other
2	AB Naujasis kalcitas	LT-2	Whitewash production furnace	102722	51564	1.AA.2.F Other
3	UAB Švenčionėlių keramika	LT-3	Furnace for ceramics	10601	1706	1.AA.2.F Other
4	UAB Tauragės keramika	LT-4	Ceramics combustion furnace	10907	8	1.AA.2.F Other
5	UAB Rokų keramika	LT-6	Ceramics combustion furnace	6076	2238	1.AA.2.F Other
6	AB Palemono keramika	LT-7	Ceramics combustion furnace	7950	3786	1.AA.2.F Other
7	AB Dvarčionių keramika	LT-8	Ceramics combustion furnace	11225	6204	1.AA.2.F Other
8	AB Alytaus keramika	LT-10	Ceramics combustion furnace	1563	851	1.AA.2.F Other
9	AB Ekranas	LT-11	Glass melting furnace	9450	0	1.AA.2.F Other
10	UAB Kauno stiklas	LT-12	Glass melting furnace	12202	13622	1.AA.2.F Other
11	AB Warta Glass Panevėžys	LT-13	Glass melting furnace	23803	21840	1.AA.2.F Other
12	AB ORLEN Lietuva	LT-14	Oil refining factory	2320645	1903476	1.AA.1.B Petroleum Refining
13	AB Klaipėdos kartonas	LT-15	Boiler house	32312	35036	1.AA.2. D Pulp, Paper and Print
14	AB Grigiškės	LT-16	Boiler house	64803	13985	1.AA.2. D Pulp, Paper and Print
15	AB Simega	LT-17	Boiler house	11525	0	1.AA.4.C Agriculture/ Forestry/ Fisheries
16	AB Achema	LT-18	Boiler house	212557	112079	1.AA.2.C Chemicals
17	AB Nordic Sugar Kėdainiai	LT-20	Boiler house, oilcake desiccation	55599	30844	1.AA.2.E Food processing, Beverages and Tobacco
18	AB Anykščių vynas	LT-22	Boiler house	2987	2685	1.AA.2.E Food processing, Beverages and Tobacco
19	AB Lifosa	LT-23	Boiler house	99939	645	1.AA.2.C Chemicals
20	UAB Lino apdaila	LT-24	Boiler house	10607	4188	1.AA.2.F Other
22	AB Klaipėdos nafta	LT-27	Boiler house	19691	27814	1.AA.1.A Public electricity and heat production
23	Ŗ.B. Dembavos šiltnamiai	LT-29	Boiler house	4879	171	1.AA.4.C Agriculture/ Forestry/ Fisheries
24	UAB ARVI cukrus	LT-30	Boiler house	17153	16274	1.AA.2.E Food processing, Beverages and Tobacco
25	AB Įmonių grupė "Alita"	LT-31	Boiler house, desiccation of apple oilcake	9439	1538	1.AA.2.E Food processing, Beverages and Tobacco
26	UAB Pasodėlė	LT-32	Boiler house	4663	0	1.AA.4.C Agriculture/ Forestry/ Fisheries
27	AB Klaipėdos mediena	LT-33	Boiler house	24390	13393	1.AA.4.C Agriculture/ Forestry/ Fisheries
28	UAB Matuizų plytinė	LT-35	Boiler house	14911	0	1.AA.2.F Other
29	AB Jonavos šilumos tinklai	LT-36	Jonava boiler house	28261	30824	1.AA.1.A Public electricity and heat production
30	AB Jonavos šilumos tinklai	LT-37	Girele boiler house	8532	199	1.AA.1.A Public electricity and heat production
31	UAB Mažeikių šilumos tinklai	LT-38	Mazeikiai boiler house	43068	7131	1.AA.1.A Public electricity and heat production

No	Company	Installation ID	Name of the installation	EUA Allocations	Verified emissions, t CO2	Corresponding CRF Sector (Fuel combustion)
32	UAB Raseinių šilumos tinklai	LT-39	Raseiniai boiler house No 4	8817	1682	1.AA.1.A Public electricity and heat production
33	UAB Ukmergės šiluma	LT-40	Ukmerge boiler house No 1	5941	5738	1.AA.1.A Public electricity and heat production
35	UAB Molėtų šiluma	LT-42	Moletai boiler house	7643	74	1.AA.1.A Public electricity and heat production
36	UAB Šilutės šilumos tinklai	LT-43	Šilute boiler house	18726	2415	1.AA.1.A Public electricity and heat production
37	UAB Vilniaus energija	LT-44	Vilnius power plant No 2 (E-2)	507560	305033	1.AA.1.A Public electricity and heat production
38	UAB Vilniaus energija	LT-45	Vilnius power plant No 3 (E-3)	599578	368613	1.AA.1.A Public electricity and heat production
39	UAB Vilniaus energija	LT-46	Vilnius boiler house No 2	18897	13001	1.AA.1.A Public electricity and heat production
40	UAB Vilniaus energija	LT-48	Vilnius boiler house No 8	17944	6	1.AA.1.A Public electricity and heat production
41	UAB Širvintų šiluma	LT-49	Širvintu boiler house No 3	7843	312	1.AA.1.A Public electricity and heat production
42	AB Šiaulių energija	LT-50	Šiauliai southern boiler house	117319	90073	1.AA.1.A Public electricity and heat production
43	AB Klaipėdos energija	LT-54	Gargždai boiler house no. 4	8466	8632	1.AA.1.A Public electricity and heat production
44	AB Klaipėdos energija	LT-55	Power plant	92021	61693	1.AA.1.A Public electricity and heat production
45	UAB Radviliškio šiluma	LT-56	Radviliškis city boiler house	12328	1152	1.AA.1.A Public electricity and heat production
46	UAB Utenos šilumos tinklai	LT-57	Utena boiler house	38266	15395	1.AA.1.A Public electricity and heat production
47	UAB Tauragės šilumos tinklai	LT-58	Taurage - Berže boiler house	20149	1144	1.AA.1.A Public electricity and heat production
48	UAB Šalčininkų šilumos tinklai	LT-60	Šalcininkai boiler house	6013	5318	1.AA.1.A Public electricity and heat production
49	VI Pravieniškių 2-ieji pataisos namai	LT-61	Katiline	4966	3834	1.AA.1.A Public electricity and heat production
50	UAB Varėnos šiluma	LT-62	Varena boiler house	19409	824	1.AA.1.A Public electricity and heat production
51	AB Panevėžio energija	LT-63	Panevežys boiler house No 2	58222	16223	1.AA.1.A Public electricity and heat production
52	AB Panevėžio energija	LT-64	Rokiškis region boiler house	31806	2327	1.AA.1.A Public electricity and heat production
53	AB Panevėžio energija	LT-65	Panevežys region boiler house No 1	63048	33943	1.AA.1.A Public electricity and heat production
54	AB Panevėžio energija	LT-66	Pasvalys region boiler house	7361	5239	1.AA.1.A Public electricity and heat production
55	AB Panevėžio energija	LT-67	Zarasai boiler house No 4	8158	3600	1.AA.1.A Public electricity and heat production
56	UAB Geoterma	LT-68	Klaipeda geothermal PP	44553	15362	1.AA.1.A Public electricity and heat production
57	AB Kauno energija	LT-69	Petrašiunai PP	21390	3392	1.AA.1.A Public electricity and heat production
58	AB Kauno energija	LT-70	Pergale boiler house	5687	1908	1.AA.1.A Public electricity and heat production
59	AB Kauno energija	LT-71	Šilkas boiler house	2965	1552	1.AA.1.A Public electricity and heat production
60	AB Kauno energija	LT-72	Noreikiškes region boiler house	9976	3757	1.AA.1.A Public electricity and heat production

No	Company	Installation ID	Name of the installation	EUA Allocations	Verified emissions, t CO2	Corresponding CRF Sector (Fuel combustion)
61	AB Kauno energija	LT-73	Garliava region boiler house	7264	5943	1.AA.1.A Public electricity and heat production
62	AB Kauno energija	LT-74	Jurbarkas region boiler house	9054	8186	1.AA.1.A Public electricity and heat production
63	UAB Ignalinos šilumos tinklai	LT-75	Ignalina boiler house No 2	8999	1	1.AA.1.A Public electricity and heat production
64	UAB Plungės šilumos tinklai	LT-76	Plunge boiler house No 1	19131	514	1.AA.1.A Public electricity and heat production
65	UAB Birštono šiluma	LT-77	Birštonas region boiler house	5014	1212	1.AA.1.A Public electricity and heat production
66	UAB Litesko filialas "Druskininkų šiluma"	LT-78	Druskininkai industry boiler house	40450	26186	1.AA.1.A Public electricity and heat production
67	UAB Litesko filialas "Biržų siluma"	LT-79	Boiler house of Biržai city hall	10320	722	1.AA.1.A Public electricity and heat production
68	UAB Litesko filialas "Vilkaviškio šiluma"	LT-80	Vilkaviškis boiler house	8027	4287	1.AA.1.A Public electricity and heat production
69	UAB Litesko filialas "Telšų šiluma"	LT-81	Luokeboiler house	14835	6304	1.AA.1.A Public electricity and heat production
70	UAB Litesko filialas "Kelmės šiluma"	LT-82	Mackevicius boiler house	5695	1016	1.AA.1.A Public electricity and heat production
71	UAB Litesko filialas "Palangos šiluma"	LT-83	Palanga boiler house	19052	6765	1.AA.1.A Public electricity and heat production
72	UAB Litesko filialas "Marijampolės šiluma"	LT-84	Kazlu Ruda boiler house	5422	749	1.AA.1.A Public electricity and heat production
73	UAB Litesko filialas "Marijampolės šiluma"	LT-85	Marijampole region boiler house	37160	17545	1.AA.1.A Public electricity and heat production
74	UAB Litesko filialas "Alytaus energija"	LT-86	Alytus region boiler house	95308	60608	1.AA.1.A Public electricity and heat production
75	AB Lietuvos elektrinė	LT-87	Lietuvos PP	546506	682723	1.AA.1.A Public electricity and heat production
76	UAB Kauno termofikacijos elektrinė	LT-88	Kaunas PP	562250	431604	1.AA.1.A Public electricity and heat production
77	UAB Kaišiadorių šiluma	LT-89	Kaišiadoriai boiler house	8585	2497	1.AA.1.A Public electricity and heat production
78	UAB Kretingos šilumos tinklai	LT-90	Kretinga boiler house No 2	9133	0	1.AA.1.A Public electricity and heat production
79	AB Klaipėdos energija	LT-91	Klaipeda region boiler house	75096	51295	1.AA.1.A Public electricity and heat production
80	AB Klaipėdos energija	LT-92	Lypkiai regiopn boiler house	21436	32247	1.AA.1.A Public electricity and heat production
81	AB Klaipėdos energija	LT-93	Gargždai boiler house	2210	17	1.AA.1.A Public electricity and heat production
82	AB Pagirių šiltnamiai	LT-94	boiler house	26326	2	1.AA.1.A Public electricity and heat production
83	AB Prienų šilumos tinklai	LT-95	Prienai boiler house No 2	200	0	1.AA.1.A Public electricity and heat production
84	UAB Pramonės energija	LT-96	CHP-1	55194	0	1.AA.1.A Public electricity and heat production
85	VI Ignalinos atominė elektrinė	LT-97	Boiler house	18791	8224	1.AA.1.A Public electricity and heat production
86	UAB Prienų energija	LT-98	Trakai boiler house	0	0	1.AA.1.A Public electricity and heat production
87	UAB Prienų energija	LT-99	Lentvaris boiler house	3236	1834	1.AA.1.A Public electricity and heat production
88	UAB Gargždų plytų gamykla	LT-100	Boiler house	3436	0	1.AA.2.F Other

89	UAB Akmenės energija	LT-101	Zalgiris boiler house	13521	4210	1.AA.1.A Public electricity and heat production
No	**Company**	**Installation ID**	**Name of the installation**	**EUA Allocations**	**Verified emissions, t CO2**	**Corresponding CRF Sector (Fuel combustion)**
90	AB Panevėžio energija	LT-102	Panevežys thermal PP	100300	100402	1.AA.1.A Public electricity and heat production
91	UAB Swedspan Girių Bizonas	LT-103	Fuel combustion plants	67436	28174	1.AA.4.C Agriculture/ Forestry/ Fisheries
92	AB Grigiškės PGC Naujieji Verkiai	LT-104	Boiler house	8151	0	1.AA.2. D Pulp, Paper and Print
93	UAB NEO GROUP	LT-105	Boiler house	59231	36265	1.AA.2.C Chemicals
94	AB Panevėžio energija	LT-106	Kedaniai region boiler house	20963	135	1.AA.1.A Public electricity and heat production
95	UAB Paroc	LT-107	Plants producing stone-wool	70149	55478	1.AA.2.C Chemicals
96	UAB Vilniaus energija	LT-109	Region boiler house No 7	1368	0	1.AA.1.A Public electricity and heat production
97	AB Vilniaus GKG-3	LT-108	Boiler DE-14-25 GM	550	329	1.AA.1.A Public electricity and heat production
98	UAB Agro Neveronys	LT-112	Boiler house	34192	4887	1.AA.4.C Agriculture/ Forestry/ Fisheries
99	UAB Orion Global Pet	LT-113	Boiler house	20637	13205	1.AA.2.C Chemicals
100	UAB Pramonės energija	LT-114	Boiler house	23275	75	1.AA.1.A Public electricity and heat production
101	VĮ "Visagino energija"	LT-115	Thermal boiler house	66236	75582	1.AA.1.A Public electricity and heat production
			Total:	8037268	5606375	

ANNEX VI CRF SUMMARY TABLES

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
Inventory 2011

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) (1)	**3.443,42**	**3.047,53**	**4.412,49**	**216,65**	**NA,NO**	**8,12**	**11.128,20**
1. Energy	**11.255,97**	**464,92**	**99,57**				**11.820,46**
A. Fuel Combustion (Sectoral Approach)	11.246,87	204,21	99,55				11.550,63
1. Energy Industries	4.419,06	8,84	18,57				4.446,47
2. Manufacturing Industries and Construction	1.155,56	4,33	6,72				1.166,61
3. Transport	4.430,26	11,65	39,81				4.481,71
4. Other Sectors	1.229,21	179,38	34,34				1.442,93
5. Other	12,79	0,00	0,11				12,90
B. Fugitive Emissions from Fuels	9,10	260,71	0,03				269,83
1. Solid Fuels	NO	NO	NO				NO
2. Oil and Natural Gas	9,10	260,71	0,03				269,83
2. Industrial Processes	**2.625,22**	**NA,NE,NO**	**885,02**	**216,65**	**NA,NO**	**8,12**	**3.735,01**
A. Mineral Products	381,60	NA,NE,NO	NA,NE,NO				381,60
B. Chemical Industry	2.231,08	NO	885,02	NO	NO	NO	3.116,10
C. Metal Production	3,72	NO	NO	NO	NO	NO	3,72
D. Other Production	8,82						8,82
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NO	NA,NO
F. Consumption of Halocarbons and SF_6 (2)				216,65	NA,NO	8,12	224,77
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**82,29**		**3,66**				**85,95**
4. Agriculture		**1.670,87**	**3.309,10**				**4.979,97**
A. Enteric Fermentation		1.185,58					1.185,58
B. Manure Management		485,29	268,31				753,60
C. Rice Cultivation		NO					NO
D. Agricultural Soils(3)		NA,NE	3.040,79				3.040,79
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry(1)	**-10.527,05**	**1,95**	**41,61**				**-10.483,49**
A. Forest Land	-11.143,80	0,98	23,37				-11.119,45
B. Cropland	3.700,05	0,04	4,90				3.704,99
C. Grassland	-3.138,86	0,93	1,25				-3.136,68
D. Wetlands	55,57	NE,NO	12,08				67,65
E. Settlements	NE,NO	NE	NE				NE,NO
F. Other Land	NE,NO	NE,NO	NE,NO				NE,NO
G. Other	NE	NE	NE				NE
6. Waste	**6,99**	**909,79**	**73,54**				**990,31**
A. Solid Waste Disposal on Land	NA	807,75					807,75
B. Waste-water Handling		102,04	73,23				175,26
C. Waste Incineration	6,99	NA	0,31				7,30
D. Other	NA	NA	NA				NA
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: (4)							
International Bunkers	619,38	0,64	2,53				622,55
Aviation	166,95	0,02	1,43				168,40
Marine	452,44	0,62	1,09				454,15
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**4.372,16**						**4.372,16**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	21.611,70
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	11.128,20

