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NATIONAL GREENHOUSE GAS EMISSION INVENTORY REPORT 1990-2010

REPUBLIC OF LITHUANIA

VILNIUS, 2012

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 1990-2010 including KP-LULUCF data tables for years 2008-2010.
3. SEF (Standard Electronic Format) tables for reporting of Kyoto units (AAUs, ERUs, CERs, tCERs, lCERs, RMUs) in the National registry during the year 2011.

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Abbreviations

AB	Stock company (SC)
AIRBC	Agricultural Information and Rural Business Centre
BOD	Biochemical Oxygen Demand
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
CR	CORINAIR emission factor.
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
FF	forest land remaining forest land
FM	Forest Management
FOD	First Order Decay
GDP	Gross Domestic Product
GHG	Greenhouse gases
GLM	Grazing land management
HFC	Hydrofluorocarbon
HSPP	Hydro Storage Power Plant
IE	Included elsewhere
Kt	thousand tonnes
L	level
LF	forest land areas 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
NHF	Nature Heritage Fund
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
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

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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 submitted in 2010 and 2011.

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 (NOx), 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 2010.

For the preparation of the inventory CRF Reporter v.3.5.2 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 1990-2010 is presented in Table 1.

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

GHG source and sink categories	Energy	Industrial Processes	Solvent and Other Product Use	Agriculture	LULUCUF	Waste	Total (including LULUCF)	Total (excluding LULUCF)
1990	33.787,38	4.295,65	197,61	9.986,44	-6.291,60	1.165,70	43.141,18	49.432,78
1991	35.924,56	4.323,57	195,83	9.121,67	-6.955,50	1.187,72	43.797,85	50.753,35
1992	20.238,64	2.513,58	193,87	6.221,24	-6.848,58	1.202,37	23.521,12	30.369,70
1993	16.261,95	1.594,98	191,53	5.114,09	-786,71	1.216,13	23.591,97	24.378,68
1994	15.373,22	1.663,38	188,98	4.366,54	-6.187,80	1.216,00	16.620,32	22.808,12
1995	14.311,23	2.020,88	186,36	4.192,15	-3.785,24	1.216,69	18.142,08	21.927,32
1996	14.773,95	2.493,06	183,75	4.591,80	1.724,47	1.215,84	24.982,87	23.258,40
1997	14.304,84	2.429,39	181,17	4.762,76	-69,32	1.218,34	22.827,18	22.896,50
1998	15.054,79	2.846,52	178,61	4.365,87	-7.644,04	1.219,59	16.021,33	23.665,37
1999	12.624,41	2.809,13	176,07	4.173,12	-7.177,53	1.214,93	13.820,13	20.997,66
2000	11.026,04	3.031,45	173,54	3.910,53	-7.582,92	1.222,06	11.780,69	19.363,61
2001	11.673,78	3.266,84	171,18	4.071,53	-7.842,86	1.241,67	12.582,14	20.425,00
2002	11.745,46	3.468,58	168,99	4.285,64	-2.443,66	1.250,65	18.475,66	20.919,31
2003	11.718,80	3.304,01	166,73	4.394,51	-8.786,26	1.257,25	12.055,04	20.841,30
2004	12.338,90	3.733,45	164,36	4.371,33	-5.312,51	1.232,14	16.527,67	21.840,18
2005	13.032,76	4.096,37	161,92	4.413,71	-2.786,53	1.213,85	20.132,08	22.918,62
2006	13.197,17	4.355,05	131,36	4.440,02	-3.887,40	1.190,77	19.426,97	23.314,37
2007	13.349,42	6.164,59	121,75	4.631,10	-1.725,04	1.176,02	23.717,85	25.442,89
2008	13.138,91	5.501,82	95,53	4.419,59	-7.512,46	1.175,00	16.818,39	24.330,85
2009	11.944,06	2.302,17	100,34	4.443,42	-10.927,19	1.169,47	9.032,28	19.959,47
2010	12.848,36	2.249,17	92,62	4.458,33	-11.714,57	1.161,25	9.095,17	20.809,74
2010/1990, %	-61,97	-47,64	-53,13	-55,36	86,19	-0,38	-78,92	-57,90

The most significant source of greenhouse gas emissions in Lithuania is energy sector with an around 62% of the total emissions in 2010. Agriculture is the second most significant source and accounted for 21,4% of total emissions. The emissions from industrial processes are about 11% of total greenhouse gas emissions, from waste sector – 5,6%.

The composition of greenhouse gas emissions by sectors in 2010 is presented in Figure 1.