TABLE 10 EMISSION TRENDS: CO_2 (Part 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**32.246,74**	**34.346,77**	**19.268,91**	**15.389,42**	**14.456,96**	**13.494,43**	**13.975,41**	**13.514,11**	**14.198,39**	**11.856,10**	**10.327,61**
A. Fuel Combustion (Sectoral Approach)	32.245,71	34.344,10	19.263,88	15.383,60	14.449,57	13.484,29	13.963,13	13.497,33	14.176,48	11.837,75	10.302,58
1. Energy Industries	13.517,78	14.583,52	8.580,29	7.254,95	7.210,82	6.355,29	7.034,93	6.477,76	7.280,51	5.897,29	5.038,29
2. Manufacturing Industries and Construction	5.739,06	5.855,94	2.787,62	1.783,02	1.808,04	1.510,48	1.391,72	1.385,28	1.371,28	1.055,47	985,39
3. Transport	7.475,06	7.631,17	5.135,54	4.020,35	3.305,75	3.828,83	3.869,59	4.204,21	4.331,16	3.796,46	3.361,24
4. Other Sectors	5.513,82	6.273,47	2.760,43	2.325,28	2.124,95	1.789,69	1.666,89	1.430,07	1.193,52	1.088,52	917,66
5. Other	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO
B. Fugitive Emissions from Fuels	1,03	2,67	5,03	5,82	7,40	10,14	12,28	16,78	21,91	18,35	25,03
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	1,03	2,67	5,03	5,82	7,40	10,14	12,28	16,78	21,91	18,35	25,03
2. Industrial Processes	**3.463,97**	**3.455,09**	**1.847,51**	**894,04**	**1.241,73**	**1.456,47**	**1.628,16**	**1.491,71**	**1.626,88**	**1.503,25**	**1.428,71**
A. Mineral Products	2.141,74	2.021,37	1.082,46	500,62	483,13	424,93	405,01	441,49	508,86	419,80	357,34
B. Chemical Industry	1.291,50	1.407,23	747,22	377,90	743,50	1.017,25	1.208,38	1.034,94	1.102,14	1.067,12	1.055,46
C. Metal Production	21,41	17,17	8,50	6,21	5,79	4,97	5,45	5,96	6,56	7,00	7,47
D. Other Production	9,32	9,32	9,32	9,32	9,32	9,32	9,32	9,32	9,32	9,32	8,44
E. Production of Halocarbons and SF_6											
F. Consumption of Halocarbons and SF_6											
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	100,42	100,59	100,48	100,00	99,31	98,55	97,80	97,09	96,38	95,70	95,03
4. Agriculture											
A. Enteric Fermentation											
B. Manure Management											
C. Rice Cultivation											
D. Agricultural Soils											
E. Prescribed Burning of Savannas											
F. Field Burning of Agricultural Residues											
G. Other											
5. Land Use, Land-Use Change and Forestry[(2)]	**-4.337,00**	**-4.255,04**	**-4.222,29**	**-5.573,94**	**-4.410,39**	**-3.429,12**	**1.776,01**	**157,64**	**-7.714,10**	**-7.760,85**	**-9.301,39**
A. Forest Land	-7.819,47	-7.757,27	-7.622,56	-8.219,24	-7.672,26	-5.476,52	372,81	-1.063,38	-8.437,55	-8.239,64	-9.617,52
B. Cropland	5.772,10	5.211,77	5.042,86	4.855,18	4.682,01	4.494,04	4.326,35	4.211,87	4.052,16	3.891,01	3.619,64
C. Grassland	-2.362,36	-2.531,35	-2.699,37	-2.837,69	-3.057,70	-3.150,97	-2.997,85	-3.307,42	-3.750,98	-4.017,87	-4.333,64
D. Wetlands	72,73	72,73	72,73	63,31	75,27	74,85	74,70	67,08	67,96	211,14	71,14
E. Settlements	NE,NO	749,08	774,13	354,57	1.313,93	524,65	NE,NO	249,49	249,49	394,51	958,99
F. Other Land	NE,NO	NE,NO	209,92	209,92	248,36	104,83	NE,NO	NE,NO	104,83	NE,NO	NE,NO
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**4,33**	**4,33**	**1,21**	**3,59**	**1,11**	**4,08**	**1,38**	**1,37**	**1,44**	**0,62**	**1,84**
A. Solid Waste Disposal on Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Waste-water Handling											
C. Waste Incineration	4,33	4,33	1,21	3,59	1,11	4,08	1,38	1,37	1,44	0,62	1,84
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LULUCF	**31.478,45**	**33.651,72**	**16.995,82**	**10.813,11**	**11.388,73**	**11.624,42**	**17.478,76**	**15.261,91**	**8.208,99**	**5.694,82**	**2.551,81**
Total CO_2 emissions excluding net CO_2 from LULUCF	**35.815,45**	**37.906,77**	**21.218,11**	**16.387,05**	**15.799,12**	**15.053,53**	**15.702,75**	**15.104,27**	**15.923,09**	**13.455,67**	**11.853,19**
Memo Items:											
International Bunkers	**701,44**	**978,89**	**1.119,76**	**618,77**	**597,40**	**566,57**	**514,07**	**283,10**	**239,94**	**305,54**	**366,01**
Aviation	399,27	480,54	194,69	107,93	114,57	118,04	96,66	90,81	81,85	76,07	73,40
Marine	302,17	498,35	925,07	510,84	482,83	448,53	417,41	192,29	158,09	229,47	292,62
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	1.309,57	1.309,57	1.310,56	1.956,99	2.023,26	2.122,39	2.325,26	2.379,88	2.623,75	2.719,70	2.968,07

TABLE 10 EMISSION TRENDS: CO_2 (Part 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**10.953,69**	**11.041,00**	**11.028,23**	**11.643,97**	**12.318,14**	**12.491,17**	**12.723,67**	**12.556,63**	**11.293,49**	**12.185,18**	**11.255,97**	**-65,09**
A. Fuel Combustion (Sectoral Approach)	10.916,42	11.006,68	10.997,98	11.620,08	12.300,98	12.476,79	12.711,44	12.546,48	11.284,35	12.176,06	11.246,87	-65,12
1. Energy Industries	5.510,08	5.324,72	5.198,12	5.371,04	5.627,07	5.173,95	4.712,82	4.809,94	4.783,13	5.288,21	4.419,06	-67,31
2. Manufacturing Industries and Construction	961,52	1.047,38	1.064,41	1.154,93	1.250,79	1.468,62	1.441,80	1.276,93	1.014,11	1.114,95	1.155,56	-79,87
3. Transport	3.556,94	3.678,13	3.724,83	4.060,01	4.320,64	4.587,18	5.344,20	5.322,52	4.368,40	4.510,12	4.430,26	-40,73
4. Other Sectors	887,17	955,37	1.007,15	1.024,78	1.090,06	1.234,98	1.196,81	1.124,81	1.107,44	1.246,89	1.229,21	-77,71
5. Other	0,72	1,08	3,47	9,32	12,42	12,06	15,82	12,28	11,27	15,89	12,79	100,00
B. Fugitive Emissions from Fuels	37,27	34,32	30,25	23,89	17,15	14,38	12,23	10,15	9,15	9,12	9,10	786,23
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
2. Oil and Natural Gas	37,27	34,32	30,25	23,89	17,15	14,38	12,23	10,15	9,15	9,12	9,10	786,23
2. Industrial Processes	**1.507,66**	**1.539,43**	**1.534,24**	**1.505,61**	**1.603,79**	**1.823,42**	**2.957,79**	**2.460,10**	**1.540,29**	**1.453,91**	**2.625,22**	**-24,21**
A. Mineral Products	359,90	354,06	363,00	425,95	444,71	598,18	599,68	520,73	304,57	326,28	381,60	-82,18
B. Chemical Industry	1.131,61	1.168,86	1.155,48	1.063,09	1.141,83	1.208,06	2.339,83	1.925,12	1.223,12	1.115,27	2.231,08	72,75
C. Metal Production	7,80	7,51	6,96	7,05	7,19	6,87	6,54	4,78	4,03	4,11	3,72	-82,61
D. Other Production	8,35	9,00	8,81	9,52	10,05	10,31	11,74	9,47	8,58	8,25	8,82	-5,41
E. Production of Halocarbons and SF_6												
F. Consumption of Halocarbons and SF_6												
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
3. Solvent and Other Product Use	94,22	93,43	92,65	91,57	90,01	88,52	87,47	86,61	85,72	84,04	82,29	-18,05
4. Agriculture												
A. Enteric Fermentation												
B. Manure Management												
C. Rice Cultivation												
D. Agricultural Soils												
E. Prescribed Burning of Savannas												
F. Field Burning of Agricultural Residues												
G. Other												
5. Land Use, Land-Use Change and Forestry[(2)]	**-12.771,40**	**-5.399,86**	**-9.803,62**	**-6.649,27**	**-4.789,06**	**-4.797,72**	**-3.571,63**	**-8.508,42**	**-10.696,16**	**-10.437,29**	**-10.527,05**	**142,73**
A. Forest Land	-11.969,98	-4.035,96	-8.243,52	-4.836,21	-3.065,58	-4.639,47	-3.196,54	-9.295,30	-11.868,19	-10.854,54	-11.143,80	42,51
B. Cropland	3.199,58	3.046,18	2.661,07	2.575,64	2.449,87	3.147,14	3.346,45	3.792,27	3.953,31	3.669,41	3.700,05	-35,90
C. Grassland	-4.565,78	-4.678,15	-4.699,25	-4.690,89	-4.687,94	-4.370,44	-4.067,69	-3.734,50	-3.441,59	-3.308,62	-3.138,86	32,87
D. Wetlands	71,36	58,16	194,31	197,37	55,78	57,60	56,47	56,06	126,70	56,47	55,57	-23,59
E. Settlements	249,49	209,91	144,66	104,82	458,80	723,86	289,69	394,51	394,51	NE,NO	NE,NO	0,00
F. Other Land	243,93	NE,NO	139,10	NE,NO	NE,NO	283,59	NE,NO	278,54	139,10	NE,NO	NE,NO	0,00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
6. Waste	**2,44**	**2,24**	**6,02**	**3,09**	**5,69**	**5,23**	**0,73**	**0,61**	**0,64**	**1,93**	**6,99**	**61,54**
A. Solid Waste Disposal on Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
B. Waste-water Handling												
C. Waste Incineration	2,44	2,24	6,02	3,09	5,69	5,23	0,73	0,61	0,64	1,93	6,99	61,54
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Total CO_2 emissions including net CO_2 from LULUCF	**-213,39**	**7.276,24**	**2.857,52**	**6.594,97**	**9.228,57**	**9.610,62**	**12.198,03**	**6.595,52**	**2.224,00**	**3.287,76**	**3.443,42**	**-89,06**
Total CO_2 emissions excluding net CO_2 from LULUCF	**12.558,01**	**12.676,10**	**12.661,14**	**13.244,24**	**14.017,63**	**14.408,34**	**15.769,66**	**15.103,94**	**12.920,15**	**13.725,06**	**13.970,47**	**-60,99**
Memo Items:												
International Bunkers	**413,13**	**432,37**	**441,65**	**465,96**	**595,91**	**595,98**	**578,83**	**515,36**	**516,80**	**590,39**	**619,38**	**-11,70**
Aviation	98,25	83,44	93,48	105,90	139,13	158,13	198,08	229,43	109,95	145,35	166,95	-58,19
Marine	314,88	348,93	348,17	360,05	456,77	437,85	380,75	285,92	406,85	445,04	452,44	49,73
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
CO_2 Emissions from Biomass	3.228,97	3.487,01	3.682,47	3.862,30	3.905,53	4.091,57	4.113,09	4.354,90	4.493,86	4.480,39	4.372,16	233,86

TABLE 10 EMISSION TRENDS: CH_4 (Part 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	18,45	19,42	14,10	15,48	15,48	16,09	17,07	17,77	18,83	18,92	19,32
A. Fuel Combustion (Sectoral Approach)	11,34	11,95	6,72	7,74	7,39	7,44	8,17	8,35	8,53	8,73	8,66
1. Energy Industries	0,42	0,48	0,29	0,27	0,26	0,22	0,24	0,23	0,28	0,20	0,19
2. Manufacturing Industries and Construction	0,31	0,32	0,18	0,11	0,12	0,10	0,10	0,11	0,12	0,10	0,10
3. Transport	1,84	2,14	1,38	1,06	0,88	1,05	1,04	1,15	1,11	0,99	0,77
4. Other Sectors	8,76	9,01	4,87	6,30	6,14	6,08	6,78	6,86	7,03	7,44	7,60
5. Other	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO
B. Fugitive Emissions from Fuels	7,11	7,46	7,37	7,74	8,08	8,65	8,91	9,42	10,30	10,19	10,66
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	7,11	7,46	7,37	7,74	8,08	8,65	8,91	9,42	10,30	10,19	10,66
2. Industrial Processes	**0,18**	**0,20**	**0,11**	**0,01**	**0,06**	**0,08**	**0,04**	**0,05**	**0,02**	**NA,NE,NO**	**0,02**
A. Mineral Products	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	NA,NE,NO	NA,NE,NO
B. Chemical Industry	0,18	0,20	0,11	0,01	0,06	0,08	0,04	0,05	0,02	NO	0,02
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production											
E. Production of Halocarbons and SF_6											
F. Consumption of Halocarbons and SF_6											
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use											
4. Agriculture	**205,73**	**193,23**	**146,62**	**123,39**	**109,21**	**104,11**	**102,60**	**106,77**	**94,97**	**88,01**	**78,13**
A. Enteric Fermentation	153,65	144,79	112,86	93,89	80,47	75,63	75,61	77,90	68,31	64,25	56,58
B. Manure Management	52,08	48,44	33,76	29,50	28,74	28,48	27,00	28,87	26,66	23,76	21,55
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**0,11**	**0,10**	**0,24**	**0,14**	**0,14**	**0,14**	**0,14**	**0,14**	**0,10**	**0,14**	**0,14**
A. Forest Land	0,02	0,01	0,15	0,06	0,06	0,06	0,06	0,06	0,01	0,05	0,05
B. Cropland	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
C. Grassland	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**49,43**	**50,44**	**51,27**	**52,00**	**52,16**	**52,16**	**52,43**	**52,70**	**52,82**	**52,77**	**52,92**
A. Solid Waste Disposal on Land	41,15	42,15	43,04	43,82	44,04	44,11	44,44	44,76	44,93	45,04	45,44
B. Waste-water Handling	8,28	8,29	8,23	8,18	8,11	8,05	7,99	7,94	7,90	7,73	7,48
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CH_4 emissions including CH_4 from LULUCF	**273,90**	**263,38**	**212,35**	**191,03**	**177,05**	**172,58**	**172,29**	**177,43**	**166,74**	**159,84**	**150,52**
Total CH_4 emissions excluding CH_4 from LULUCF	**273,79**	**263,28**	**212,10**	**190,88**	**176,91**	**172,44**	**172,14**	**177,29**	**166,65**	**159,70**	**150,38**
Memo Items:											
International Bunkers	0,02	0,04	0,06	0,03	0,03	0,03	0,03	0,01	0,01	0,02	0,02
Aviation	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Marine	0,02	0,03	0,06	0,03	0,03	0,03	0,03	0,01	0,01	0,02	0,02
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass											

TABLE 10 EMISSION TRENDS: CH_4 (Part 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	20,35	20,29	20,44	20,37	21,18	21,61	21,25	21,86	22,26	22,39	22,14	19,99
A. Fuel Combustion (Sectoral Approach)	8,92	8,97	9,15	9,21	9,48	9,86	9,55	9,87	9,87	9,97	9,72	-14,25
1. Energy Industries	0,25	0,28	0,30	0,35	0,35	0,37	0,36	0,41	0,46	0,46	0,42	-0,28
2. Manufacturing Industries and Construction	0,12	0,18	0,22	0,23	0,23	0,25	0,25	0,22	0,17	0,20	0,21	-33,28
3. Transport	0,78	0,77	0,79	0,81	0,85	0,81	0,74	0,74	0,65	0,62	0,55	-69,92
4. Other Sectors	7,77	7,73	7,84	7,83	8,05	8,44	8,21	8,50	8,60	8,69	8,54	-2,53
5. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
B. Fugitive Emissions from Fuels	11,43	11,32	11,29	11,16	11,70	11,75	11,70	11,99	12,38	12,41	12,41	74,59
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
2. Oil and Natural Gas	11,43	11,32	11,29	11,16	11,70	11,75	11,70	11,99	12,38	12,41	12,41	74,59
2. Industrial Processes	**0,06**	**0,06**	**0,08**	**0,09**	**0,08**	**0,10**	**0,10**	**0,11**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**-100,00**
A. Mineral Products	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	NA,NE,NO	NA,NE,NO	0,00
B. Chemical Industry	0,06	0,06	0,08	0,09	0,08	0,10	0,10	0,11	NO	NO	NO	-100,00
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
D. Other Production												
E. Production of Halocarbons and SF_6												
F. Consumption of Halocarbons and SF_6												
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
3. Solvent and Other Product Use												
4. Agriculture	**81,77**	**85,02**	**87,51**	**86,42**	**87,37**	**89,80**	**89,74**	**86,95**	**83,06**	**81,92**	**79,57**	**-61,33**
A. Enteric Fermentation	57,86	59,66	61,66	60,80	61,03	63,02	64,47	62,12	58,96	57,17	56,46	-63,26
B. Manure Management	23,92	25,37	25,85	25,62	26,35	26,78	25,26	24,83	24,10	24,75	23,11	-55,63
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
D. Agricultural Soils	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
5. Land Use, Land-Use Change and Forestry	**0,11**	**0,21**	**0,16**	**0,15**	**0,04**	**0,46**	**0,03**	**0,06**	**0,15**	**0,05**	**0,09**	**-15,21**
A. Forest Land	0,02	0,12	0,07	0,04	0,01	0,19	0,01	0,02	0,05	0,00	0,05	118,51
B. Cropland	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	-43,87
C. Grassland	0,08	0,08	0,08	0,10	0,02	0,26	0,02	0,04	0,09	0,04	0,04	-47,70
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
6. Waste	**54,13**	**54,38**	**54,37**	**53,21**	**51,98**	**50,62**	**49,79**	**49,41**	**48,32**	**46,98**	**43,32**	**-12,36**
A. Solid Waste Disposal on Land	46,92	47,38	47,82	46,96	46,07	45,29	44,56	43,78	43,03	42,09	38,46	-6,53
B. Waste-water Handling	7,22	7,00	6,56	6,25	5,91	5,33	5,23	5,62	5,29	4,89	4,86	-41,31
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Total CH_4 emissions including CH_4 from LULUCF	**156,42**	**159,96**	**162,56**	**160,23**	**160,66**	**162,59**	**160,91**	**158,39**	**153,78**	**151,34**	**145,12**	**-47,02**
Total CH_4 emissions excluding CH_4 from LULUCF	**156,32**	**159,75**	**162,41**	**160,08**	**160,62**	**162,13**	**160,88**	**158,33**	**153,63**	**151,29**	**145,03**	**-47,03**
Memo Items:												
International Bunkers	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,02	0,03	0,03	0,03	37,50
Aviation	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-58,19
Marine	0,02	0,02	0,02	0,02	0,03	0,03	0,02	0,02	0,03	0,03	0,03	51,08
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
CO_2 Emissions from Biomass												

TABLE 10 EMISSION TRENDS: N_2O (Part 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990 (Gg)	1991 (Gg)	1992 (Gg)	1993 (Gg)	1994 (Gg)	1995 (Gg)	1996 (Gg)	1997 (Gg)	1998 (Gg)	1999 (Gg)	2000 (Gg)
1. Energy	**0,36**	**0,42**	**0,26**	**0,24**	**0,22**	**0,23**	**0,24**	**0,25**	**0,27**	**0,25**	**0,24**
A. Fuel Combustion (Sectoral Approach)	0,36	0,42	0,26	0,24	0,22	0,23	0,24	0,25	0,27	0,25	0,24
1. Energy Industries	0,08	0,09	0,05	0,05	0,05	0,04	0,04	0,04	0,05	0,04	0,03
2. Manufacturing Industries and Construction	0,04	0,04	0,02	0,02	0,02	0,01	0,01	0,01	0,01	0,01	0,01
3. Transport	0,15	0,19	0,12	0,09	0,07	0,09	0,09	0,10	0,11	0,10	0,09
4. Other Sectors	0,10	0,10	0,07	0,09	0,09	0,09	0,09	0,09	0,10	0,10	0,10
5. Other	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2. Industrial Processes	**3,00**	**3,14**	**2,30**	**2,41**	**1,88**	**2,10**	**2,88**	**3,18**	**4,11**	**4,33**	**5,08**
A. Mineral Products	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	NA,NE,NO	NA,NE,NO
B. Chemical Industry	3,00	3,14	2,30	2,41	1,88	2,10	2,88	3,18	4,11	4,33	5,08
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production											
E. Production of Halocarbons and SF_6											
F. Consumption of Halocarbons and SF_6											
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	0,31	0,31	0,30	0,30	0,29	0,28	0,28	0,27	0,27	0,26	0,25
4. Agriculture	**19,26**	**17,44**	**11,53**	**9,48**	**8,30**	**8,05**	**9,33**	**9,61**	**9,21**	**9,22**	**9,09**
A. Enteric Fermentation											
B. Manure Management	2,86	2,64	1,96	1,60	1,36	1,26	1,24	1,27	1,10	1,02	0,90
C. Rice Cultivation											
D. Agricultural Soils	16,41	14,80	9,57	7,88	6,94	6,79	8,09	8,34	8,11	8,19	8,18
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**0,16**	**0,16**	**0,16**	**0,15**	**0,17**	**0,16**	**0,14**	**0,15**	**0,17**	**0,19**	**0,19**
A. Forest Land	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07
B. Cropland	0,03	0,03	0,03	0,03	0,03	0,03	0,01	0,02	0,04	0,06	0,06
C. Grassland	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
D. Wetlands	0,05	0,05	0,05	0,04	0,05	0,05	0,05	0,05	0,05	0,05	0,05
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**0,26**	**0,26**	**0,26**	**0,26**	**0,26**	**0,26**	**0,25**	**0,25**	**0,25**	**0,25**	**0,25**
A. Solid Waste Disposal on Land											
B. Waste-water Handling	0,26	0,26	0,26	0,26	0,26	0,26	0,25	0,25	0,25	0,25	0,25
C. Waste Incineration	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total N_2O emissions including N_2O from LULUCF	**23,34**	**21,73**	**14,81**	**12,85**	**11,12**	**11,08**	**13,12**	**13,71**	**14,27**	**14,49**	**15,10**
Total N_2O emissions excluding N_2O from LULUCF	**23,19**	**21,57**	**14,64**	**12,69**	**10,95**	**10,91**	**12,98**	**13,56**	**14,10**	**14,31**	**14,91**
Memo Items:											
International Bunkers	**0,01**	**0,02**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,00**	**0,00**	**0,00**	**0,00**
Aviation	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Marine	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass											

TABLE 10 EMISSION TRENDS: N_2O (Part 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**0,26**	**0,27**	**0,28**	**0,30**	**0,31**	**0,34**	**0,37**	**0,38**	**0,32**	**0,33**	**0,32**	**-10,10**
A. Fuel Combustion (Sectoral Approach)	0,26	0,27	0,28	0,30	0,31	0,34	0,37	0,38	0,32	0,33	0,32	-10,12
1. Energy Industries	0,04	0,04	0,05	0,05	0,05	0,05	0,05	0,06	0,07	0,07	0,06	-20,38
2. Manufacturing Industries and Construction	0,01	0,02	0,02	0,02	0,03	0,03	0,03	0,02	0,02	0,02	0,02	-39,10
3. Transport	0,10	0,10	0,11	0,12	0,12	0,14	0,18	0,18	0,13	0,13	0,13	-13,48
4. Other Sectors	0,10	0,10	0,10	0,10	0,11	0,11	0,11	0,11	0,11	0,11	0,11	13,00
5. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	814,17
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
2. Oil and Natural Gas	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	814,17
2. Industrial Processes	**5,61**	**6,06**	**6,31**	**6,99**	**7,79**	**7,81**	**10,04**	**9,38**	**2,12**	**1,86**	**2,85**	**-4,73**
A. Mineral Products	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	NA,NE,NO	NA,NE,NO	0,00
B. Chemical Industry	5,61	6,06	6,31	6,99	7,79	7,81	10,04	9,38	2,12	1,86	2,85	-4,73
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
D. Other Production												
E. Production of Halocarbons and SF_6												
F. Consumption of Halocarbons and SF_6												
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
3. Solvent and Other Product Use	0,25	0,24	0,24	0,23	0,22	0,13	0,10	0,01	0,03	0,01	0,01	-96,23
4. Agriculture	**9,30**	**9,93**	**10,16**	**10,25**	**10,41**	**10,32**	**11,47**	**10,42**	**10,53**	**10,53**	**10,67**	**-44,59**
A. Enteric Fermentation												
B. Manure Management	0,92	0,94	0,98	0,97	0,98	1,01	1,01	0,96	0,90	0,89	0,87	-69,72
C. Rice Cultivation												
D. Agricultural Soils	8,38	8,98	9,18	9,29	9,43	9,32	10,46	9,46	9,63	9,64	9,81	-40,21
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
5. Land Use, Land-Use Change and Forestry	**0,18**	**0,17**	**0,14**	**0,15**	**0,14**	**0,24**	**0,21**	**0,23**	**0,20**	**0,13**	**0,13**	**-13,54**
A. Forest Land	0,07	0,07	0,07	0,07	0,07	0,08	0,07	0,07	0,07	0,07	0,08	5,89
B. Cropland	0,05	0,05	0,03	0,03	0,02	0,10	0,10	0,11	0,08	0,01	0,02	-37,52
C. Grassland	0,01	0,01	0,01	0,01	0,00	0,02	0,00	0,00	0,01	0,00	0,00	-47,70
D. Wetlands	0,05	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	-23,59
E. Settlements	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
F. Other Land	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0,00
6. Waste	**0,25**	**0,25**	**0,25**	**0,25**	**0,25**	**0,24**	**0,24**	**0,24**	**0,24**	**0,24**	**0,24**	**-8,19**
A. Solid Waste Disposal on Land												
B. Waste-water Handling	0,25	0,25	0,25	0,25	0,24	0,24	0,24	0,24	0,24	0,24	0,24	-8,36
C. Waste Incineration	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	67,67
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Total N_2O emissions including N_2O from LULUCF	**15,84**	**16,92**	**17,38**	**18,17**	**19,11**	**19,09**	**22,43**	**20,66**	**13,45**	**13,10**	**14,23**	**-39,03**
Total N_2O emissions excluding N_2O from LULUCF	**15,66**	**16,75**	**17,24**	**18,02**	**18,98**	**18,84**	**22,21**	**20,43**	**13,25**	**12,98**	**14,10**	**-39,20**
Memo Items:												
International Bunkers	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**0,01**	**-39,12**
Aviation	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,00	0,00	0,00	-58,19
Marine	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	51,08
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
CO_2 Emissions from Biomass												

TABLE 10 EMISSION TRENDS HFCs, PFCs and SF_6 (Part 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990 (Gg)	1991 (Gg)	1992 (Gg)	1993 (Gg)	1994 (Gg)	1995 (Gg)	1996 (Gg)	1997 (Gg)	1998 (Gg)	1999 (Gg)	2000 (Gg)
Emissions of HFCs(3) - (Gg CO_2 equivalent)	**NA,NO**	**NA,NO**	**NA,NO**	**0,10**	**0,27**	**2,75**	**3,66**	**5,41**	**8,15**	**10,62**	**13,61**
HFC-23	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-32	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,00	0,00	0,00
HFC-41	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
HFC-125	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,00	0,00	0,00
HFC-143	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,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,00	0,00
HFC-236fa	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
Unspecified mix of listed HFCs(4) - (Gg CO_2 equivalent)	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(3) - (Gg CO_2 equivalent)	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**
CF_4	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_2F_6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_3F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
$c\text{-}C_4F_8$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	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 CO_2 equivalent)	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 CO_2 equivalent)	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**4,30**	**0,05**	**0,05**	**0,08**	**0,10**	**0,14**	**0,33**
SF_6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,00	0,00	0,00

TABLE 10 EMISSION TRENDS HFCs, PFCs and SF_6 (Part 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs[(3)] - (Gg CO_2 equivalent)	**18,10**	**24,19**	**33,85**	**50,15**	**68,39**	**92,53**	**122,66**	**152,64**	**167,08**	**190,18**	**216,65**	**100,00**
HFC-23	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-32	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
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	0,00
HFC-125	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,01	0,01	0,01	0,02	100,00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-134a	0,01	0,01	0,01	0,02	0,02	0,03	0,05	0,06	0,06	0,07	0,08	100,00
HFC-152a	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-143a	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,01	0,01	0,01	0,02	100,00
HFC-227ea	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
HFC-236fa	NA,NO	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Unspecified mix of listed HFCs[(4)] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Emissions of PFCs[(3)] - (Gg CO_2 equivalent)	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**0,00**
CF_4	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C_2F_6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C_3F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
$c-C_4F_8$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Unspecified mix of listed PFCs[(4)] - (Gg CO_2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Emissions of SF6[(3)] - (Gg CO_2 equivalent)	**0,26**	**0,35**	**2,03**	**0,78**	**1,35**	**1,18**	**0,88**	**3,21**	**2,77**	**5,85**	**8,12**	**100,00**
SF_6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00

TABLE 10 EMISSION TRENDS
SUMMARY (Part 1 of 2)

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	CO_2 equivalent (Gg)										
CO_2 emissions including net CO_2 from LULUCF	31.478,45	33.651,72	16.995,82	10.813,11	11.388,73	11.624,42	17.478,76	15.261,91	8.208,99	5.694,82	2.551,81
CO_2 emissions excluding net CO_2 from LULUCF	35.815,45	37.906,77	21.218,11	16.387,05	15.799,12	15.053,53	15.702,75	15.104,27	15.923,09	13.455,67	11.853,19
CH_4 emissions including CH_4 from LULUCF	5.751,98	5.530,97	4.459,26	4.011,60	3.718,06	3.624,27	3.618,07	3.726,05	3.501,61	3.356,74	3.160,98
CH_4 emissions excluding CH_4 from LULUCF	5.749,67	5.528,90	4.454,15	4.008,55	3.715,02	3.621,23	3.615,03	3.723,01	3.499,57	3.353,74	3.158,03
N_2O emissions including N_2O from LULUCF	7.236,86	6.735,41	4.589,87	3.982,22	3.445,96	3.433,78	4.067,60	4.250,74	4.424,99	4.493,26	4.681,01
N_2O emissions excluding N_2O from LULUCF	7.188,74	6.686,83	4.539,65	3.934,54	3.394,26	3.383,40	4.023,47	4.204,19	4.372,14	4.435,36	4.622,59
HFCs	NA,NO	NA,NO	NA,NO	0,10	0,27	2,75	3,66	5,41	8,15	10,62	13,61
PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
SF_6	NA,NO	NA,NO	NA,NO	NA,NO	4,30	0,05	0,05	0,08	0,10	0,14	0,33
Total (including LULUCF)	**44.467,29**	**45.918,10**	**26.044,95**	**18.807,03**	**18.557,31**	**18.685,27**	**25.168,14**	**23.244,20**	**16.143,83**	**13.555,57**	**10.407,73**
Total (excluding LULUCF)	**48.753,87**	**50.122,50**	**30.211,91**	**24.330,24**	**22.912,96**	**22.060,96**	**23.344,97**	**23.036,97**	**23.803,04**	**21.255,52**	**19.647,75**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	CO_2 equivalent (Gg)										
1. Energy	32.744,95	34.883,84	19.646,13	15.789,18	14.849,86	13.903,45	14.407,93	13.963,72	14.676,63	12.331,85	10.807,37
2. Industrial Processes	4.396,79	4.434,17	2.561,62	1.642,78	1.831,78	2.111,50	2.525,83	2.484,35	2.910,30	2.856,09	3.018,96
3. Solvent and Other Product Use	197,52	195,83	193,87	191,53	188,98	186,36	183,75	181,17	178,61	176,07	173,54
4. Agriculture	10.292,09	9.464,70	6.651,94	5.530,83	4.866,13	4.680,76	5.046,05	5.221,04	4.848,59	4.704,95	4.457,30
5. Land Use, Land-Use Change and Forestry[(5)]	-4.286,58	-4.204,40	-4.166,96	-5.523,22	-4.355,65	-3.375,69	1.823,18	207,24	-7.659,21	-7.699,94	-9.240,01
6. Waste	1.122,51	1.143,96	1.158,36	1.175,92	1.176,21	1.178,88	1.181,41	1.186,69	1.188,91	1.186,56	1.190,58
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)[(5)]	**44.467,29**	**45.918,10**	**26.044,95**	**18.807,03**	**18.557,31**	**18.685,27**	**25.168,14**	**23.244,20**	**16.143,83**	**13.555,57**	**10.407,73**

TABLE 10 EMISSION TRENDS SUMMARY (Part 2 of 2)

GREENHOUSE GAS EMISSIONS	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
												(%)
CO_2 emissions including net CO_2 from LULUCF	-213,39	7.276,24	2.857,52	6.594,97	9.228,57	9.610,62	12.198,03	6.595,52	2.224,00	3.287,76	3.443,42	-89,06
CO_2 emissions excluding net CO_2 from LULUCF	12.558,01	12.676,10	12.661,14	13.244,24	14.017,63	14.408,34	15.769,66	15.103,94	12.920,15	13.725,06	13.970,47	-60,99
CH_4 emissions including CH_4 from LULUCF	3.284,89	3.359,11	3.413,83	3.364,75	3.373,81	3.414,29	3.379,19	3.326,25	3.229,45	3.178,14	3.047,53	-47,02
CH_4 emissions excluding CH_4 from LULUCF	3.282,66	3.354,76	3.410,52	3.361,68	3.372,95	3.404,68	3.378,51	3.324,99	3.226,32	3.177,09	3.045,57	-47,03
N_2O emissions including N_2O from LULUCF	4.909,54	5.245,10	5.388,22	5.632,26	5.925,60	5.916,43	6.951,87	6.406,13	4.169,99	4.061,15	4.412,49	-39,03
N_2O emissions excluding N_2O from LULUCF	4.854,25	5.192,90	5.343,63	5.584,65	5.882,97	5.841,24	6.885,67	6.334,48	4.106,78	4.022,40	4.370,88	-39,20
HFCs	18,10	24,19	33,85	50,15	68,39	92,53	122,66	152,64	167,08	190,18	216,65	100,00
PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
SF_6	0,26	0,35	2,03	0,78	1,35	1,18	0,88	3,21	2,77	5,85	8,12	100,00
Total (including LULUCF)	**7.999,39**	**15.904,99**	**11.695,45**	**15.642,91**	**18.597,71**	**19.035,06**	**22.652,62**	**16.483,76**	**9.793,28**	**10.723,09**	**11.128,20**	**-74,97**
Total (excluding LULUCF)	**20.713,27**	**21.248,30**	**21.451,18**	**22.241,50**	**23.343,28**	**23.747,97**	**26.157,37**	**24.919,27**	**20.423,10**	**21.120,58**	**21.611,70**	**-55,67**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
												(%)
1. Energy	11.461,38	11.551,44	11.544,79	12.164,11	12.858,95	13.049,23	13.283,25	13.132,81	11.861,22	12.757,79	11.820,46	-63,90
2. Industrial Processes	3.265,63	3.445,00	3.528,66	3.724,08	4.088,94	4.341,00	6.195,16	5.525,20	2.367,15	2.227,99	3.735,01	-15,05
3. Solvent and Other Product Use	170,87	168,22	165,58	162,64	159,22	127,72	117,56	90,95	95,38	87,41	85,95	-56,49
4. Agriculture	4.599,14	4.862,90	4.987,46	4.993,67	5.062,77	5.086,29	5.439,91	5.057,12	5.008,98	4.984,65	4.979,97	-51,61
5. Land Use, Land-Use Change and Forestry [(5)]	-12.713,88	-5.343,31	-9.755,72	-6.598,59	-4.745,58	-4.712,91	-3.504,75	-8.435,51	-10.629,82	-10.397,49	-10.483,49	144,57
6. Waste	1.216,25	1.220,74	1.224,69	1.196,99	1.173,40	1.143,73	1.121,50	1.113,19	1.090,37	1.062,74	990,31	-11,78
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
Total (including LULUCF) [(5)]	**7.999,39**	**15.904,99**	**11.695,45**	**15.642,91**	**18.597,71**	**19.035,06**	**22.652,62**	**16.483,76**	**9.793,28**	**10.723,09**	**11.128,20**	**-74,97**

Annex VII. LULUCF AREA MATRIX, RESULTED FROM STUDIES PRESENTED IN CHAPTER 7.7.