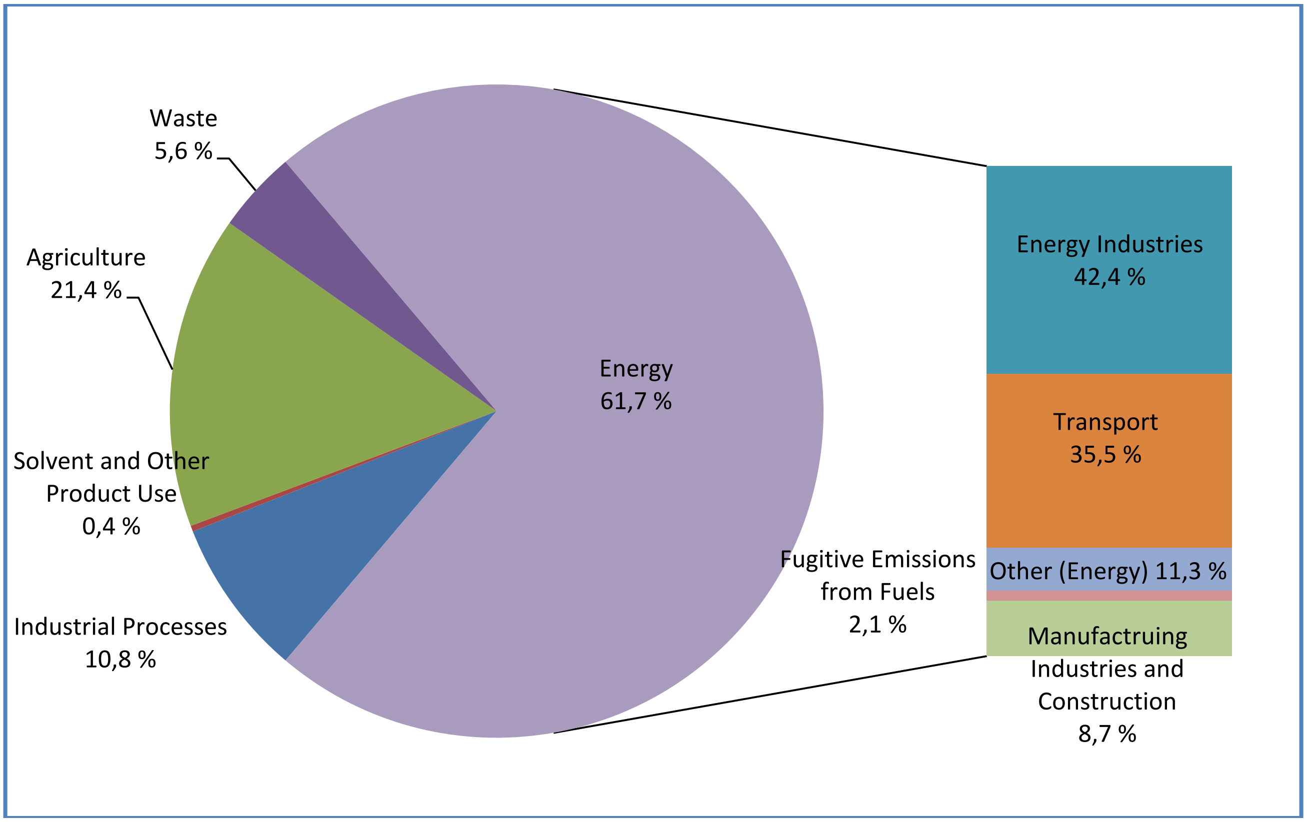


Figure 1. The composition of Lithuanian GHG emissions (CO_2 eq.) by sectors (excl. LULUCF) in 2010

The total GHG emission (excl. LULUCF) amounted to 20809,7 Gg CO_2 equivalents in 2010. The emission have decreased by 58% 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 for 89% in 2010 of the total national CO_2 emission (excl. LULUCF). The energy industries contribute 44% and the transport sector accounts for 37% of the CO_2 emission in energy section.

Comparing with 2009 CO_2 emission from energy sector in 2010 increased by 7,9% wherein CO_2 emission from the energy industries and transport sector increased by 10,7% and 2,9%, respectively. Increase of emissions in the energy industries increase of fuel consumption.

The most important GHG in 2010 is carbon dioxide (CO_2), it contributed 66,5% to the total national GHG emissions expressed in CO_2 eq., followed by N_2O (17,2%) and CH_4 (15,4%). HFCs and SF_6 together amounted 0,9% of the overall GHG emissions in the country.

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 2010 comparing with 2009 increased by 4,3% due to increase of energy consumption.

An overview of estimated GHG emissions is presented in Fig. 2, which shows GHG emissions by gases, expressed in CO_2 eq. (excl. LULUCF) for the period 1990-2010.

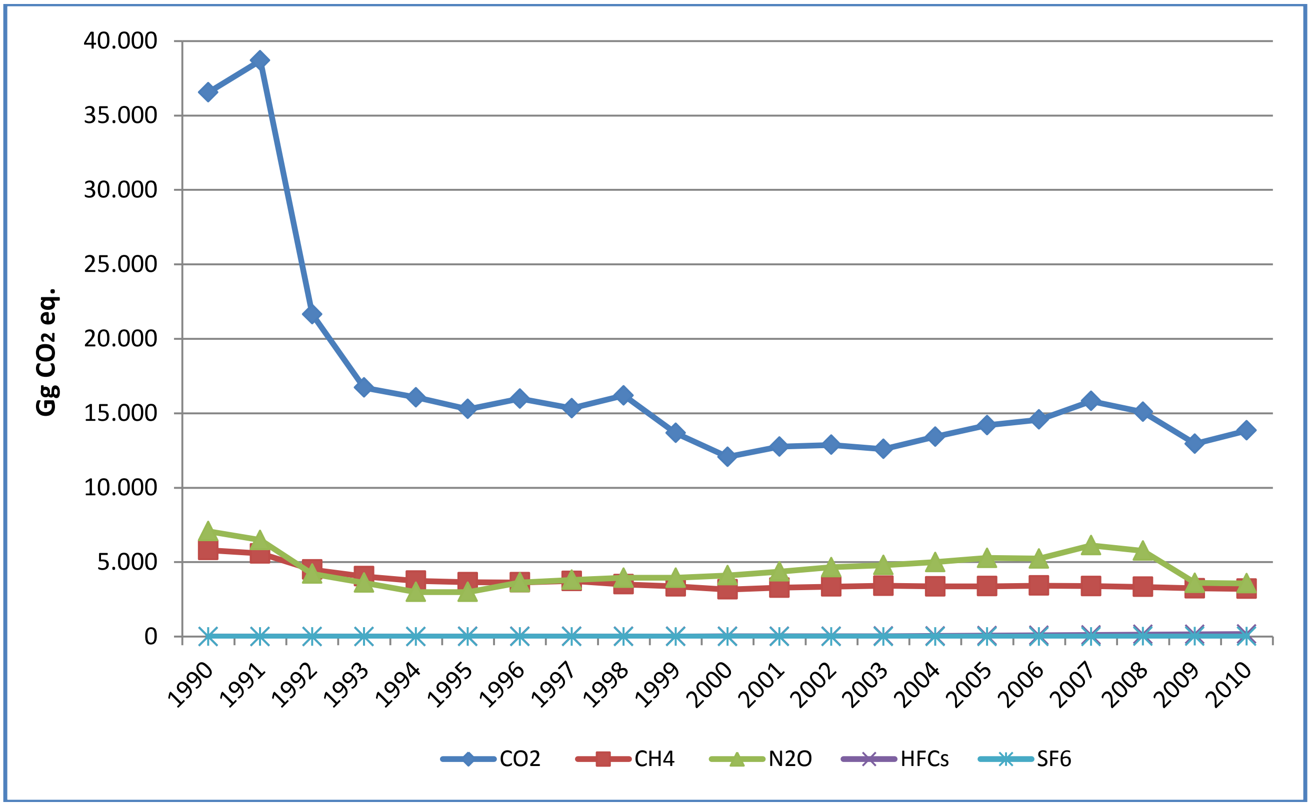


Figure 2. Trends of GHG emissions by gas in CO_2 eq., Gg (excl. LULUCF)

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 an around 62% share of the total emissions (excl. LULUCF) in 2010. Emissions from energy include CO_2, CH_4, N_2O gases.

CO_2 emission from energy sector contained 89% of the total national CO_2 emissions (excl. LULUCF) in 2010. The main categories are energy industries and transport which contribute 39% and 32,5% to the total national CO_2 emission (excl. LULUCF), respectively. Comparing with 2009 CO_2 emissions from energy sector increased by 7,9% wherein CO_2 emissions from energy industries and transport sector increased by 10,7% and 2,9%, respectively. The slight increase of CH_4 and N_2O emissions are also observed. The emissions of CH_4 have increased by 1% and N_2O emissions increased by 2,9%. This increase is due to the growth of energy consumption. This increase was stipulated by growing activities in all sectors but the major impact was from the manufacturing and transport sectors. In the households as well as in the trade and services sector changes were minor.

The second important source of GHG emissions is agriculture sector accounting for 21,4% of the total GHG emissions (excl. LULUCF). This sector is the most significant source of CH_4 and N_2O emissions accounting for 51,8% and 78,2% of the total CH_4 and N_2O emissions, respectively. The main source of CH_4 emissions is enteric fermentation contributing 72% to the total agricultural CH_4 emissions. Agricultural soils are the most significant source of N_2O emissions accounting for 89,7% of the total agricultural N_2O emissions. Comparing with 2009 GHG emissions in agriculture sector in 2010 has not changed a lot with a small increase of 0,3 %.

Emissions from industrial processes amount to 10,8% of the total GHG emissions (excl. LULUCF) in 2010. The main categories are: ammonia production, nitric acid production and cement production. Ammonia production is the largest source (from industrial processes) of CO_2 emissions contributing 5,5% to the total national emissions (excl. LULUCF) in 2010. Nitric acid production is the single source of N_2O emissions in industrial processes sector and accounts for 2,8% in the total national emissions (excl. LULUCF) in 2010. The GHG emissions in 2010 decreased by 2,3% comparing with 2009. The decline of GHG emission from industrial processes in 2010 was mainly due to installation of the secondary catalyst in nitric acid production plant in 2008.

The use of solvents in industries and households contribute only 0,4% of the total GHG emissions (excl. LULUCF). The greenhouse gas emissions decreased by 7,7% in 2010 comparing with the previous year. This reduction was caused by population decrease.

Waste sector accounted for 5,6% of the total GHG emissions in 2010 (excl. LULUCF). The solid waste disposal on land is the second important source of CH_4 emissions. It contributes 29,7% to the total CH_4 emissions (excl. LULUCF). There was 0,7% decline in CH_4 emission in 2010 caused by extraction of landfill gas from the newly launched 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. Lithuania is located in the middle latitudes climate zone and belongs to the Atlantic forest area in the continental southwest region. Only the Baltic coastal region is closer to the climate of Western Europe and the climate can be attributed to individual Southern Baltic climate 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.

Over the past 16 years (1991-2006) the average annual air temperature throughout the territory of Lithuania broke through 6ºC threshold, and reached 6,5-7,9°C. The average annual air temperature in Lithuania in 1991-2006 comparing with 1961-1990 rose by 0,7-0,9°C, which shows climate warming. The most striking trends of warming are in the Northern and Western side of Lithuania. From 1961, the year 2008 was the warmest in Lithuania with the average annual air temperature of 8,3°C.

At the end of the twentieth century the number of extremely hot days increased with the daily maximum air temperature equal to or above 30°C. Their probability in 1991-2006 comparing with 1961-1990 increased by 2-2,5 times and now amounts to 2-6 days per year. The highest probability is in southern and south-western Lithuania. Meanwhile, frosty days when the daily minimum air temperature drops to -20°C and below have decreased significantly: if in the period of 1961-1990 an average of 12-15 days during the winter in the East of Lithuania occurred, in the recent years they occurred for only 8-9 days per season. It was found out, that the change in the probability of extremely hot and cold days originated mainly due to a higher rates of recurrence of anticyclone processes during the summer and less frequent in winter.

An average number of days with snow cover comparing the period of 1961-1990 with 1991-2006 decreased by 4-10 days. However, the maximum snow thickness increased by 0,8-2 cm. This relates to increasing precipitation in the cold period and more frequent snowfalls in the recent years.

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 1990-2010. 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. For the preparation of inventory CRF Reporter v.3.5.2 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).

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 Forestry 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 1-1.