1990

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2054182	399	3994	2396	399	0	**2061370**	7188
Cropland	0	2402468	22367	0	799	399	**2426033**	-39541
Grassland	0	61110	1237381	3595	799	4793	**1307678**	42339
Wetlands	0	399	399	362268	0	0	**363066**	-5193
Settlements	0	1198	1198	0	321128	799	**324323**	1198
Other land	0	0	0	0	0	47530	**47530**	-5991
Initial	***2054182***	***2465574***	***1265339***	***368259***	***323125***	***53521***	***6530000***	0

1991

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2061370	399	3994	2396	399	0	**2068559**	7189
Cropland	0	2362926	22367	0	799	399	**2386492**	-39541
Grassland	0	61110	1279719	3595	799	4793	**1350015**	42337
Wetlands	0	399	399	357075	0	0	**357874**	-5192
Settlements	0	1198	1198	0	322326	799	**325521**	1198
Other land	0	0	0	0	0	41539	**41539**	-5991
Initial	***2061370***	***2426033***	***1307678***	***363066***	***324323***	***47530***	***6530000***	0

1992

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2068559	399	3195	1997	0	399	**2074550**	5991
Cropland	0	2320189	25562	0	0	799	**2346550**	-39942
Grassland	0	62308	1320858	2396	1598	4793	**1391954**	41939
Wetlands	0	399	0	353480	0	2396	**356276**	-1598
Settlements	0	2396	399	0	323924	399	**327119**	1598
Other land	0	799	0	0	0	32752	**33551**	-7988
Initial	***2068559***	***2386492***	***1350015***	***357874***	***325521***	***41539***	***6530000***	0

1993

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	Final	Net change
Forest land	2074550	1198	3994	0	0	0	**2079742**	5192
Cropland	0	2283842	23565	1198	799	1598	**2311003**	-35547
Grassland	0	59513	1363595	1598	1598	5192	**1431496**	39542
Wetlands	0	399	399	353480	0	399	**354679**	-1597
Settlements	0	799	399	0	324723	0	**325921**	-1198
Other land	0	799	0	0	0	26361	**27160**	-6391
Initial	***2074550***	***2346550***	***1391954***	***356276***	***327119***	***33551***	***6530000***	0

1994

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2079343	0	2396	399	399	0	**2082538**	2796
Cropland	0	2239508	29157	0	0	799	**2269464**	-41539
Grassland	0	67501	1398344	799	799	5592	**1473034**	41538
Wetlands	0	799	0	353480	0	399	**354679**	0
Settlements	0	2796	1598	0	324723	0	**329116**	3195
Other land	399	399	0	0	0	20370	**21169**	-5991
Initial	***2079742***	***2311003***	***1431496***	***354679***	***325921***	***27160***	***6530000***	0

1995

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2082538	0	1598	799	0	0	**2084935**	2397
Cropland	0	2206756	25962	0	0	399	**2233117**	-36347
Grassland	0	59513	1444277	2396	2796	4394	**1513375**	40341
Wetlands	0	799	1198	351483	0	1198	**354679**	0
Settlements	0	1997	0	0	326320	399	**328717**	-399
Other land	0	399	0	0	0	14778	**15178**	-5991
Initial	***2082538***	***2269464***	***1473034***	***354679***	***329116***	***21169***	***6530000***	0

1996

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2084935	399	3195	1598	0	0	**2090127**	5192
Cropland	0	2207555	8388	0	0	0	**2215942**	-17175
Grassland	0	25163	1501792	399	0	0	**1527355**	13980
Wetlands	0	0	0	352682	0	0	**352682**	-1997
Settlements	0	0	0	0	328717	0	**328717**	0
Other land	0	0	0	0	0	15178	**15178**	0
Initial	***2084935***	***2233117***	***1513375***	***354679***	***328717***	***15178***	***6530000***	0

1997

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2090127	799	2396	399	0	0	**2093722**	3595
Cropland	0	2163619	19571	0	0	399	**2183590**	-32352
Grassland	0	51125	1504588	0	0	0	**1555713**	28358
Wetlands	0	0	399	352282	0	0	**352682**	0
Settlements	0	399	399	0	328317	0	**329116**	399
Other land	0	0	0	0	399	14778	**15178**	0
Initial	***2090127***	***2215942***	***1527355***	***352682***	***328717***	***15178***	***6530000***	0

1998

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2093722	0	3195	0	0	399	**2097317**	3595
Cropland	0	2096518	37944	0	0	0	**2134462**	-49128
Grassland	0	86273	1514174	0	0	0	**1600447**	44734
Wetlands	0	0	0	352282	0	0	**352282**	-400
Settlements	0	399	399	399	329116	0	**330314**	1198
Other land	0	399	0	0	0	14778	**15178**	0
Initial	***2093722***	***2183590***	***1555713***	***352682***	***329116***	***15178***	***6530000***	0

1999

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2096917	399	1598	1198	0	0	**2100113**	2796
Cropland	0	2036606	51924	0	0	0	**2088530**	-45932
Grassland	0	97057	1546127	0	0	0	**1643184**	42737
Wetlands	399	0	0	351084	0	0	**351483**	-799
Settlements	0	399	799	0	330314	0	**331513**	1199
Other land	0	0	0	0	0	15178	**15178**	0
Initial	***2097317***	***2134462***	***1600447***	***352282***	***330314***	***15178***	***6530000***	0

2000

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2100113	399	2396	2396	0	399	**2105704**	5591
Cropland	0	1978292	51125	0	0	0	**2029416**	-59114
Grassland	0	107841	1588465	399	399	0	**1697105**	53921
Wetlands	0	0	0	348687	0	0	**348687**	-2796
Settlements	0	1997	1198	0	331113	0	**334309**	2796
Other land	0	0	0	0	0	14778	**14778**	-400
Initial	***2100113***	***2088530***	***1643184***	***351483***	***331513***	***15178***	***6530000***	0

2001

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2105704	799	2396	0	0	0	**2108900**	3196
Cropland	0	1925170	42338	0	0	0	**1967507**	-61909
Grassland	0	103049	1651572	399	399	399	**1755819**	58714
Wetlands	0	0	0	348288	0	0	**348288**	-399
Settlements	0	399	399	0	333909	399	**335107**	798
Other land	0	0	399	0	0	13979	**14379**	-399
Initial	***2105704***	***2029416***	***1697105***	***348687***	***334309***	***14778***	***6530000***	0

2002

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2108900	0	3994	399	0	0	**2113293**	4393
Cropland	0	1878438	40341	0	0	0	**1918779**	-48728
Grassland	0	88270	1711084	0	0	0	**1799355**	43536
Wetlands	0	0	399	347889	0	799	**349087**	799
Settlements	0	799	0	0	335107	0	**335906**	799
Other land	0	0	0	0	0	13580	**13580**	-799
Initial	***2108900***	***1967507***	***1755819***	***348288***	***335107***	***14379***	***6530000***	0

2003

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2112894	799	3595	1198	399	0	**2118885**	5592
Cropland	0	1853275	23565	0	0	0	**1876841**	-41938
Grassland	0	64705	1771396	0	0	399	**1836500**	37145
Wetlands	399	0	0	347889	0	0	**348288**	-799
Settlements	0	0	399	0	335507	0	**335906**	0
Other land	0	0	399	0	0	13181	**13580**	0
Initial	***2113293***	***1918779***	***1799355***	***349087***	***335906***	***13580***	***6530000***	0

2004

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2118486	399	6391	1598	0	0	**2126873**	7988
Cropland	0	1825716	29157	0	0	0	**1854873**	-21968
Grassland	0	50326	1800154	399	0	0	**1850879**	14379
Wetlands	399	0	799	346291	0	399	**347889**	-399
Settlements	0	399	0	0	335906	0	**336306**	400
Other land	0	0	0	0	0	13181	**13181**	-399
Initial	***2118885***	***1876841***	***1836500***	***348288***	***335906***	***13580***	***6530000***	0

2005

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2126474	799	5592	1598	0	399	**2134861**	7988
Cropland	0	1815331	19971	0	0	0	**1835302**	-19571
Grassland	0	37545	1824917	0	0	0	**1862462**	11583
Wetlands	0	0	399	346291	0	399	**347090**	-799
Settlements	399	1198	0	0	336306	0	**337903**	1597
Other land	0	0	0	0	0	12382	**12382**	-799
Initial	***2126873***	***1854873***	***1850879***	***347889***	***336306***	***13181***	***6530000***	0

2006

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2134063	799	5592	1598	0	0	**2142051**	7190
Cropland	0	1802949	90267	0	0	0	**1893217**	57915
Grassland	0	31154	1764206	799	0	0	**1796159**	-66303
Wetlands	0	399	399	344693	0	0	**345492**	-1598
Settlements	399	0	1598	0	337903	0	**339900**	1997
Other land	399	0	399	0	0	12382	**13181**	799
Initial	***2134861***	***1835302***	***1862462***	***347090***	***337903***	***12382***	***6530000***	0

2007

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2142051	2796	3195	1997	0	399	**2150439**	8388
Cropland	0	1866057	86673	0	0	0	**1952729**	59512
Grassland	0	24364	1705093	0	0	0	**1729457**	-66702
Wetlands	0	0	399	343495	0	0	**343894**	-1598
Settlements	0	0	799	0	339900	0	**340699**	799
Other land	0	0	0	0	0	12781	**12781**	-400
Initial	***2142051***	***1893217***	***1796159***	***345492***	***339900***	***13181***	***6530000***	0

2008

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2150439	1598	4793	399	0	0	**2157229**	6790
Cropland	0	1925969	100253	0	399	0	**2026621**	73892
Grassland	0	24764	1622015	399	0	0	**1647178**	-82279
Wetlands	0	0	799	343096	0	0	**343894**	0
Settlements	0	399	799	0	340300	0	**341498**	799
Other land	0	0	799	0	0	12781	**13580**	799
Initial	***2150439***	***1952729***	***1729457***	***343894***	***340699***	***12781***	***6530000***	0

2009

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	Net change
Forest land	2156829	0	3195	0	0	0	**2160024**	2795
Cropland	0	2009046	71495	0	0	0	**2080541**	53920
Grassland	0	17175	1570891	0	799	399	**1589264**	-57914
Wetlands	399	0	399	343894	0	0	**344693**	799
Settlements	0	399	799	0	340699	0	**341897**	399
Other land	0	0	399	0	0	13181	**13580**	0
Initial	***2157229***	***2026621***	***1647178***	***343894***	***341498***	***13580***	***6530000***	0

2010

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2160024	399	5592	399	0	0	**2166415**	6391
Cropland	0	2078944	5991	0	0	0	**2084935**	4394
Grassland	0	1198	1577681	799	0	0	**1579678**	-9586
Wetlands	0	0	0	343495	0	0	**343495**	-1198
Settlements	0	0	0	0	341897	0	**341897**	0
Other land	0	0	0	0	0	13580	**13580**	0
Initial	***2160024***	***2080541***	***1589264***	***344693***	***341897***	***13580***	***6530000***	0

2011

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2166415	1997	4793	0	0	0	**2173205**	6790
Cropland	0	2076547	13979	0	0	0	**2090527**	5592
Grassland	0	6391	1560905	399	0	0	**1567695**	-11983
Wetlands	0	0	0	343096	0	0	**343096**	-399
Settlements	0	0	0	0	341897	0	**341897**	0
Other land	0	0	0	0	0	13580	**13580**	0
Initial	***2166415***	***2084935***	***1579678***	***343495***	***341897***	***13580***	***6530000***	0

ANNEX VIII. IMPROVEMENTS IN RESPONSE TO RECOMMENDATIONS PROVIDED IN THE 2012 ARR

No.	ERT recommendations	Reference to para of the ARR 2012	Lithuania`s response	Where in the NIR/CRF
	Cross-cutting issues			
1.	Lithuania uses its key category analysis to select the methods to estimate GHG emissions and removals, but not to prioritize the development and improvement of the inventory. The ERT recommends that the Party also use the key category analysis to prioritize the development and improvement of the inventory.	Para 19	In 2013 submission prioritization of inventory improvements using key category assessment results are described in Chapter 1.5 and 1.7	Chapter 1.5 Chapter 1.7 Annex II
2.	Since Lithuania has reported a complete uncertainty analysis (see para. 22 below), the ERT encourages the Party to conduct a tier 2 key category analysis to take into account the information on uncertainties when prioritizing inventory improvements.	Para 20	In 2013 Lithuania have performed Tier 2 key categories analysis for the first time for 1990, 2000, 2005, 2010 and 2011 inventory years.	Chapter 1.5 Annex II
3.	Lithuania has reported a tier 1 uncertainty analysis generally in line with the IPCC good practice guidance. However, the Party has reported the uncertainties for CO_2, CH_4 and N_2O emissions separately for every category. The ERT recommends that Lithuania, in its next annual submission, perform the uncertainty analysis for each category for all gases combined, thereby allowing the Party to use this information to greater effect when planning inventory improvements (see para. 19 above). In response to a recommendation from the previous review report, Lithuania has included the solvent and other product use sector in the uncertainty analysis reported in annex II to the NIR. However, Lithuania has reported in the first paragraph of page 48 in the NIR that this sector is excluded from the uncertainty analysis. The ERT therefore recommends that Lithuania improve the consistency of the information on the uncertainty analysis in the next annual submission.	Para 22	Responding to ERT recommendations uncertainty analysis is reported according to GPG 2000 Tier 1 (table 6.1) and for each category for all gases combined. Results of combined uncertainty were the same as Tier 1 and enable us to identify subcategories for national GHG inventory improvements. Solvent and other product use sector is included in the uncertainty analysis and reported in annex II of the NIR. Typing error in page 48 in the NIR is corrected.	Chapter 1.7 Annex II
4.	The Ministry of Environment and the Environmental Protection Agency updated the QA/QC plan in 2011, adding some category-specific QC procedures. The Environmental Protection Agency is responsible for the coordination and implementation of the plan while the Ministry of Environment supervises the process. In its NIR, Lithuania explained that its QA/QC procedures are formally incorporated in the inventory improvement process, but that further improvements are planned. Under a partnership project with Norway, Lithuania will further develop the competence and expertise of its team of inventory experts and improve its QA/QC procedures. The partnership project is scheduled	Para 25	Norway partnership project is still delayed and is planned to start in 2013 or 2014. However part of the issues that had to be resolved during Norway Project are now being solved in EU support Project „Assistance to MS with KP reporting".	Chapter 1.2.1

	to run in 2012 and 2013. The ERT encourages the Party to report on the progress made in its next annual submission.			
5.	As part of its archiving system, Lithuania uses specific data flow documentation protocols (tabular forms) that record the sources of the data (AD, EFs and other parameters) and the locations where these are stored, and include specific columns where QA/QC staff can ask questions to and receive answers from the sector experts. The ERT noted that these protocols also allow external reviewers to access all information necessary to assess the quality of any emissions estimate in the inventory of the 2012 annual submission and in all previous submissions since 2006. The ERT noted that some data providers regularly update their data. However, the documentation protocols do not record the date on which the data were received. The ERT encourages Lithuania to add a column in the protocols in which to record the date and time of each data delivery.	Para 28	This recommendation is taken into account in this submission.	GHG inventory archive
6.	The ERT also noted that, for some methods based on complex models (e.g. road transportation), the protocols allow external users to quickly access the calculation spreadsheets or the assumptions used in the calculations. The ERT therefore encourages Lithuania to include an explanatory note in all calculation sheets that briefly documents any assumptions used in the calculations.	Para 29	This recommendation is taken into account in this submission.	GHG inventory archive
7.	Lithuania has reported information on its accounting of Kyoto Protocol units in the required SEF tables, as required by decisions 15/CMP.1 and 14/CMP.1. The ERT took note of the findings included in the SIAR on the SEF tables and the SEF comparison report.[16] The SIAR was forwarded to the ERT prior to the review, pursuant to decision 16/CP.10. The ERT reiterates the main findings and recommendations contained in the SIAR.	Para 161	The only recommendation was related to the reporting of discrepancies. The R-2 table is submitted as a part of this NIR.	R-2 table
8.	Lithuania did not provide information on changes in its reporting of the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol in its annual submission. The ERT recommends that Lithuania report any changes in its information provided under Article 3, paragraph 14, in accordance with decision 15/CMP.1, annex, chapter I.H, in the next annual submission.	Paras 168-170	In this submission only changes to information on minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol comparing to previous NIR were reported.	Chapter 15
	Energy			

9.	To further improve the transparency of the NIR, the ERT recommends that the Party include, in its next annual submission, information to justify the recalculations of key categories in terms of an improvement in accuracy, transparency or completeness. For example, if the AD from the energy balances are updated, the ERT recommends that Lithuania include, in the NIR, information on the fuels updated and the underlying reasons for the updates.	Para 35	Lithuania included in the NIR information on the fuels updated and provided reasons for the updates of AD.	Chapter 3
10.	The ERT strongly reiterates the recommendation from the previous review report that Lithuania include the information to justify the use of the EFs from the 2006 IPCC Guidelines in its next annual submission.	Para 38	In this submission, country specific CO_2 EFs were applied based on the results of study "Determination of national GHG emission factors for energy sector", which was prepared by Lithuanian Energy Institute. Plant specific CO_2 EFs based on EU ETS data were used where appropriate. 1996 IPCC default emission factors were used for CH_4 and N_2O emissions estimation, except biogas, peat and used tires (industrial waste). CH_4 and N_2O emission factors for biogas, peat and used tires were based on the results of study "Determination of national GHG emission factors for energy sector".	Chapter 3, Annex IV
11.	The transparency of the transport section of the NIR could be improved by, for example, including information on: the assumption for the surrogate data used to extrapolate the jet kerosene consumption trend prior to 2001 for civil aviation; the data sources for the different parameters used in road transportation; and the fluctuations in the N_2O implied emission factor (IEF) for gasoline in road transportation for the period 2006–2008. In response to a question raised by the ERT during the review, Lithuania provided additional information explaining these issues. The ERT recommends that the Party include these explanations in its next annual submission.	Para 41	The assumption for the surrogate data used to extrapolate the jet kerosene consumption trend prior to 2001 for civil aviation presented in the NIR. The data sources for the different parameters used in road transportation was clarified. The description of fluctuations in the N_2O implied emission factor (IEF) for gasoline in road transportation for the period 2006–2008 was provided.	Chapter 3.4.1.2 Chapter 3.4.2.2 Chapter 3.4.2.3
12.	Category-specific QA/QC procedures are not described in detail in the NIR, where the only references are to the general QA/QC plan. In response to a question raised by the ERT during the review, the ERT learned that the sector expert for the energy sector does not have a working manual to follow. The ERT recommends that Lithuania strengthen its QC procedures by developing formal documentation on the assumptions, EFs, AD sources and QC procedures for each key category. The ERT also recommends that the Party include descriptions of	Para 42	Lithuania included descriptions of the tier 2 QA/QC procedures carried out for the key categories: comparison between the inventory data and the data reported under the EU ETS. Documentation on the EFs, AD sources and QC procedures are provided to the	Chapter 3.7

	the tier 2 QA/QC procedures carried out for the key categories (e.g. analyses of the differences between the inventory data and the data reported under the European Union emissions trading scheme (EU ETS) and information on how such analyses are used to improve the GHG inventory) in the next annual submission.		Environment Protection Agency and is stored in inventory archive.	
13.	The energy sector largely fulfils the IPCC quality criteria for comparability. However, the ERT noted that fugitive emissions from natural gas transmission and distribution are reported under other (oil and natural gas) instead of under natural gas, as required by the IPCC good practice guidance. To improve the comparability of the Party's reporting, the ERT recommends that Lithuania reallocate the fugitive emissions from natural gas transmission and distribution to the appropriate category in accordance with the IPCC good practice guidance in its next annual submission.	Para 43	In this submission Lithuania reallocated the fugitive emissions from natural gas transmission and distribution to the appropriate category in accordance with the IPCC good practice guidance.	Chapter 3.6
14.	The ERT noted that Lithuania has indicated in the CRF tables and in the NIR (e.g. page 88) that it uses a tier 1 method to estimate CO_2 emissions from stationary combustion. In response to a question raised by the ERT during the review regarding the choice of method used to estimate CO_2 emissions from stationary combustion, the Party clarified that the methodological approaches applied by the Party are in accordance with an IPCC tier 2 method, because the energy statistics used are available for specific categories and, in many cases, country-specific EFs are also available. The ERT recommends that Lithuania clarify which methodological approach is used to estimate the emissions and document this correctly in the next annual submission.	Para 44	Lithuania clarified which methodological approach is used to estimate the emissions (Tier2/Tier3) and documented this correctly in this year submission.	Chapter 3
15.	Emissions from the energy sector are generally estimated consistently over time. However, the ERT noted inconsistencies in the IEFs for CO_2, CH_4 and N_2O emissions from flaring of oil (the IEFs for CO_2, CH_4 and N_2O for the period 1990–2009 reported in CRF table 1.B.2 are 67.00 kg/m^3, 137.50 g/m^3 and 0.640 g/m^3, respectively, but 67.48 kg/m^3, 138.49 g/m^3 and 0.644 g/m^3, respectively, for 2010). In response to a question raised by the ERT during the review, Lithuania explained that the emissions were correctly estimated but that an error produced when transferring the AD to the CRF Reporter software was the cause of the inconsistent IEFs. The ERT recommends that Lithuania, in the next annual submission, improve its QA/QC procedures by performing time-series checks of data after they have been inputted into the CRF Reporter software and explain any recalculation for emissions from flaring in the oil industry.	Para 45	Lithuania improved QA/QC procedures by performing time-series checks of data and corrected these errors.	Chapter 3.6