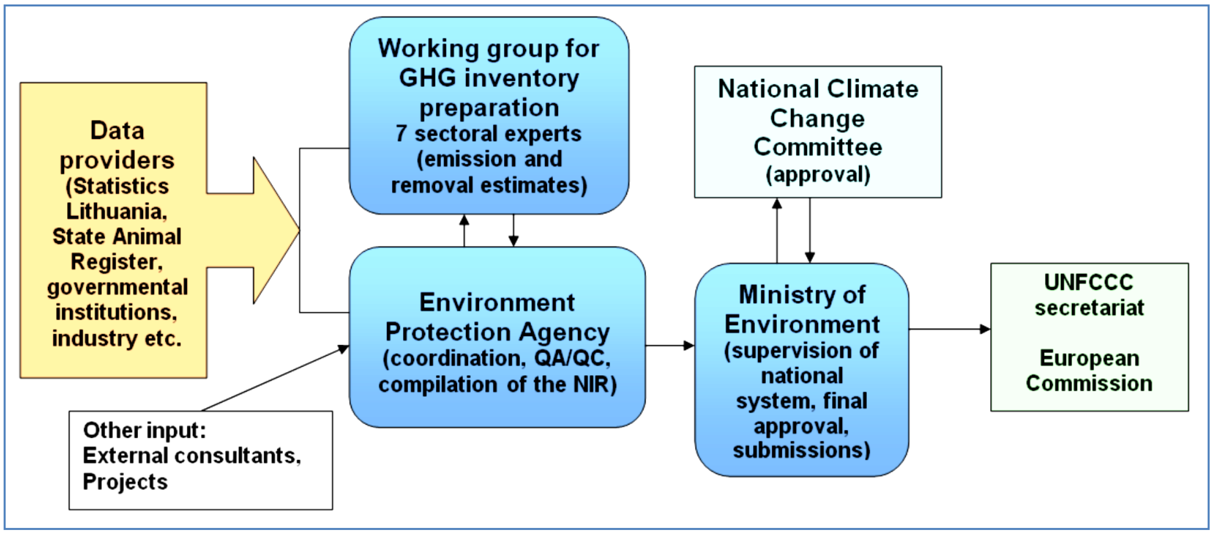


Figure 1-1. Institutional set-up for GHG inventory

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 year 2011 was nominated as an entity responsible for GHG inventory preparation by the Order of 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 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 preparatory 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 submissions and all supporting reference material is stored and maintained. Backups are prepared on regular basis following the EPA's information management procedures.

State Forest Service

The State Forest Service (SFS) compiles the National Forest Inventory 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 year 2010 State Forest Service in the GHG inventory preparation process is responsible for LULUCF (forestry part) sector and Kyoto Protocol 3.3 and 3.4 removals and emission calculations for the LULUCF sector by the order of the Minister of Environment 29 of July, 2010 No D1-666. SFS representative is also a member of the recently established 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 sector and KP-LULUCF;
- 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 sector and KP-LULUCF;
- Uncertainty assessment for 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 emission 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 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 April 2010. 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;

Dr. Saulius Marcinkonis (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 (2001-2009)*; *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 (NOx, SO_2, CO, NMVOC) emissions under the Convention of Long-range Transboundary Air Pollution;
- Agricultural Information and Rural Business Centre of Ministry of Agriculture (data on livestock);
- 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 2012 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" will start. 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 sectoral experts involved in the inventory development process. This became very important now, when permanent working group for GHG inventory was newly established and some of the experts have no experience with reporting of GHG calculations.
- The establishment of Quality assurance/Quality control (QA/QC) procedures as well as documenting, archiving system improvement. Despite that Lithuania has a formal QA/QC plan, QA/QC system needs further improvement.
- Implementation of studies to fill in the reporting gaps in particular inventory areas.

Project will be implemented during the years 2012-2013 and the budget allocated for this project amounts to 772 500 Eur.

A number of studies aiming to improve GHG inventory estimates were initiated in 2012:

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 which accurately reflect the carbon content and other physical properties of fossil fuel consumed in country is required. Procurement tender was announced in March 2012. Study results are to be ready in August 2012.

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 is needed in order to complement GHG inventory and collect more detailed information on F-gases use in Lithuania during 1990-2010. Procurement procedure for this study was started in April 2012. Study results are to be ready in August 2012.

Study on research and evaluation of methane producing capacity in the Lithuanian manure management systems. Procurement tender was announced in March 2012. Study results are to be ready in August 2012.

Study on research and analyses of methane emissions from wastewater and sludge. The study is required as data is not sufficient for the proper calculation of GHG emissions in waste sector. Procurement tender was announced in April 2012. Study results are to be ready in August 2012.

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 2012 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 2012

Activity	Responsible institutions	Deadlines
Updated QA/QC plan 2012	EPA, MoE	August 2011
Data collection - sending of official letters to data providers; Methods development; QC procedures, data archiving	EPA, WG sectoral experts	September-October 2011
Meetings of all involved institutions for defining specific areas for improvements and recalculations	MoE, EPA, SFS, WG sectoral experts	September 2011
Sectoral experts input results to EPA	WG sectoral experts	October-November 2011
Filling CRF Reporter database, QC procedures, data archiving	EPA	November 2011
Prepare CRF tables and NIR part on LULUCF and KP-LULUCF and sending to EPA, data archiving	SFS	November 2011
Prepare draft NIR and send to MoE and other institutions for comments	EPA	By December 2011
Comments from MoE and others to EPA	MoE	By 15 December 2011
Submission of CRF tables, xml file and elements of the NIR to European Commission	MoE	By 15 January 2012
Possible CRF and NIR updates and final approval by MoE	EPA, MoE	By March 2012
Sending NIR to NCCC for comments and final approval,	MoE	By 15 March 2012

QA procedures		
Submission of updated CRF tables, xml file and NIR to European Commission	MoE	By 15 March 2012
Submission of CRF tables, xml file and NIR to UNFCCC secretariat	MoE	By 15 April 2012

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.

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, 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 *Good Practice Guidance* (2000). Both level assessment and trend assessment of the key source categories including and excluding LULUCF were conducted for all the years for which inventory estimates are available, following the Tier 1 approach. The base year for the analysis is 1990 for the greenhouse gases CO_2, CH_4, N_2O and 1995 for the greenhouse F-gases HFC, PFC and SF_6. Any source category that met the 95% threshold was identified as a key source category.

In this submission 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 68% in 1990 and 61,7% in 2010 of the total emissions (excluding LULUCF). The second important sector is Agriculture Sector accounting for 20% in the base year and 21,4% in 2010 of the total GHG emissions (excluding LULUCF).

The key category with a highest contribution to national total emissions in 2010 is 1.AA.1A Public electricity and heat production – *gaseous fuels* (CO_2) accounting for 16% of the emission (excluding 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 13% of the emission (excluding LULUCF).

The second most important source of greenhouse gas emissions in 2010 is 1.AA.3.B Road transportation – *diesel oil* (CO_2). Its contribution to national total is 13% compared to 4% in the base year. This increase is due to a shift from gasoline to diesel driven vehicles. The second most important source of greenhouse gas emissions in 1990 was 1.AA.1A Public electricity and heat production – *gaseous fuels* (CO_2) accounting for 12% of the emission (excluding LULUCF).

Except for 1.AA.3.E Off-road vehicles and machinery and 2.F Consumption of Halocarbons and SF_6 all key categories of last submission were identified as Level assessment key in this year's submission too.

The results of the analyses 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 (years 1990, 2010, 1990-2010)

KEY category	GHG	Level without LULUCF 1990	Level with LULUCF 1990	Level without LULUCF 2010	Level with LULUCF 2010	Trend (1990-2010) without	Trend (1990-2010) with

						LULUCF	**LULUCF**
1.AA.1.A Public electricity and heat production, gaseous fuel	CO_2	X	X	X	X	X	X
1.AA.1.A Public electricity and heat production, liquid fuel	CO_2	X	X	X	X	X	X
1.AA.1.B Petroleum refining, liquid fuel	CO_2	X	X	X	X	X	X
1.AA.2 Manufacturing industries and construction, gaseous fuels	CO_2	X	X	X	X	X	X
1.AA.2 Manufacturing industries and construction, liquid fuels	CO_2	X	X			X	X
1.AA.2 Manufacturing industries and construction, solid fuels	CO_2			X	X	X	X
1.AA.3.B Road transportation, diesel	CO_2	X	X	X	X	X	X
1.AA.3.B Road transportation, gasoline	CO_2	X	X	X	X	X	X
1.AA.3.B Road transportation, LPG	CO_2			X	X	X	X
1.AA.3.C Railways	CO_2	X	X	X			
1.AA.3.E Off-road vehicles and machinery	CO_2	X	X			X	X
1.AA.4 Other sectors, biomass	CH_4			X		X	X
1.AA.4.A Commercial/Institutional	CO_2	X	X	X	X	X	X
1.AA.4.B Residential	CO_2	X	X	X	X	X	X
1.AA.4.C Agriculture/Forestry/Fisheries	CO_2	X	X			X	X
1.B. Fugitive Emissions from Fuels	CH_4			X	X	X	X
2. F Consumption of Halocarbons and SF_6 since 1995	HFC			X		X	X
2.A.1. Cement Production	CO_2	X	X	X	X	X	X
2. A.2 Lime production	CO_2					X	
2.A.7 Bricks and tiles	CO_2					X	
2.B.1. Ammonia Production	CO_2	X	X	X	X	X	X
2.B.2. Nitric Acid Production	N_2O	X	X	X	X	X	
4.A. Enteric Fermentation, cattle	CH_4	X	X	X	X	X	X

4.B. Manure Management	N_2O	X	X	X	X		X
4.B. Manure Management, cattle	CH_4	X	X	X	X		
4.B. Manure Management, swine	CH_4	X	X	X	X		
4.D.1. Direct Soil Emissions, crop residues	N_2O			X	X		
4.D.1. Direct Soil Emissions, manure fertilizers	N_2O	X	X	X	X		
4.D.1. Direct Soil Emissions, synthetic N fertilizer	N_2O	X	X	X	X	X	
4.D.2. Pasture Range and Paddock Manure	N_2O	X	X	X	X		
4.D.3. Indirect Emissions	N_2O	X	X	X	X		
5.A.1. Forest Land remaining Forest Land	CO_2		X		X		X
5.A.2 Land converted to Forest Land	CO_2				X		X
5.B. Cropland	CO_2		X				X
5.C. Grassland	CO_2		X		X		X
6.A. Solid Waste Disposal on Land	CH_4	X	X	X	X	X	X

1.5.2 KP-LULUCF

Key category analysis for KP-LULUCF was developed according to the section 5.4 of the IPCC 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.

As in 2011 Lithuanian National System for the preparation of the GHG inventory was under enhancement for essential changes and improvements, QA/QC plan was updated in 2011. The Ministry of Environment and the Environment Protection Agency was responsible for the development of the updated QA/QC Plan. The EPA will be 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 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.

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.

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.

UNFCCC reviews performed by the ERTs help to fulfil 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 Good Practice Guidance 2000*. Quantitative uncertainties assessment was carried out for the emission level 2010 and for 1990-2010 (1995-2010 for F-gases) trend in emissions for all source categories (except Solvents use) 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.

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

Overall uncertainty

The uncertainties as percentage of the total national emissions including LULUCF in 2010 by different gases are the following:

CO_2	±9,83%
CH_4	±14,90%
N_2O	±19,23%

The total GHG emission in the year 2010 is estimated with an uncertainty of ±26,26% and the trend of GHG emission 1990-2010 has been estimated to be ±4,12%.

The uncertainties as percentage of total national emissions excluding LULUCF in 2010 by different gases are the following:

CO_2	±1,39%
CH_4	±6,43%
N_2O	±8,21%

The total GHG emission in the year 2010 is estimated with an uncertainty of ±10,53% and the trend of GHG emission 1990-2010 has been estimated to be ±2,21%.

Comparing with last year submission, uncertainty including LULUCF increased substantially. This increase is related to recalculations in LULUCF sector - emissions and removals from Grassland and Cropland were estimated for the first time in this submission, therefore their uncertainty was included in overall uncertainty calculation in this submission. In this submission uncertainty of solvent and other product use emissions was included for the first time.