16.	The previous review report noted that the use of country-specific CO_2 EFs for some fuels was not properly documented in the NIR. In response to a question raised by the current ERT during the review, Lithuania presented results and documentation from a national study on CO_2 EFs carried out in 2012 (mentioned in the NIR as a planned improvement) and including most fuels. The ERT commends Lithuania for its efforts to properly document and justify its country-specific CO_2 EFs and recommends that the Party report the results of the study in its next annual submission, including documentation justifying the appropriateness of the EFs to national circumstances (in an annex to the NIR or in a separate peer-reviewed report referenced in the NIR).	Para 46	Lithuania included the summary of the study "Determination of national GHG emission factors for energy sector", performed by Lithuanian Energy Institute in August 2012 in an Annex IV to the NIR.	Annex IV
17.	In the energy sector, the Party uses a constant country-specific CO_2 EF for natural gas (56.90 t/TJ) for all categories for the whole time series (1990–2010), which is higher than the default value from the Revised 1996 IPCC Guidelines (56.10 t/TJ). In response to a question raised by the ERT during the review, Lithuania explained that the Party is considering to use an updated country-specific CO_2 EF (55.23 t/TJ) based on a new national study. The ERT recommends that Lithuania include information on any recalculation in the next annual submission. In the industrial processes sector (NIR table 4.14), the Party stated that the annual carbon content of natural gas used for ammonia production is based on CO_2 measurements performed by the laboratory of Lithuania's natural gas supplier (AB Lietuvos dujos). The carbon content of natural gas shows relatively significant variations over time (0.396–0.521 kg C/m^3), indicating that an annually variable CO_2 EF may better reflect the CO_2 emissions from natural gas combustion. In response to a question raised by the ERT during the review, Lithuania explained that the information on annual carbon content of natural gas used for ammonia production provided in table 4-14 in the NIR is no longer relevant and that the Party is using the same country-specific CO_2 EF (56.90 t/TJ) as in the energy sector. The ERT encourages Lithuania to derive annually variable CO_2 EFs if information on annual natural gas carbon content is available and report on any results in the next annual submission.	Para 47	In the year submission the updated country-specific CO_2 EF (55.23 t/TJ) based on a new national study was used. Lithuania included information on recalculations in the NIR.	Chapter 3
18.	Lithuania uses a country-specific CO_2 EF for residual oil (81.29 t/TJ) that is higher than the IPCC default value (77.40 t/TJ), without providing explanations for the large divergence. During the review, the Party explained that the residual oil actually contains two different types of oil – regular residual fuel oil and "non-tradable oil" – with two different CO_2 EFs (77.60 t/TJ and 81.29 t/TJ, respectively). Further, Lithuania expressed its intention to revise the emission estimates in the 2013 annual submission by accounting for the fuel oils	Para 48	Lithuania resolved this issue and in this submission recalculated the CO_2 emissions from residual fuel oil using the new information and included explanatory information in the NIR.	Chapter 3

	separately. The ERT commends Lithuania for its efforts to resolve the issue and recommends that the Party, in its next annual submission, recalculate the CO_2 emissions from residual fuel oil using the new information and include information justifying changes.			
19.	Lithuania has estimated the uncertainties for all categories and gases in the energy sector, mainly based on the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and the 2006 IPCC Guidelines. In most cases, the ERT agrees with the estimated uncertainties. However, with regard to biomass consumption in other sectors, Lithuania applies an uncertainty of ±5 per cent, which is lower than the suggested range in the IPCC good practice guidance (from ±10 to ±30 per cent for well-developed statistical systems and from ±30 to ±60 per cent for less-developed statistical systems). In response to a question raised by the ERT during the review, Lithuania explained that it intends to use the range ±30 to ±60 per cent for biomass consumption in its next annual submission. The ERT recommends that the Party make the intended changes and report thereon in its next annual submission.	Para 49	Uncertainty with regard to biomass consumption was corrected (AD uncertainty 50 per cent, EF - 50 per cent for biomass).	Chapter 3, Annex II
20.	In addition to implementing the results of the newly developed country-specific CO_2 EFs for stationary combustion (see para. 46 above), the NIR mentions several planned improvements for the categories under transport, including: using a tier 2 methodology for civil aviation emissions using detailed AD on take-off/landing cycles; refining the AD for liquefied petroleum gas fuel cars to match the tier 3 methodology used for road transportation; and investigating the possibility of implementing a tier 2 approach for railways. The ERT recommends that Lithuania use the results of the key category analysis when determining the focus of its improvement efforts.	Para 50	Recalculation of CH_4 and N_2O at new Tier 2 method for Civil aviation during 2006-2011 was done. Recalculation of Road transport emissions of CH_4 and N_2O at new Tier 3 method for LPG was done. Lithuania investigated the possibility to apply Tier 2 for railways transport. It was concluded that data is not complete to improve the accuracy and reduce uncertainty.	Chapter 3.4.1 Chapter 3.4.2
21.	For 2010, the CO_2 emissions estimated using the reference approach are 0.19 per cent higher than the CO_2 emissions estimated using the sectoral approach. The differences between the reference and sectoral approaches for every year in the period 1990–2010 range from –4.62 per cent to 1.75 per cent. With regard to gaseous and solid fuels, there are systematic differences over time, with the sectoral approach resulting in higher CO_2 emissions than the reference approach for all years of the time series, whereas the differences for energy consumption are much smaller, indicating the differences in the CO_2 EF used. The ERT encourages Lithuania to investigate any systematic differences in the net calorific values and CO_2 EF used in the reference and sectoral approaches and include the results in the next annual submission.	Para 51	Lithuania investigated systematic differences in the net calorific values used in the reference and sectoral approaches and included the results in this year submisison.	Chapter 3.2.1
22.	There are large differences between the total energy consumption reported to	Para 52	Lithuania reported all imported natural gas in	Chapter 3.2

	the International Energy Agency (IEA) (215,080.00 TJ for 2010) and that reported in CRF table 1.A(b) (194,968.00 TJ for 2010). In response to a question raised by the ERT during the review week, Lithuania explained that this is mainly due to the differences in natural gas imports (103,990.00 TJ for 2010 according to the data reported to IEA and 81,703.00 TJ according to the data reported in the CRF tables for 2010). In CRF table 1.A(b), Lithuania has excluded all natural gas used as non-energy use from the import data. This is not in line with the IPCC good practice guidance. The Party also explained that it intends to correct this in the 2013 annual submission. The ERT recommends that Lithuania report all imported natural gas in CRF table 1.A(b) in the next annual submission.		CRF table 1.A(b) in this year submission.	
23.	Lithuania further explained that the differences in natural gas consumption between the IEA data and the reference approach may also be due to the use of different types of calorific values: the reference approach uses a net calorific value whereas the IEA data are reported using a gross calorific value. The ERT encourages Lithuania to investigate the effect of the use of different types of calorific values and include the results in the next annual submission.	Para 53	The differences in natural gas consumption between the IEA data and the reference approach are due to the use of different types of calorific values: the reference approach uses a net calorific value whereas the IEA data are reported using a gross calorific value. This explanation is provided in the NIR.	Chapter 3.2.1
24.	In addition, there are several significant differences between the IEA data and the values in the CRF tables, including: crude oil imports for 1991–1994 and 2000; crude oil stocks for 1990; refinery feedstock imports for 1990–2010; refinery feedstock stocks for 1990–2010; and naphtha exports for 2001–2009. In response to a question raised by the ERT during the review, the Party explained that it intends to investigate these differences in cooperation with Statistics Lithuania. The ERT recommends that Lithuania explain and, if appropriate, correct these differences in the next annual submission.	Para 54	Lithuania explained these differences in the NIR.	Chapter 3.2.1
25.	Information on bunker fuels is provided by Statistics Lithuania for the complete time series (1990–2010) for marine activities. With regard to aviation fuel, information is only available from 2001 onwards. Following a recommendation from the previous review report, Lithuania extrapolated the data for aviation fuel for the period 1990–2000 using surrogate parameters. The ERT noted that the description in the NIR of the assumptions used for the extrapolation was not transparent. In response to a question raised by the ERT during the review, Lithuania provided extensive information clarifying the underlying parameters and assumptions used. The ERT recommends that the Party improve the transparency of the NIR by including a summary of this information in the next annual submission.	Para 55	The description in the NIR of the assumptions used for the extrapolation is provided.	Chapter 3.4.1.2
26.	The ERT noted discrepancies between CRF tables 1.A(b) and 1.C for jet kerosene	Para 56	The corrections were made for international	Chapter 3.2.2

	(international aviation bunkers) for the period 1990–2005 and for 2010. For example, for 2010, Lithuania has reported 2,237.00 TJ of jet kerosene for international bunkers in CRF table 1.A(b) but 2,012.00 TJ in CRF table 1.C . In response to a question raised by the ERT during the review, Lithuania expressed its intention to correct these inconsistencies in the next annual submission. The ERT recommends that the Party correct these inconsistencies and include a QC check for inconsistencies between CRF tables 1.A(b) and 1.C in the next annual submission.		bunkers in CRF table 1.A(b). Lithuania improved QA/QC procedures by performing time-series checks of data and corrected these errors.	
27.	The information on feedstocks and non-energy use of fuels is reported separately from other fuel consumption by Statistics Lithuania in the energy balances. In Lithuania, large amounts of natural gas are used for the production of ammonia and methanol. However, the Party has reported that the carbon stored from natural gas used for nonenergy use has been excluded from the reference approach in CRF table 1.A(d). This is not in line with the Revised 1996 IPCC Guidelines. The ERT recommends that Lithuania include the natural gas used for non-energy purposes in the reference approach, and account for it as feedstocks and carbon stored in CRF table 1.A(d) accordingly, in the next annual submission.	Para 57	Lithuania included the natural gas used for non-energy purposes in the reference approach and accounted for it as feedstocks and carbon stored in CRF table 1.A(d) accordingly.	Chapter 3.2
28.	To further improve the transparency of the reporting, the ERT recommends that Lithuania indicate, for each fuel, how feedstocks and non-energy use of fuels have been accounted for and where they have been allocated (i.e. the amount stored on a long-term basis in products and the amount released as CO_2 during its use) in the next annual submission. The ERT also recommends that the Party cross-check the data reported as nonenergy use under the energy sector with the data reported under the industrial processes sector, in the next annual submission.	Para 58	The data reported as non-energy use under the energy sector was cross-checked with the data reported under the industrial processes sector. Information on feedstocks and non-energy use of fuels are provided in the NIR.	Chapter 3.2.3
29.	The previous review report recommended that Lithuania include an explanation of the non-energy use of gaseous fuels in the documentation boxes in CRF tables 1.A(c) and 1.A(d). In its 2012 annual submission, Lithuania has included some information in the documentation box of CRF table 1.A(c) but not for CRF table 1.A(d). The current ERT reiterates the recommendation from the previous review report that Lithuania include an explanation of the non-energy use of gaseous fuels in the documentation box in CRF table and 1.A(d), in the next annual submission.	Para 59	Lithuania included an explanation of the non-energy use of gaseous fuels in the NIR.	Chapter 3.2.3
30.	In response to a question raised by the ERT during the review, Lithuania explained that the coke used for the production of metals is reported together with coking coal consumption under other (manufacturing industries and	Para 60	Lithuania reported emissions from coke and coking coal separately in this year submission.	Chapter 3

	construction). The ERT believes that this may lead to a possible underestimation of emissions, as coke normally has a higher carbon content than coking coal. Lithuania corrected its reporting of coke and coking coal in the revised CRF tables submitted during the review week by using the CO_2 EF for coke from the Revised 1996 IPCC Guidelines to estimate CO_2 emissions from coke. The ERT recommends that the Party report emissions from coke and coking coal separately in the next annual submission.			
31.	Lithuania has estimated CH_4 emissions from biomass combustion using a tier 1 approach. This is not in line with the IPCC good practice guidance as some categories under stationary combustion are key categories. In response to a question raised by the ERT during the review, the Party explained that measurements conducted over a long period of time are needed to develop country-specific CH_4 EFs. The ERT reiterates the recommendation from the previous review report that Lithuania estimate these emissions, in its next annual submission, using a tier 2 approach (e.g. by investigating whether internationally referenced EFs or the EFs used by neighbouring countries are also appropriate to national circumstances).	Para 61	Lithuania has estimated CH_4 emissions from biomass combustion using a tier 1 as analysis of EFs used by neighbouring countries (Latvia, Estonia, Poland etc.) showed that these countries are using 1996 IPCC default values.	Chapter 3
32.	Lithuania has applied a CH_4 EF from the 2006 IPCC Guidelines to estimate emissions from diesel oil in off-road vehicles and other machinery (other transportation) without justifying why it is appropriate for the Party. The ERT concluded that the CH_4 EF used may lead to a possible underestimation of emissions, as its value (1.67 kg/TJ) is lower than the default value from the Revised 1996 IPCC Guidelines (5 kg/TJ in table 1-7). Lithuania submitted revised emission estimates in the CRF tables submitted during the review week by applying the default EF from the Revised 1996 IPCC Guidelines. The ERT recommends that Lithuania justify the use of the CH_4 EF for diesel oil for off-road vehicles and other machinery from the 2006 IPCC Guidelines or apply the default EF from the Revised 1996 IPCC Guidelines in the next annual submission.	Para 62	Following ERT 2012 recommendations IPCC 1996 EF for CH_4 and N_2O was applied in this submission.	Chapter 3.4.5.2.2.
33.	Lithuania has used country-specific CH_4 EFs to estimate CH_4 emissions from residual fuel oil and diesel oil from navigation without providing proper justification. The ERT believes that the EFs used may lead to a possible underestimation of emissions, because the values of these EFs (3.0 kg/TJ in both cases) are lower than the default values from the Revised 1996 IPCC Guidelines (5 kg/TJ in both cases). Lithuania submitted revised estimates in the CRF tables submitted during the review week by applying the default EFs from the Revised 1996 IPCC Guidelines. The ERT recommends that Lithuania justify the use of the country-specific CH_4 EFs or apply the default EFs from the Revised 1996 IPCC	Para 63	Following ERT 2012 recommendations for Water-navigation EF CH_4 by Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories was applied in this submission.	Chapter 3.4.4.2