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 1990-2010. 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	√	√	√			
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 CO2 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				NA/NO	NA/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	√			
E Prescribed burning of savannas		NO	NO			

	F	Field burning of agricultural residues		NA/NO	NA/NO			
	G	Other		NO	NO			
5		**Land use, land use change and forestry**						
	A	Forest land	√	√	√			
	B	Cropland	√	√	√			
	C	Grassland	√	√	√			
	D	Wetlands	√	NE/NO	NE/NO			
	E	Settlements	√ NA/NE/NO	NA/NE	NA/NE			
	F	Other land	√ NE/NO	NA/NE	NA/NE			
	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

2 TRENDS IN GREENHOUSE GAS EMISSIONS

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

Total GHG emissions (excl. LULUCF) amounted to 20809,7 Gg CO_2 eq. in 2010. 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 2010 have decreased by approximately 58% compared to the base year excluding LULUCF and by 78,9% including LULUCF. Figure 2-1 shows the estimated total greenhouse gas emissions in CO_2 eq. from 1990 to 2010.

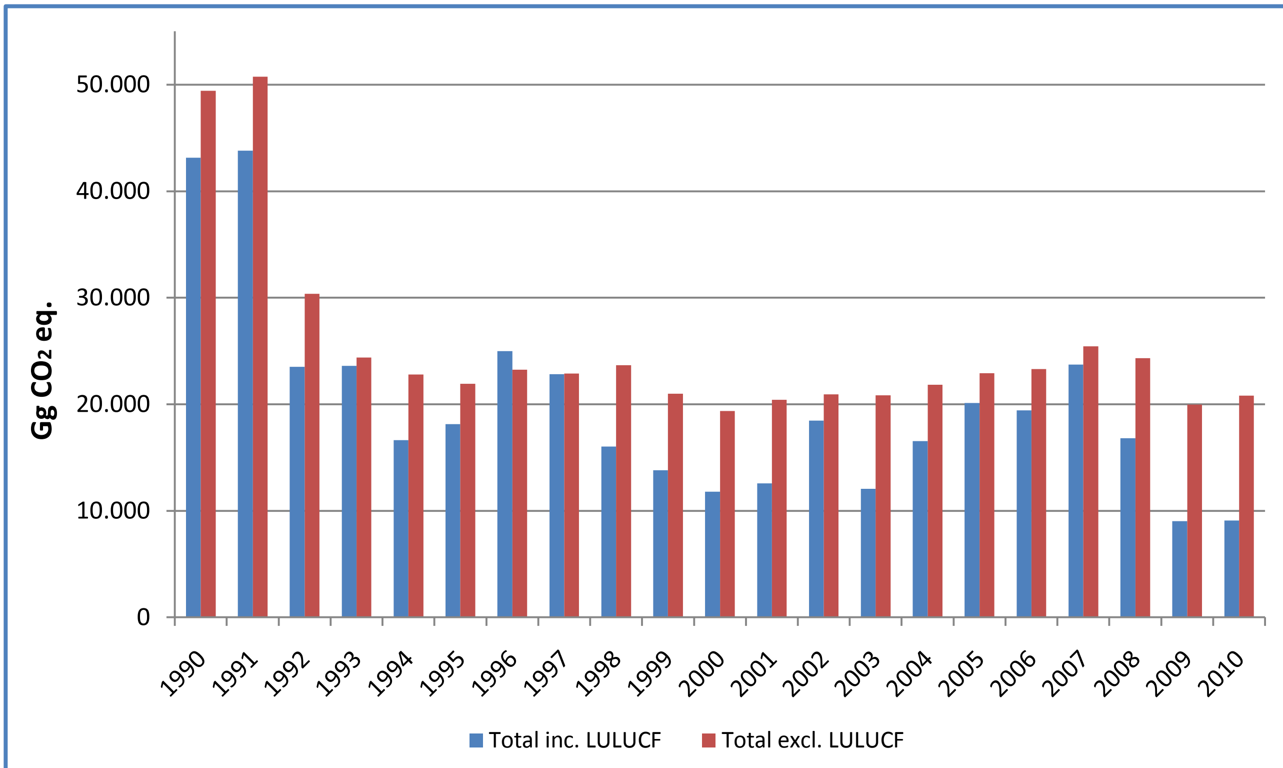


Figure 2-1. Emission trends for aggregated greenhouse gas

The most important greenhouse gas is carbon dioxide (CO_2), it contributed 66,5% to the total national GHG emissions expressed in CO_2 eq. in 2010, followed by N_2O (17,2%) and CH_4 (15,4%). PFCs, HFCs and SF_6 amounted together to 0,9% of the overall greenhouse gas emissions in the country.

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 2010 was observed. 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) has varied from 60% to 76%. CO_2 emissions have decreased by 62% since 1990. In 2010, the actual CO_2 emission (incl. LULUCF) was 93% less 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 2009 CO_2 emissions increased by 6,8% including LULUCF or 6,9% excluding LULUCF.

The largest source of CO_2 emissions is energy sector which contributes around 89% of all CO_2 emissions. Compared to 2009 CO_2 emissions increased by 7,9%. This increase is due to the growth of the energy consumption. Figure 2-2 shows the distribution of CO_2 emissions in 2010 by the main sectors and subsectors.

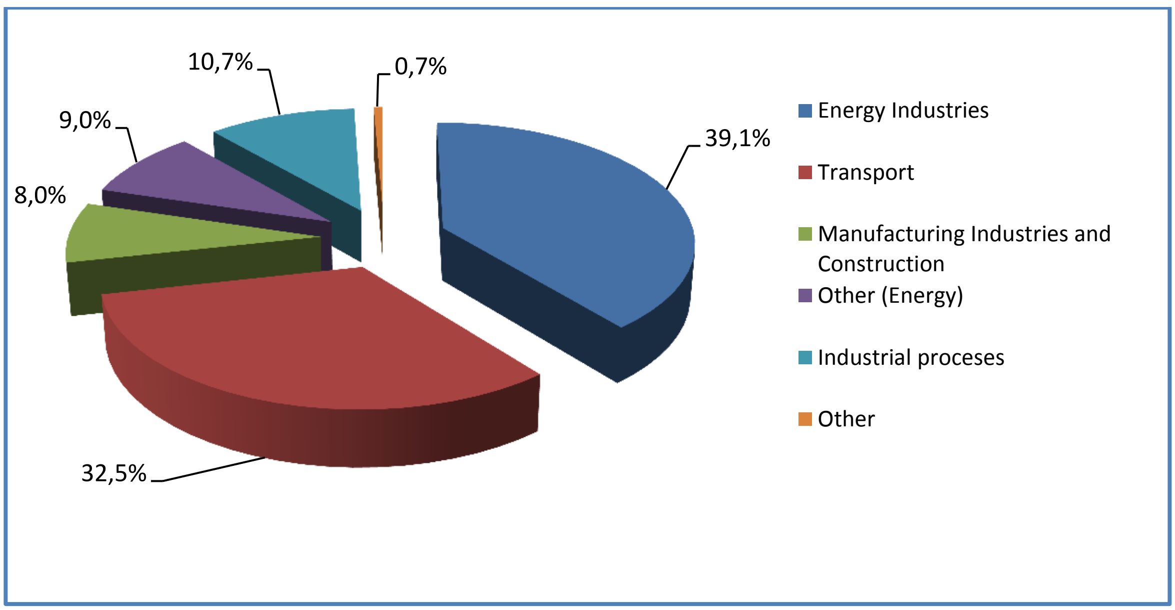


Figure 2-2. Distribution of CO_2 emissions by the main sectors

Nitrous oxide

Nitrous oxide is the second most important GHG accounting for 17,2% in the total national greenhouse gas emissions (excl. LULUCF). Agriculture is the main source of N_2O emissions in 2010 contributing 78,2% to the total N_2O emissions. Particularly these are emissions from agricultural soils – contributing for 70,2% of the total N_2O emisions, and manure management which accounts for 8% in the total national GHG emissions.

N_2O emission from atmospheric deposition and nitrogen leaching and run-off in 2010 decreased by 52,6% and 48,7% respectively compared to the 1990 year due to decrease of consumption of synthetic fertilizers and number of livestock population.

The second significant source of N_2O emissions is nitric acid production. It contributes 16,2% 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 2010 by the main sectors and sub-sectors.

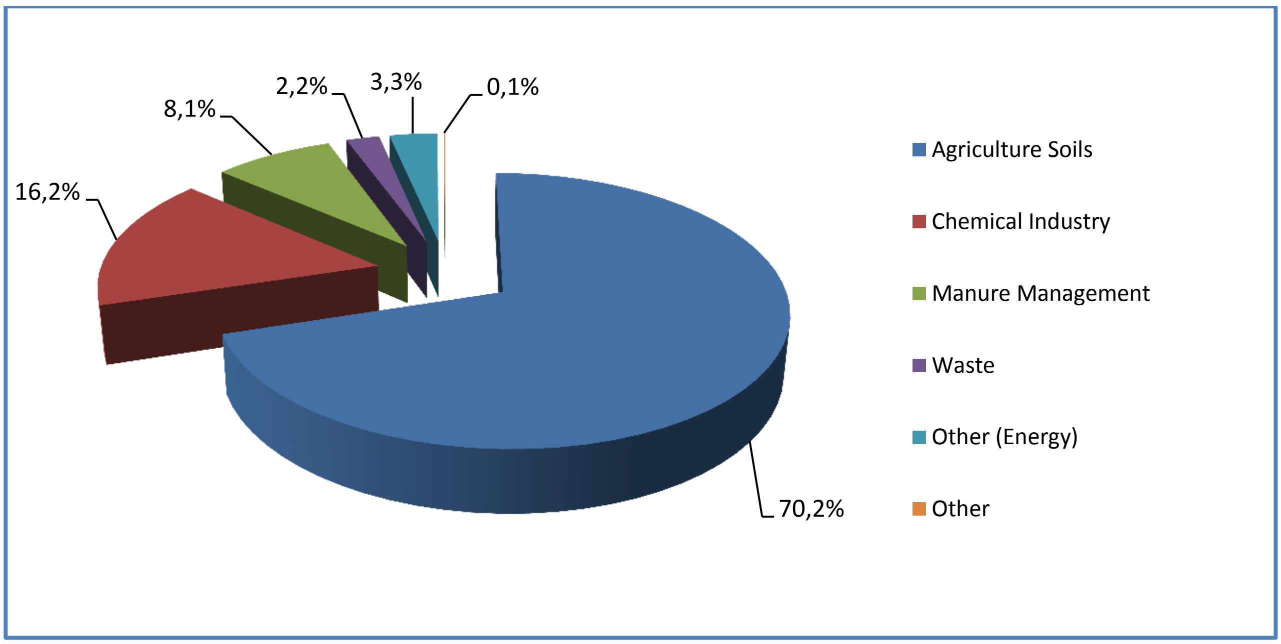


Figure 2-3. Distribution of N_2O emissions by the main sectors and subsectors

Methane

The largest sources of methane emissions are agricultural sector, contributing with 51,8% in 2010, waste sector - 33,6% and oil and natural gas sector - 8%, see Figure 2-4. The emission from agriculture derives from enteric fermentation and manure management contributing with 37,2% and 14,5 % of the total national CH_4 emission (excl LULUCF).