	Guidelines, in the next annual submission.			
	Industrial processes and solvent use			
34.	Lithuania has used the notation key "NE" (not estimated) to report emissions for the entire time series for some categories for which methodologies and/or EFs are not available in the IPCC good practice guidance or the Revised 1996 IPCC Guidelines, including: CO_2 emissions from road paving with asphalt; CH_4 and N_2O emissions from glass production; CO_2 emissions from chemical products, manufacture and processing; and N_2O emissions from degreasing and dry cleaning, and from other solvent and other product use (except for the use of N_2O for anaesthesia, where emissions have been estimated). The ERT encourages Lithuania to explore the possibility of estimating these emissions in its next annual submission.	Para 67	In 2012 submission Lithuania has concentrated on issues related to emissions of F-gases. Due to limited resources there were no possibilities to estimate emissions for the categories for which methodologies and/or EFs are not available in the IPCC good practice guidance or the Revised 1996 IPCC Guidelines.	-
35.	Since its previous annual submission, Lithuania has made many improvements to the information on the industrial processes sector in the NIR. The NIR is more complete, more transparent, better structured and now contains information on category-specific QA/QC activities for some categories. The ERT encourages Lithuania to continue to improve its inventory, for example by explaining, in its next annual submission, emission trends, especially where they show large variations or are particular to national circumstances, as well as any inter-annual fluctuations in the IEFs, in the next annual submission.	Para 68	In 2012 submission Lithuania has made substantial improvements in the chapter Consumption of Halocarbons and SF6.	Chapter 4.7
36.	Similarly to what was identified in the previous review report, Lithuania has used a tier 2 methodology from the IPCC good practice guidance with plant-specific data (data on annual clinker production, the calcinated fraction of the cement kiln dust data and the calcium oxide and magnesium oxide content of the clinker) to estimate CO_2 emissions from cement production for the period 1990–2004, while for the period 2005–2010, the Party has used data reported under the EU ETS. Lithuania compared the results of the two methods for the period 2005–2010 and concluded that the difference between them is minor and, hence, the consistency of the entire time series has been maintained, in line with the IPCC good practice guidance. In response to a question raised by the ERT during the review, the Party explained that the difference between the methods is less than 0.2 per cent. The ERT reiterates the recommendation that Lithuania provide information on the comparison of the two methods in its next annual submission in order to increase the transparency of its reporting.	Para 69	Comparison of CO_2 emissions (Tier 2 versus EU ETS) for 2005-2009 is provided in the chapter 4.2.1 (section "Source-specific QA/QC and verification").	Chapter 4.2.1
37.	As identified in the previous review report, the ERT noted some inter-annual variations in the IEF for ammonia production. For example, the IEF for 2003 was 1.66 t CO_2/t ammonia, while for all other years of the time series the IEFs were	Para 70	Explanations for the variations in implied emission factor (t CO_2 per tonne of ammonia) provided in the Chapter 4.3.1 section on	Chapter 4.3.1

	higher than 2.0 t CO_2/t ammonia. The ERT reiterates the recommendation that Lithuania explain these variations, in particular for the years where the inter-annual fluctuations are most significant, in its next annual submission.		methodological issues.	
38.	The ERT noted that, according to the CO_2 emissions from ammonia production calculations provided during the review, the CO_2 emissions are calculated by multiplying the natural gas consumption (in TJ) by a country-specific CO_2 EF (56.90 t/TJ). The carbon content of the natural gas is then calculated from the emissions. The ERT also noted that the information in the NIR, which states that the CO_2 emissions are calculated from gas consumption and carbon content data, is incorrect (see para. 47 above). The ERT further noted that Lithuania has used an oxidation factor of 1.0 in the calculations, thereby assuming that all carbon is oxidized. To improve the transparency of its reporting, the ERT recommends that Lithuania correct and improve the information on the estimation and allocation of CO_2 emissions from ammonia production, including an explanation of how the natural gas consumption is divided between thermal processes and production processes.	Para 72	Information on the estimation and allocation of CO_2 emissions from ammonia production updated and corrected (Chapter 4.3.1 section on methodological issues).	Chapter 4.3.1
39.	The ERT noted that Lithuania has provided disaggregated emission estimates for different HFC species in table 4-33 of the NIR, including for HFC-365mfc and HFC-245fa. The ERT also noted that these two HFC species are not included in the list of HFCs contained in the UNFCCC reporting guidelines and therefore commends Lithuania for reporting these emissions. The ERT further noted that the Party has reported HFC emissions from foam blowing under an unspecified mix of HFCs listed in CRF table 2(II), and that these emissions include emissions of HFC-365mfc and HFC-245fa. The ERT recommends that Lithuania exclude the emissions of HFC-365mfc and HFC-245fa from CRF table 2(II), and report the emissions from these two species in CRF table 9(b) in the next annual submission. As the Party has already reported disaggregated data on emissions of HFC-134a and HFC-227ea in table 4-33 of the NIR, the ERT recommends that Lithuania report these emissions separately in CRF table 2(II) in the next annual submission.	Para 76	Emissions of HFC-365mfc and HFC-245fa were excluded from CRF table 2(II), and reported in CRF table 9(b). HFC-134a and HFC-227ea emissions were reported separately in CRF table 2(II) also.	CRF 2.F.2
40.	Lithuania carried out a survey in 2008 to collect data on F-gases from importers and users. The results of the survey, along with new AD, were used in the 2012 annual submission. The ERT noted that the Party has not included information in the NIR on the methods used by the sector experts to derive the estimates of F-gas emissions. In response to a question raised by the ERT during the review, Lithuania provided more information on the methods used by the experts, including how data extrapolation was used where AD were not available and	Para 77	Detailed information on the data sources, methods of data collection and data extrapolation provided in the Chapter 4.7.	Chapter 4.7

	how the information from supply companies was used in the estimations. The ERT recommends that the Party include this information in its next annual submission, in order to improve the transparency of its reporting.			
41.	The leakage rate factor for lifetime emissions of HFCs from commercial and industrial refrigeration equipment is among the lowest for reporting Parties. For example, for HFC-125 emissions from commercial refrigeration, Lithuania has used a product life factor of 3.0 per cent, compared with a range of 1.5–24.3 per cent for all reporting Parties. In response to a question raised by the ERT during the review, Lithuania explained that this factor is based on the results of a survey of the eight companies involved in the installation and operation of equipment containing F-gases (2008 survey (see para. 77 above)). The ERT welcomes the Party's intention to use the results from the 2012 study (see para. 74 above) in the next annual submission and encourages Lithuania to provide additional information in the NIR to corroborate the low leakage factor.	Para 79	The results of the 2012 study were used to improve the estimates of emissions of HFCs from commercial and industrial refrigeration equipment (Chapter 4.7.1.2). However, justification of the product life factor of 3.0 per cent was not improved. The 2012 study has concluded that current data collection practice (commercial and industrial refrigeration) do not allow for estimation of emissions according to the IPCC Guidelines and recommended to continue following the revised calculation model which so far has been applied for the preparation of national reports.	Chapter 4.7.1.2
42.	In CRF table 2(II).F, Lithuania has reported HFC emissions from the disposal of commercial and industrial refrigeration equipment as "NE" for 2010. In response to a question raised by the ERT during the review, the Party explained that, according to the 2008 survey (see para. 77 above), fluorinated refrigerants in commercial and industrial refrigeration equipment were used in Lithuania in newly installed systems from approximately 2003 onwards. The Party has therefore assumed that the commercial and industrial systems have not yet reached the end of their operational lifetime limit. No data are thus far available on the decommissioning of commercial and industrial refrigeration equipment in the country; this was confirmed by the single national recycling company. The ERT encourages Lithuania to include data on the decommissioning of all refrigeration equipment in its data collection procedures in the next annual submission. Further, the ERT recommends that the Party, in its next annual submission, report emissions from the disposal of commercial and industrial refrigeration equipment as "NO" (rather than as "NE") until the decommissioning of this equipment begins.	Para 80	Disposal of commercial and industrial refrigeration equipment reported as "NO" in CRF (2.IIA.F.1.2 and 2.IIA.F.1.4).	CRF 2.IIA.F.1.2 and 2.IIA.F.1.4
Agriculture				

43.	Lithuania has reported GHG emissions from rice cultivation, prescribed burning of savannas and field burning of agricultural residues as "NO". Further, the Party has reported CH4 emissions from all relevant categories under agricultural soils as "NA", indicating that neither the Revised 1996 IPCC Guidelines nor the IPCC good practice guidance provide a methodology to estimate these emissions. The ERT encourages Lithuania to estimate these emissions in the next annual submission. If this is not possible, the ERT recommends that the Party report these CH4 emissions as "NE" in the next annual submission.	Para 82	In 2013 submission CH_4 emissions from agricultural soils are reported as "NE".	CRF table 4.D.1
44.	The ERT commends the Party for the improvements in transparency and consistency in the 2012 annual submission following the recommendations in the previous Review report (e.g. the provision of some explanatory and background information on the methodologies used to estimate the country-specific CH4 EFs). However, the ERT considered that the information provided was not sufficient to replicate the emission calculations (see para. 90 below). The ERT reiterates the recommendation from the previous review report that Lithuania report the unpublished information and data necessary to calculate the country-specific CH4 EFs.	Para 85	See response to para 90 below.	
45.	Lithuania has calculated the uncertainty in the agriculture sector following a tier 1 approach. The Party uses default values from the IPCC good practice guidance to quantify the uncertainty of the EFs. With regard to the AD, Lithuania describes the potential sources of the uncertainties for the CH4 emissions from enteric fermentation and manure management. The ERT reiterates the recommendation from the previous review report that Lithuania provide more detailed information on the uncertainties of the AD and EFs used in its uncertainty analysis.	Para 86	In 2013 submission uncertainty estimates of B_0 from cattle and swine are reported including these estimates in overall uncertainty estimation for Enteric Fermentation.	Chapter 6.3.1.3
46.	In the NIR, Lithuania has provided a description of the QA/QC activities implemented in response to the recommendations from the previous review report. However, some recommendations have not yet been addressed, including: typographical errors; the inconsistency between CRF tables 4.A and 4.B(a) regarding the animal mass reported for swine; and the inconsistency between the non-dairy cattle subcategories reported in NIR tables 6.5 and 6.8. In addition, the livestock population values reported for cattle and sheep in the CRF tables differ from the values reported to the Food and Agriculture Organization of the United Nations (FAO) and the rationale is not provided in the NIR. In response to questions raised by the ERT during the review, Lithuania explained that this difference is due to the different accounting rules applied and, for some years of the time series, the different data sources used. The ERT recommends	Para 87	– The error concerning inconsistency between swine weight in CRF tables 4.A and 4.B(a) was eliminated. The right value for average swine mass for 2009 is 67.90 kg. – Table 6-5 presents data on CH_4 emissions from enteric fermentation by livestock category and Table 6-8 presents the data on number of non-dairy cattle by sub-categories. – Starting with 2007 data on the population of cattle and sheep are provided by the register of Agricultural Information and	CRF table 4.A. Chapter 6.2.1 Table 6.11 Chapter 6.2.2 Table 6-5 Table 6-8 Chapter 6.2.2

	that the Party provide this information in the next annual submission. The ERT also recommends that, in its next annual submission, Lithuania improve its QC activities to ensure the consistency and transparency of its reporting.		Rural Business Centre (AIRBC). Statistical data on livestock population in FAO database are provided by Statistics Lithuania. Information on different data source usage is provided in the NIR.	
47.	Lithuania has reported, in CRF tables 4.A (additional information) and 4.B(a) that the mass of non-dairy cattle is 326.21 kg and the mass of swine is 67.90 kg. However, in the NIR, the Party has incorrectly reported that the mass of non-dairy cattle is 323.94 (NIR table 6.25) and the mass of swine is 66.96 kg (NIR table 6.26). In response to a question raised by the ERT during the review, Lithuania confirmed that the correct values are those reported in the CRF tables. The ERT recommends that the Party correct the animal mass information for non-dairy cattle and swine in the NIR and reiterates the recommendation from the previous review report that Lithuania develop and implement effective QA/QC procedures to prevent these types of errors in the next annual submission.	Para 88	The data reported in Table 6-25 and Table 6-26 (weight of non-dairy cattle and swine) of the 2012 submission were presented for the year 2009 as for comparison between neighboring countries the data for the year 2010 was not available at the moment of NIR compilation.	Chapter 6.2.4
48.	Lithuania has defined an enhanced characterization for cattle, sheep and swine and has applied country-specific CH4 EFs. The subcategories defined do not include livestock under weaning age as this livestock is assumed not to produce CH4 emissions. In response to questions raised by the ERT during the review, the Party explained that the weaning period is negligible: one–three days for cattle, 21–28 days for swine and two months for sheep. The ERT recommends that Lithuania provide this information in its next annual submission.	Para 90	Based on Litnuanian scientific references it was determined that weaning age of calves is up to ten days, lambs up to five days and piglets up to five-seven days. At this age they are nourished by milk only and CH4 conversion factor is assumed to be zero. This explanation is provided in 2013 submission.	Chapter 6.2.2
49.	The ERT noted a lack of transparency in the information reported by Lithuania on enteric fermentation; for example, the weight and weight gain required for the estimation of the CH4 EF for the tier 2 method for enteric fermentation are not provided in the NIR; CRF table 4.A (additional information) is only partly completed (e.g. all indicators for sheep are reported as "NA"); and the data sources for the swine population size and for the methane conversion factor <u>(MCF) for CH4 emissions from enteric fermentation</u> are not reported. The ERT recommends that Lithuania improve the transparency of its reporting and enhance its QC activities in the next annual submission.	Para 91	– More detailed information and methodology of estimation of average weight and weight gain of non-dairy cattle and swine are presented in 2013 submission. – For calculations of CH_4 emissions from enteric fermentation of Sheep the average mass or other parameters indicated in CRF were not relevant as GE was calculated according to the feeding standarts therefore all parameters indicated as "NA". – The total population of swine and	CRF table 4.A. Chapter 6.2.2 Table 6-9 and Table 6-11 CRF table 4.A CRF table 4.A.

			population of swine by sub-categories are obtained from the data base of Statistics Lithuania. – *IPCC GPG 2000* default methane convertion factors (MCF) were used for CH_4 emission calculations from manure management. These values are provided in 2013 submission.	Chapter 6.2.2 Table 6-10 CRF table 4.B(a) Chapter 6.3.1.2 Table 6-38
50.	In CRF table 4.B(a), Lithuania has reported the average typical animal mass, the average daily excretion of volatile solids and the average CH4 production potential as "NE" for sheep, goats, horses and poultry. In response to a question raised by the ERT during the review, Lithuania explained that, as a tier 1 method is used for this category, these data are not required. The ERT agreed with the Party that these data are not required when a tier 1 method is used and concluded that the appropriate notation key is therefore "NA". The ERT recommends that the Party correct this error in the next annual submission.	Para 93	Notation keys corrected to "NA".	CRF table 4.B(a)
51.	Lithuania has used for the first time a tier 2 method for the estimation of CH4 emissions from enteric fermentation for sheep. The ERT noted that this implies that the Party has the necessary data to implement a tier 2 method for the estimation of CH4 emissions from manure management for sheep. In response to a question raised by the ERT during the review, Lithuania acknowledged the possibility of implementing a tier 2 method for sheep. The ERT encourages the Party to implement a tier 2 method for the estimation of CH4 emissions from manure management in the next annual submission.	Para 95	Lithuania has calculated CH_4 emissions from manure management of sheep using Tier 2 method for the whole time series in 2013 submission.	CRF table 4.B(a) Chapter 6.3.1.2
52.	Lithuania has used the N retention as input data to calculate the N excretion rate for cattle and swine, but the Party has not provided the reference for the data in the NIR. The ERT recommends that Lithuania improve the transparency of the information on the country-specific N excretion rate for cattle and swine by providing the source of these data in the next annual submission.	Para 97	Values of N intake and N retention for cattle and swine that were used for calculation of N excretion in accordance with IPCC GPG 2000 eq. 4.19, p. 4.45, were calculated based on national reference "Gyvulininkystės žinynas (*Livestock manual*). Baisogala, Institute of Animal Science of LVA. 2007, p. 584-601".	Chapter 6.3.2.2 Table 6-50
53.	For the calculation of N2O emissions from livestock, except cattle and swine, Lithuania has used a default N excretion rate from the Revised 1996 IPCC Guidelines without applying the default adjustment factor to this parameter for young animals, as suggested by the IPCC good practice guidance. The ERT recommends that Lithuania apply the default adjustment factor to the default N excretion rate for young animals in the next annual submission.	Para 98	The calculations are expected to be prepared and performed for the submission of April 15th 2013.	-

54.	Lithuania has estimated direct N2O emissions from agricultural soils using a tier 1a method with a default EF and other emission parameters from the IPCC good practice guidance. As agricultural soils is a key category, the ERT reiterates the encouragement from the previous review report that Lithuania implement a higher-tier method for the estimation of emissions from this category in the next annual submission.	Para 100	For 2013 submission we have recalculated sub-categories "N-fixing crops" and "Crop residues" using Tier 1b method. Also in this submission we have calculated emissions from sewage sludge for the first time. The method for calculation was indicated as Tier 1b as national activity data on nitrogen content (%) in sewage sludge was used. According to IPCC 2000 GPG it is appropriate to use combined methods for estimation of emissions from direct soils if activity data for other sub-categories is not available. Tier 1b method for overall direct soils emission calculation was inapplicable as EF for application of synthetic fertilizers and animal manure under different conditions are not available.	CRF table 4.D.1.3 CRF table 4.D.1.4 CRF table 4.D.1.6 Chapter 6.5.1.2
55.	In response to a recommendation from the previous review report, Lithuania has compared the national data on synthetic fertilizer consumption provided by UAB Agrochema with the data provided by the International Fertilizer Industry Association (IFA) in the NIR, but the Party did not explain the differences observed between the data from the two sources. In response to a question raised by the ERT during the review, Lithuania indicated that it is difficult to explain the differences between the national data and the IFA data on synthetic fertilizer consumption, as Lithuania does not have any information on the methodology and data sources used to calculate the IFA data. The ERT recommends that Lithuania continue to investigate these differences and report on the findings in the next annual submission, in order to improve the transparency of its reporting.	Para 101	Lithuania will continue investigating inconsistency between the national data and IFA database on Synthetic N fertilizers consumption and as soon as any findings will be available they will be reported in the NIR.	
56.	The ERT also noted a lack of transparency with regard to the approach used to estimate the fraction of livestock N excreted and deposited onto soil during grazing (FracGRAZ) when calculating N2O emissions from animal manure applied to soils, as the underlying background information is not provided in the NIR. In response to a question raised by ERT during the review, Lithuania provided this information. The ERT reiterates the recommendation from the previous review report that the Party provide the background information used to calculate FracGRAZ in the next annual submission.	Para 102	Reestimation and explanation of $Frac_{GRAZ}$ calculations are provided in 2013 annual inventory report.	CRF table 4.D Chapter 6.5.1.2

57.	The ERT noted that sewage sludge is applied as a soil amendment in Lithuania, but the associated emissions are not estimated. In response to a question raised by the ERT during the review, the Party explained that there are no data in Lithuania on the N content in sewage sludge and no default data are contained in the Revised 1996 IPCC Guidelines or the IPCC good practice guidance. The ERT noted that the Party, as a Member State of the EU, is bound by EU directive 86/278/EEC11 and its amendments, and that data on the N content in sewage sludge for Lithuania may be or become available. The ERT strongly encourages Lithuania to research the availability of country-specific data on N content in sewage sludge applied to soils and report N2O emissions from this activity in the next annual submission. If these data are not available, the ERT strongly encourages the Party to explore the possibility of using the values from neighbouring countries in order to estimate the N2O emissions from this activity in the next annual submission.	Para 103	Lithuania has calculated direct and indirect N_2O emissions from application of sewage sludge.	CRF table 4.D.1.6 Chapter 6.5.1.2
58.	Lithuania has estimated indirect N2O emissions from agricultural soils using a tier 1a method with a default EF and other emission parameters from the IPCC good practice guidance. As this category is a key category, the ERT reiterates the encouragement from the previous review report that Lithuania implement a higher-tier method for the estimation of emissions from this category in the next annual submission.	Para 104	Lithuania provided more accurate estimation of indirect N_2O emissions from agricultural soils using Tier 1b method for both atmospheric deposition and leaching and runn-off in this submission.	CRF table 4.D.3.1 CRF table 4.D.3.2 Chapter 6.5.3.2
	LULUCF			
59.	An extensive amount of information is reported in the NIR to explain how the different sources of data have been harmonized to produce a consistent land representation. Although the ERT considers that the time series of the land use and land-use change matrices is consistent, it recommends that Lithuania improve the transparency of its reporting by including decisions trees in the NIR that show the methods, including assumptions, and rules applied in both studies. Such decision trees would demonstrate how the Party has avoided the double counting or omission of emissions and removals in the accounting of land areas between the studies and within each study.	Para 107	Additional information provided in the NIR. Decision tree as well as other usefull information on executed studies, reconciliation of both studies was added to the report.	Chapter 7.1 Chapter 11.2
60.	The time series of the areas subject to land-use change reported in the land-use change area matrices in annex VI to the NIR shows large inter-annual variations. For example, conversion of forest land to settlements is reported as zero for all years except 2006 and 2009, where 399 ha of conversion have been reported. Similarly, conversion of settlements to forest land is reported as zero for all years except 1990, 1991 and 1994, where 399 ha of conversion have been reported. The variations are mainly due to the methodology used: in the year when a plot	Para 108	The inter-annual variations in the time series of areas subject to land use change were not completely revised at this time. However, high data jumps in Settlements land use category, that were monitored in 1993 (last submission) were corrected, and area of Settlements converted to other land uses was justified.	Annex VII

	is sampled and a land-use change observed, the method assumes that 399 ha changed to a different land-use category. However, the change is likely to have occurred gradually during the period between the two surveys, rather than in a single year. The ERT encourages Lithuania to apply data analysis techniques (e.g. a five-year rolling average), to reduce the inter-annual variations in the time series of the areas subject to land-use change.		This inconsistency has been caused by imperfect historical data used for that time period. Land use changes are monitored by using National Forest Inventory permanent sample plot grid, where single sample plot represent 399 ha. The inventory cycle is five years. Data presented by NFI is judged as reliable and is used by forest policy decision makers as well as for forest activities, investments planning etc.	
61.	The ERT noted that, with the exception of land converted from grassland to cropland and vice versa, and deforestation, the stock changes in soil organic matter (SOM) associated with land-use changes have not been estimated and are reported as "NA" and "NO" in CRF tables 5.A–5.F. The ERT reiterates the recommendations from previous review reports that Lithuania estimate the SOM changes associated with land-use changes, applying the IPCC default methodology. Where a lack of country-specific data on the soil carbon content for the different land-use categories hinders the estimation of the SOM changes, the ERT recommends that Lithuania use default data from the IPCC good practice guidance for LULUCF; the ERT notes that data on European soils are also stored in the European Union Joint Research Centre data repository.	Para 109	Carbon stock changes in soil organic matter associated with land-use changes were estimated following recommendations of ERT 2012. For conversions of Forest land, Croplands, Grasslands, Wetlands and Settlements to Other land it was assumed that all soil carbon stocks after conversion are equal to zero, such as bare or degraded soils are usually converted to Other land, therefore reported as 'NO'.	Chapters associated with estimations of carbon stoch changes in SOM from land-use changes CRF Tables 5A - 5F
62.	The ERT noted that, with the exception of land converted to forest land, Lithuania does not follow the IPCC method of reporting cumulative areas over a 20-year transition period (or over a longer transition period selected by the Party) for the land-use change conversion categories. Therefore, the ERT recommends that Lithuania report the areas converted to a different land use under the relevant land-use conversion category for 20 consecutive years before reporting them under the corresponding "land remaining" category.	Para 110	Corected according to recommendations by ERT 2012.	Chapter 7
63.	The ERT noted that the SOM changes in mineral soils due to changes in management practices are not reported under any land-use category. Having SOM stocks in equilibrium is a default assumption for forest land under the tier 1 method from the IPCC good practice guidance for LULUCF, but it is not a good practice for cropland and grassland. Further, Lithuania has reported the total	Para 111	Recommnedations were applied. Carbon stock changes in organic soils in Croplands and Grasslands were calculated. SOM changes in mineral soils due to changes in management practices were not calculated at	Chapter 7.3.2 Chapter 7.4.2 Chapter 7.5.2

	area of organic soils covered by different land uses, although only a portion of that area is drained (drainage is the single management practice reported by the Party that determines emissions). The ERT encourages Lithuania to move to a tier 2 method for forest land, where data are available, and recommends that Lithuania estimate and report the stock changes in SOM due to management changes in cropland and grassland in the next annual submission. The ERT also reiterates the recommendations from previous review reports that the Party report, in the CRF tables, the total area of organic soils and, in the information boxes of the relevant CRF tables, the portion of the area of organic soils where drainage has occurred, in the next annual submission.		this time, but this information will be provided in the next submission.	
64.	The ERT recommends that Lithuania revise, where relevant, the carbon stock change factors and assumptions used for the estimation of the carbon stock changes in biomass, dead wood and litter and ensure comparability between the land-use changes both to and from one category to another. For example, the per unit of area losses of biomass carbon stock due to the conversion of grassland to cropland are expected to be equivalent, in magnitude, to the gains of biomass carbon stock due to the conversion of cropland to grassland.	Para 112	The relevant methodology and assumption were revised and new estimations are provided in the NIR.	Chapter 7.3.1
65.	The ERT recommends that Lithuania revise the uncertainty analysis of the LULUCF sector, including by applying the equations contained in chapters 5.1 and 5.2 of the IPCC good practice guidance for LULUCF and either by providing information on the uncertainties or by justifying the values derived by expert judgement.	Para 113	Uncertainties were revised.	Chapter 7.2.4 Chapter 7.3.4 Chapter 7.4.4 Chapter 7.5.3 Chapter 7.6.3 Chapter 7.7.3
66.	For forest land remaining forest land and for land converted to forest land, the ERT noted that, when applying the stock change method from the IPCC good practice guidance for LULUCF to calculate the carbon stock changes in different pools, Lithuania has not ensured that the stocks, at two points in time, are calculated on the same area (i.e. for every pool, the area used to calculate the stock at time 1 can be different from that used to calculate the stock at time 2). This is not in line with the IPCC good practice guidance for LULUCF (e.g. equation 3.2.14 regarding the stock change method for mineral soils). This practice also results in the accounting of emissions and removals that never occur in reality, since the accounted fluxes are simply the result of the transfer of carbon stocks from one category to another; therefore, the applied method provides biased GHG emission estimates. The ERT recommends that Lithuania, when applying the stock change method, calculate the carbon stock values at two consecutive	Para 114	Estimations were revised and inconsistencies were corrected according to recommendations made by ERT 2012.	Chapter 7.2.2.1 Chapter 7.2.2.2

	points in time in the same area and revise its estimates of the carbon stock changes and associated emissions and removals in its next annual submission.			
67.	The ERT encourages Lithuania to explore alternative methods to annually forecast, on the basis of new measured data, the stock changes for areas not measured and to revise, each year, the values forecast on the basis of newly measured data, with the aim of reflecting, as far as possible, the real inter-annual variability in the carbon stocks dynamic. Further, in order to increase transparency, the ERT recommends that Lithuania report, in its NIR, annual estimates of the carbon gains and losses in forest land using the IPCC default method (equation 3.2.2 and associated equations of the IPCC good practice guidance for LULUCF).	Para 115	Estimations were revised and additional information provided in the NIR.	Chapter 7.2.2.1
68.	The ERT therefore recommends that Lithuania build a new yield curve for biomass stock, where the data sampled are aggregated on the basis of the age class to which they pertain, whenever data have been collected, so that they can be used to estimate the biomass stock of each age class for each year of the time series, including for the interpolation and extrapolation of data for age classes for which sampled data are not available. Consequently, the annual estimates of biomass carbon stocks gains can be calculated for each age class by multiplying the area of the age class using the difference between the mean value of that age class and the mean value of the previous (the younger) age class, as provided by the yield curve. The ERT also recommends that Lithuania update the yield curve on an annual basis with the newly available data so that the curve accurately reflects the actual carbon stocks dynamic in land converted to forest land.	Paras 116, 117	The methodology used for estimation of biomass stock has been revised and corrections were made in the NIR 2012.	Chapter 7.2.2.
69.	According to the NIR, Lithuania has applied a tier 1 method for woody biomass in cropland with a net carbon accumulation of 2.1 t/ha/year over a 20-year period, and, after 20 years, the biomass carbon stock of the woody plantation achieves an equilibrium level so that the annual net change becomes zero. However, Lithuania has applied the carbon stock change factor to all areas, without distinguishing between old plantations (areas containing wood crops for over 20 years, irrespective of their rotation cycle) and young plantations (areas containing wood crops for less than 20 years), thereby resulting in an overestimation of net carbon stock changes. The ERT recommends that the Party assume an equilibrium (i.e. no net stock changes) in living biomass in areas where wood crops have been established for more than 20 years prior to the inventory year, and recalculate the whole time series accordingly in its next annual submission.	Para 118	Lithuania will revise its methodology, how to distinguish between old and young plantations and will re-estimate carbon stock changes in living biomass in the next submission.	

70.	Lithuania has reported the carbon stock changes in SOM for wetlands remaining wetlands and for all pools under forest land converted to wetlands in CRF table 5.D, assuming that conversion to wetlands determines the instant oxidation of all biomass and dead organic matter. The ERT notes that the Party has not reported separately the area of wetlands that is managed, unmanaged, or where peat extraction occurs, and recommends that Lithuania do so in its next annual submission. Further, the ERT encourages the Party to distinguish between peat extracted for energy purposes and that extracted for horticultural purposes and to report, in CRF table 5(II), N_2O emissions emitted on-site due to the drainage of cultivated peat and CO_2 emissions emitted off-site due to horticultural uses, in the next annual submission. If necessary, the ERT suggests that Lithuania apply the same methodology as that used by other Parties, for example the United Kingdom of Great Britain and Northern Ireland, as described in the NIR of the United Kingdom.	Para 119	Additional, required information is provided in the NIR.	Chapter 7.5
71.	Lithuania has reported, in CRF table 5(V), CO_2 emissions from wildfires in forest land remaining forest land and land converted to forest land. However, when the stock change method is applied, CO_2 emissions due to wildfires are automatically accounted for when estimating the stock changes in forest land. The ERT therefore recommends that Lithuania report the CO_2 emissions associated with wildfires as information only in its NIR and report the emissions as "IE" (included elsewhere) in CRF table 5(V) in the next annual submission.	Para 120	Recommendation is applied.	Chapter 7.2.2.1 Chapter 7.2.2.2 CRF Table 5(V)
72.	The ERT noted that, for forest land remaining forest land and for land converted to forest land, Lithuania has used a default value for biomass consumption (19.8 t/ha) from table 3.A.1.13 of the IPCC good practice guidance for LULUCF that represents the product of the available fuel and the combustion efficiency (values B and C, respectively, in equation 3.2.20 of the IPCC good practice guidance for LULUCF). In addition, Lithuania has used incorrect CH_4 and N_2O EFs (derived from emission ratios of 0.012 and 0.007 for CH_4 and N_2O, respectively), instead of those reported in table 3.A.1.16 of the IPCC good practice guidance for LULUCF. The ERT recommends that the Party use the correct CH_4 and N_2O EFs from table 3.A.1.16 of the IPCC good practice guidance for LULUCF and recalculate the corresponding emissions and removals for the entire time series in the next annual submission. The ERT also recommends that Lithuania use country-specific data for the mass of available fuel, including dead wood and litter, in the next annual submission.	Para 121	Changes in calculations were made. Correct values were applied.	Chapter 7.2.2.1 Chapter 7.2.2.2
73.	Lithuania has reported CH4 and N2O emissions from biomass burning in wildfires for land converted to forest land as "IE" in CRF table 5(V). These emissions have	Para 122	Corrections in reporting were made.	CRF Table 5(V)

	been reported under the forest land remaining forest land category. As this method is not consistent with the IPCC good practice guidance for LULUCF, the ERT recommends that Lithuania report these emissions under the category land converted to forest land in the next annual submission. If appropriate data are not available, the ERT suggests that the Party subdivide the forest area burned on the basis of the proportional contribution of each category to the total forest land area.			
Waste				
74.	The ERT considers that the transparency of the description of the overview of the waste sector in the NIR is limited. In response to a question raised by the ERT during the review, Lithuania provided the ERT with a general overview of the waste sector. The ERT reiterates the recommendation from the previous review report that the Party improve the general overview of the waste sector in the NIR in the next annual submission. The information provided by the Party could include: the amounts and sources (e.g. domestic or industrial) of the waste generated and the waste treatment processes (e.g. the percentage of the waste disposed on land, incinerated or composted). The ERT also recommends that Lithuania describe the wastewater generation processes and the types and shares of wastewater and sludge treatment methods in the next annual submission.	para 126	Review of waste generation and management in Lithuania including description of procedures for collection of statistical data is included in the NIR as new chapter 8.2.1.	Chapters 8.2.1 and 8.3.1
75.	During the review, Lithuania also provided the ERT with additional information on the factors that have influenced the emissions trends, including the Party's independence, the changes in waste management policies and measures, the economic situation and the closure and opening of treatment plants. The ERT recommends that Lithuania report this information in its next annual submission.	para 127	Review of waste generation and management includes information on changes of waste management policies, economic situation, development of waste management facilities and changes data collection methodologies.	Chapter 8.2.1
76.	The NIR does not transparently explain whether CH4 emissions are recovered for energy purposes and where the emissions from those energy-producing activities are allocated. In response to a question raised by the ERT during the review, Lithuania explained that CH4 recovery, both in landfills and in wastewater treatment plants, is used for energy purposes and that the emissions from these electricity- and heat-producing activities are included under the energy sector. The ERT recommends that Lithuania include this information in the next annual submission.	para 128	Recovered methane both in landfills and in wastewater treatment plants, is used for energy purposes and emissions from these electricity- and heat-producing activities are included under the energy sector and reported in the 1A sector as biogas which includes biogas generated from landfills, sewage sludge and manure.	Chapter 8.2.2
77.	Lithuania has only briefly reported on the time-series consistency of the AD, EFs and parameters used for the waste sector. The ERT recommends that Lithuania improve the transparency of its reporting on time-series consistency in the next	para 129	Statistical data on waste disposal are available from 1991. It was assumed after consultations with the specialists of the Ministry of	Chapter 8.2.4

	annual submission.		Environment that data on municipal waste disposal in 1991-1997 were overestimated, hence the data were corrected based on correlation with GDP. Historic data on waste disposal starting from 1950 were evaluated taking into account available data on variations of population, economic development and considering expansion of waste management infrastructure.	
78.	The AD for the waste sector are mostly available from 1991 onwards. The ERT considers that the NIR is not always transparent with regard to the assumptions used to estimate emissions for 1990. The ERT recommends that Lithuania transparently report on the assumptions used in the NIR of the next annual submission.	para 130	For the period 1990-1998 waste disposal was evaluated (Figure 8-3) using estimated annual changes shown in Table 8-12 and population number provided by the Statistics Lithuania. The amounts of industrial waste disposed of in landfills in 1990 were assumed to be the same as in 1991. As data on waste disposal in 1990 are not available, the amount of municipal waste disposed of in 1990 was evaluated in the same way as for years 1991-1998, for industrial/commercial wastes it was assumed that amount and composition of waste of industrial and commercial origin was the same as in 1991. Bearing in mind that water usage and wastewater discharges have shrunk very substantially after the restoration of independence, with steeply increasing energy and water prices, wastewater discharge in 1990 was evaluated by linear extrapolation of 1991-1993 data.	Chapters 8.2.2 and 8.3.2
79.	Lithuania has used the first order decay (FOD) method from the 2006 IPCC Guidelines to estimate CH4 emissions from solid waste disposal on land (both managed and unmanaged sites). The ERT noted that no justification was provided in the NIR for this methodological choice. In response to a question raised by the ERT during the review, Lithuania explained that it had used the decision tree (figure 5.1) from the IPCC good practice guidance and selected the	para 132	The FOD method was selected using Decision Tree provided in the GPG 2000, p. 5.6. Parameters required for calculation are provided in the GPG 2000, however certain reservations concerning their use are provided in the guidelines. Therefore, the	Chapter 8.2.3

	FOD method to estimate the CH4 emissions from solid waste disposal, in line with the IPCC good practice guidance. The Party also explained that the 2006 IPCC Guidelines take into account the latest research (e.g. the degradable organic carbon (DOC) values provided therein allow Lithuania to disaggregate the emissions more finely by waste type). Lithuania further explained that the Revised 1996 IPCC Guidelines and the IPCC good practice guidance do not provide differentiated parameter values for the methane generation rate constant, but that the 2006 IPCC Guidelines do provide differentiated methane generation rate constants per type of waste, as used by Lithuania. The IPCC good practice guidance does not provide any parameter values for sludge, but the 2006 IPCC Guidelines do. The ERT considers the justification sufficient. The ERT recommends that Lithuania include this justification in its next annual submission.		parameters provided in the GPG 2000 were compared to parameters provided in the 2006 IPCC guidelines. GPG 2000 provides only general discussion on possible value of methane rate generation constant *k* and do not associate definite values with specific components. On the other hand, 2006 IPCC guidelines provide k values for each specific component based on the results of latest investigations. Only roughly estimated data are provided in the GPG 2000 on fractions of degradable organic carbon DOC), while 2006 IPCC guidelines more detailed evaluations and, what is especially important, provide references to the results of latest investigations on which evaluation of DOC values is based. GPG 2000 provide default value of 0.77 for fraction of degradable organic carbon (DOC_f) but warn that this default value is probably overestimated. 2006 IPCC guidelines give DOC_f value 0.5 which corresponds to the suggestion in the GHG 2000. Finally, GPG 2000 does not provide the values of parameters for sludge which was included in calculations. Therefore it was concluded that parameter values provided in the 2006 IPCC guidelines are more reliable and precise and were used for calculation of methane emissions by FOD model.	
80.	Lithuania indicated during the review week that a new study on wastewater and sewage sludge, which began in September 2012, will provide country- or plant-specific information on methane correction factors for disposed sewage sludge and will enable a more reliable calculation of CH4 emissions from sewage sludge. The ERT encourages Lithuania to include the results of the study when estimating the emissions from disposed sewage sludge in the next annual	para 133	The results of the study are included in the NIR.	Chapter 8.2.2

	submission.			
81.	Although Lithuania has estimated the CH4 emissions from managed and unmanaged waste disposal on land using methods from the 2006 IPCC Guidelines, the Party has used default uncertainty values from the IPCC good practice guidance. The ERT recommends that Lithuania, in its next annual submission, use the uncertainty values from the 2006 IPCC Guidelines if the Party also estimates the emissions using the method from the 2006 IPCC Guidelines.	para 134	Uncertainty recalculated using default uncertainty values from IPCC 2006, v. 3, Table 3.5.	Chapter 8.2.4
82.	The ERT noted that Lithuania has not transparently described in the NIR all of the assumptions used to calculate emissions from solid waste disposal on land for the time series 1950–1999. For example, the ERT noted that the assumptions used for the composition of waste for the time series 1950–1999 or for the distribution of solid waste (municipal, industrial/commercial and sewage sludge) to the different types of waste disposal sites (managed, and deep and shallow unmanaged) have not been clearly reported in the NIR. The latter assumption is especially important for sewage sludge, since sewage sludge is disposed on specific sewage sludge disposal sites. For this reason, the ERT recommends that Lithuania more transparently document the assumptions used for the AD in the next annual submission. The ERT also recommends that the Party justify the methodology used to calculate the distribution of the different solid waste types to the different waste disposal sites for all solid waste categories in the next annual submission.	para 135	There are no data and even no speculations on waste composition during the historic period 1950-1989. Assumption that waste composition in years 1950-1990 was the same as in later period has some, though not very firm, background, while we have no background at all for assuming that composition was different with higher or lower fraction of biodegradables. Therefore, the final composition of biodegradable waste determined for 1990 was used also for calculation of methane emissions in historic years 1950-1989. Distribution of solid waste (municipal, industrial/ commercial) to the different types of waste disposal sites (managed, and deep and shallow unmanaged) is detailed in Chapter 8.2.2 subchapter „Waste disposal practices“. Sewage sludge disposal conditions, same as solid waste, depend on the size of disposal site - in large cities large amounts of sludge are disposed, while in small towns disposal sites are smaller and thinner. A study on sewage sludge management performed in 2012 concluded that about 73% of sewage sludge are disposed on shallow (depth <5 m) sites for which use of MCF value 0.4 is recommended. Remaining 27% are disposed	Chapter 8.2.2

			on deep (depth >5 m) sites for which MCF value 0.8 should be used.	
83.	The previous review report recommended that Lithuania either provide an explanation as to why the waste composition is assumed to remain constant over the period 1950–1989 for all waste types and, from 1990, for municipal solid waste (MSW), or estimate the historical waste composition. In its NIR, Lithuania has reported the waste composition of MSW from various limited, partially analytical tests. However, the results of the tests are not sufficiently representative to estimate the historical waste composition. The Party has also reported that the Ministry of Environment requires, as of 2012, that regional waste centres perform analyses of the waste composition. In response to a question raised by the ERT during the review, Lithuania expressed its intention to analyse the data as soon they become available (the final results covering all four seasons are expected by the end of 2013). The ERT recommends that Lithuania analyse the results of this study and include a comparison of the waste composition between rural and urban areas, if possible for the entire time series, in future annual submissions.	para 136	There are no data and even no speculations on waste composition during the historic period 1950-1989. Assumption that waste composition in years 1950-1990 was the same as in later period has some, though not very firm, background, while we have no background at all for assuming that composition was different with higher or lower fraction of biodegradables. Therefore, the final composition of biodegradable waste determined for 1990 was used also for calculation of methane emissions in historic years 1950-1989. Review of waste composition analyses performed in 2012 is provided in Chapter 8.2.2.	Chapter 8.2.2
84.	The ERT considers that the NIR is not completely transparent with regard to why Lithuania considers the data for the period 1991–1998 reported by companies on the amount of waste disposed as industrial and commercial waste to be reliable, but does not consider the data on the waste disposed as MSW to be reliable. In response to a question raised by the ERT during the review, Lithuania explained that, in the early 1990s, the revenues for MSW collection companies depended on the amount of waste delivered to landfills, but the loads were not weighed and an overestimation of the weight of the loads is therefore suspected. On the other hand, industrial and commercial waste was transported by the companies generating the waste and was subject to a fee per truckload of waste deposited, not per the weight of each truckload of waste. To increase the transparency of the choice of AD, the ERT recommends that Lithuania include this information in the NIR of its next annual submission.	para 137	In early 1990s municipal waste was collected and transported to landfills by municipal waste collection companies and their income (as well as salaries of truck drivers) depended on the amount of waste delivered to landfills. Therefore they were going to landfills with half-empty collection trucks, but recording full loads. In the same time, industries were transporting their waste themselves. As wastes were not weighed at the landfills, industries were paying for separate truck loads and were interested to send trucks as full as possible. Substantially smaller variations of disposed industrial wastes in early nineties also confirm that reported amounts of industrial waste were more realistic.	Chapter 8.2.2
85.	Lithuania has used a default value of 0.5 contained in the IPCC good practice guidance for the share of CH4 in landfill gas. The regional waste management	para 138	Data on landfill gas recovery in TJ are provided by Statistics Lithuania. As these data	Chapter 8.2.2

	centres provide site-specific information (reported in NIR table 8-11). The ERT recommends that Lithuania, in its next annual submission, follow up on the site-specific results on the measured fraction of CH4 in the extracted landfill gas of the closed waste disposal sites that are equipped with CH4 recovery, because they could provide Lithuania with country specific or even site-specific information on the composition of the landfill gas.		are used for establishing GHG emissions in energy sector, it was decided to be consistent and use the same data for establishing methane recovery. Amount of recovered methane in Gg was calculated assuming that methane lower heating value is 50 TJ/Gg	
86.	The methane generation rate constant and the DOC fraction reported in CRF table 6.A (additional information) represent the weighted average for all components and should show slight inter-annual variations depending on the waste composition. The ERT noted that Lithuania has reported incorrect values for these two parameters in CRF table 6.A (constant methane generation rate for the period 1990–2009 and constant DOC values for the period 1990–2004 and 2006–2009) although the emission estimates are correct because the values in the FOD model are correct. The ERT recommends that Lithuania report the correct values for these two parameters for the whole time series in the next annual submission.	para 139	Methane generation rate constant and DOC fraction were corrected and reported in CRF table 6.A as weighted average for all components.	CRF Table 6.A
87.	The ERT noted that, although the formula used by Lithuania to calculate the amount of MSW disposed to the three types of landfill site is correct, it has been incorrectly reported on page 338 of the NIR: the definition of the parameter WT, "total waste generation", should read "total waste disposed minus waste disposed on the new regional landfills". The ERT recommends that Lithuania revise the NIR accordingly in the next annual submission.	para 140	Corrected.	Chapter 8.2.2
88.	Lithuania has reported CH4 emissions from other (solid waste disposal on land) as "NA", whereas in the previous annual submission it reported emission estimates together with the comment "stored sewage sludge". In response to a question raised by the ERT during the review, the Party explained that the sewage sludge from wastewater handling sites is partly disposed on separate sewage sludge disposal sites, and that these emissions are reported under solid waste disposal on land. The remaining sewage sludge is treated in anaerobic digesters, and all CH4 generated is captured and used for energy production; the associated emissions are reported under the energy sector. The ERT recommends that Lithuania include this information in the next annual submission.	para 141	Sewage sludge is disposed on separate sites which are comparable to landfills, and data on sludge disposal are collected together with data on disposal of other waste. Methane emissions from sewage sludge were recalculates and estimates separately from municipal solid waste using specific parameters (fraction of degradable organic carbon, and methane generation rate constant). The remaining sewage sludge is treated in anaerobic digesters, and all CH4 generated is captured and used for energy production; the associated emissions are reported under the energy sector.	Chapter 8.2.2
89.	Lithuania has reported N_2O emissions from industrial wastewater and sludge as	para 143	Corrected: N_2O emissions from industrial	in CRF table 6.B

	"NA" in CRF table 6.B, indicating that neither the Revised 1996 IPCC Guidelines nor the IPCC good practice guidance include a methodology to estimate these emissions. To improve transparency, the ERT recommends that Lithuania report these emissions as "NE" in the next annual submission.		wastewater and sludge as "NE" in CRF table 6.B.	
90.	The ERT noted that Lithuania has not reported in the NIR a reference for the source used to calculate the percentage of the Lithuanian population not connected to a centralized sewer network. In response to a question raised by the ERT during the review, the Party provided this information to the ERT. The ERT recommends that Lithuania include this information in its next annual submission.	para 144	Data were provided by the Lithuanian Water Suppliers Association, information included in the NIR.	Chapter 8.3.1
91.	Lithuania has used country-specific instrumental measurements of wastewater discharges and organic matter content to estimate CH4 emission from wastewater. The Party has also used the MCF from the 2011 NIR of Denmark. In response to a question raised by the ERT during the review, Lithuania explained the rationale for using the Danish MCF: Denmark was involved in the development of the Lithuanian wastewater handling system and the two systems are very similar. The ERT recommends that the Party include this information in the next annual submission. Lithuania also explained that the country specific instrumental measurements provide more reliable and precise results than the IPCC default data (EFs and AD) which are based on conditions in other countries. The ERT commends Lithuania for the method used and encourages the Party to use country-specific data on the CH4-producing capacity of its wastewater handling system as well as a country specific MCF where possible, in the next annual submission.	para 145	Denmark was involved in the development of the Lithuanian wastewater handling system after the declaration of independence and the two systems are very similar. Therefore use of data on anaerobically convertible DOC fraction should be considered justifiable. It should be emphasised that country specific instrumental measurements were used for establishing methane emissions which provide more reliable and precise results than the IPCC default data (EFs and AD) which are based on conditions in other countries.	Chapter 8.3.2
92.	Further, the ERT encourages Lithuania to include, to the extent possible, the results from the new study on wastewater and sewage sludge, which began in September 2012 and is scheduled to be completed by the end of 2012, in the next annual submission, in order to improve the accuracy of the emission estimates for wastewater and sewage sludge. Lithuania explained that it intends to include the results of the study in its 2013 annual submission.	para 146	The results of the study are included in the NIR.	Chapter 8.2.2
93.	The ERT considers that the information on the treatment of sewage sludge is not transparently presented in the NIR. In response to a question raised by the ERT during the review, Lithuania explained that the sewage sludge is deposited in specific waste disposal sites, or treated in anaerobic digesters, or incinerated or used as fertilizer in the agriculture sector. However, none of this information is provided in the NIR. The ERT recommends that Lithuania, in the next annual submission, include this information as well as information on the allocation of	para 147	Sewage sludge is disposed separately from solid waste on sites comparable to landfills. Statistical information on sewage sludge disposal are collected and stored in the same data base together with data on waste generation and management. Data on sewage sludge disposal were provided by the	Chapter 8.2.2

	the GHG emissions associated with sewage sludge.		Lithuanian EPA responsible for collection and management of statistical information on waste management. Up to 2005 wet sewage sludge generation and management data are reported and stored in the EPA database. From 2006 some companies started reporting sludge dry matter. All data were carefully checked and converted to wet sludge using dry matter/wet sludge conversion factor 0.2 Sewage sludge disposal conditions, same as solid waste, depend on the size of disposal site - in large cities large amounts of sludge are disposed, while in small towns disposal sites are smaller and thinner. A study on sewage sludge management performed in 2012 concluded that about 73% of sewage sludge are disposed on shallow (depth <5 m) sites for which use of MCF value 0.4 is recommended. Remaining 27% are disposed on deep (depth >5 m) sites for which MCF value 0.8 should be used. Part of sludge is treated in anaerobic digesters, composted or used as fertilizer in the agriculture sector. There is no methodology provided in the IPCC guidelines for estimation of CH4 or N2O from composting facilities or compost spreading on agricultural soil.	
94.	Lithuania has reported, on page 347 of its NIR, the existence of CH4 recovery in four anaerobic digestion facilities for sewage sludge; however, the Party has not reported any CH4 emissions from this potential source and no justification for doing so has been provided in the NIR. In response to a question raised by the ERT during the review, Lithuania explained that these four anaerobic digestion facilities do not emit any CH4 due to the hermetic equipment used and the operating conditions in place (e.g. the working pressure is lower than the design pressure). The ERT recommends that the Party provide a more detailed	para 148	Automatic anaerobic digestion facilities are operated under pressure lower than atmospheric and exclude any leakages of CH_4 .	Chapter 8.2.2

	explanation of the four anaerobic digesters and include a justification for the non-occurrence of emissions, in the NIR of its next annual submission.			
	KP-LULUCF			
95.	The ERT notes that it is good practice to report disaggregated estimates according to the year of the conversion. Therefore, in order to increase the transparency of its reporting on afforestation and reforestation, and deforestation, the ERT recommends that Lithuania report, in its next annual submission, estimates of the carbon stock changes for each pool, disaggregated according to the year of the area conversion.	Para 154	More detailed information provided in the NIR.	Chapter 11.3
96.	The ERT notes that Lithuania has reported, on page 387 of the NIR, that the information on the year of the onset of a KP-LULUCF activity, if it occurs after 2008, is not relevant. However, the ERT notes that the estimates of carbon stock changes are directly influenced by the year of conversion during which an afforestation, reforestation or deforestation activity occurs. Considering that Lithuania's national system, which applies a statistical approach, is able to provide annual data on land area representation, including the identification and tracking of units of land subject to KP-LULUCF activities, the ERT recommends that the Party revise the information reported in the NIR and in the KP-LULUCF CRF tables, in its next annual submission.	Para 155	Previously provided information revised and corrected.	Chapter 11.3.1.6
97.	As identified for the LULUCF sector, to estimate emissions from biomass burning, Lithuania uses a default value for biomass consumption (19.8 t/ha) from table 3.A.1.13 of the IPCC good practice guidance for LULUCF which represents the product of the available fuel and the combustion efficiency (values B and C, respectively, of equation 3.2.20 of the IPCC good practice guidance for LULUCF). In addition, the Party uses incorrect CH_4 and N_2O EFs, instead of those reported in table 3.A.1.16 of the IPCC good practice guidance for LULUCF. Further, the Party has reported, in CRF table 5(KP-II)5, CO_2 emissions associated with wildfires in forest land. However, as Lithuania uses the stock change method, the CO_2 emissions from biomass burning should be reported as "IE". The ERT recommends that the Party use the correct CH_4 and N_2O EFs from table 3.A.1.16 of the IPCC good practice guidance for LULUCF and report the CO_2 emissions in CRF table 5(KP-II)5 as "IE" in the next annual submission. The ERT also recommends that Lithuania use country-specific data on the mass of available fuel, including dead wood and litter, in the next annual submission.	Para 156	Changes in calculations were made. Correct values were applied.	CRF Table 5(KP-II) 5
98.	The ERT reiterates the findings reported in the LULUCF chapter of this report under the category forest land regarding the implementation of the stock change method (see para. 114 above) and under the category land converted to	Para 158	Changes in calculation were made and new data provided in the NIR.	Chapter 11.3.1.1

	forest land regarding the calculation of annual biomass stock values (see para. 115 above). The ERT therefore recommends that, when calculating the changes using the stock change method, Lithuania calculate the carbon stock values at two consecutive points in time in the same area (the area at time 2). The ERT also recommends that the Party, in its next annual submission, build a new yield curve for biomass stock changes and aggregate the data sampled on the basis of the age class to which they pertain, which would allow the Party to estimate the biomass stock for each age class, including in the interpolation and extrapolation of data for age classes for which sampled data are not available. This would also enable Lithuania to calculate annual estimates of the biomass carbon stocks for each age class by multiplying the area of the age class by the difference between the mean value of that age class and the mean value of the previous age class, as provided by the yield curve. The ERT further recommends that Lithuania update the yield curve on an annual basis with the newly collected data so that the curve accurately reflects the actual carbon stocks dynamic in land converted to forest land.			
99.	The ERT notes that afforestation and reforestation in natural grassland would usually result in a loss of carbon in SOM in the early years of the time series; however, Lithuania has not reported the stock changes in SOM (reported as "NA" in KP-LULUCF table 5(KP-I)A.1.1). The ERT therefore recommends that Lithuania, in its next annual submission, further revise the information that demonstrates that the SOM is not a net source by providing a comprehensive evaluation of the stock changes in SOM in afforested and reforested land (i.e. afforested/reforested cropland, abandoned agricultural land and natural grassland), in order to assess whether this pool is a net sink.	Para 159	Earlier provided data was revised and new assumptions and calculations were made in this submission.	Chapter 11.3.1.1
100.	The ERT reiterates the findings reported in the LULUCF chapter of this report under the category forest land regarding the implementation of the stock change method (see para. 114 above) and under the category forest land remaining forest land regarding the calculation of annual biomass stock change values (see para. 115 above). The ERT therefore recommends that, when calculating the changes using the stock change method, Lithuania calculate the carbon stock values at two consecutive points in time in the same area (the area at time 2), in the next annual submission. The ERT encourages the Party to explore methods to provide annual forecasts, on the basis of newly measured data, of the stock changes for areas not measured and to revise, each year, the values forecast on the basis of newly measured data, with the aim of reflecting, as far as possible, the real inter-annual variability in the carbon stocks dynamic.	Para 160	New assumptions and method were employed in this submission. Further information provided in the NIR.	Chapter 11.3.1.1

	Further, with the aim of verifying the reported estimates, the ERT recommends that Lithuania report, in its NIR, annual estimates of the carbon gains and losses in forest land using the IPCC default method (equation 3.2.2 and associated equations of the IPCC good practice guidance for LULUCF).			