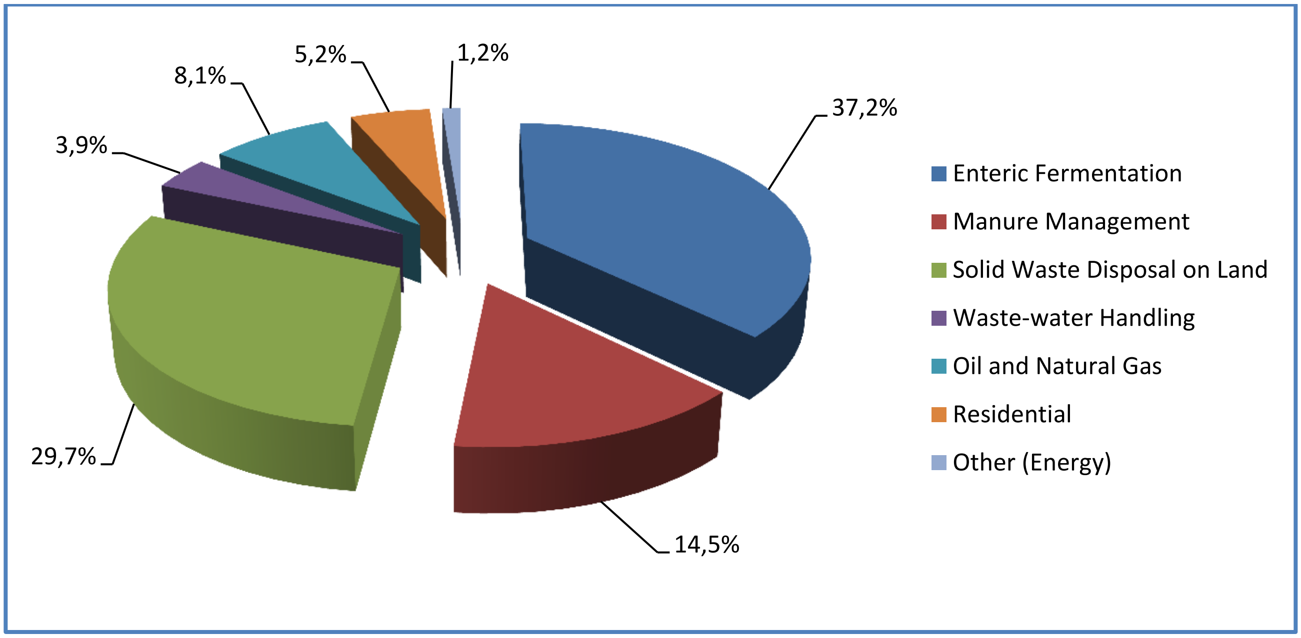


Figure 2-4. Distribution of CH_4 emissions by the main sectors

The emission of CH_4 has decreased by 45% from 1990 to 2010. The emissions of CH_4 mainly decreased due to reduction of livestock.

HFCs and SF_6

The F-gases contribute 0,9% to the total national greenhouse gas emissions. The emissions of F-gases have increased during 1995-2010. A key driver behind the trend has been the substitution of ozone depleting substances (ODS) by F-gases in many applications. In Figure 2-5 the development of emissions of F-gases during 1995-2010 is presented.

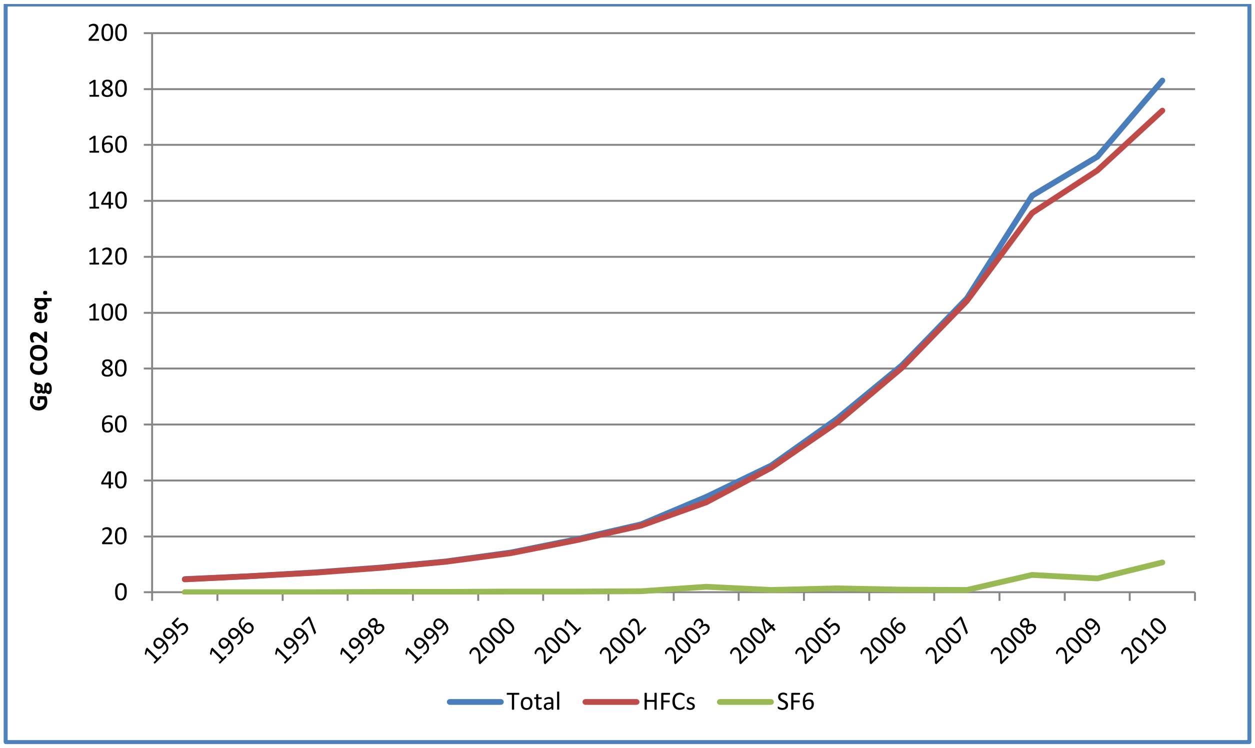


Figure 2-5. Emission trends for F-gases

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.

Energy

The energy sector is the most significant source of greenhouse gas emissions in Lithuania with 61,7% share of the total emissions (excl. LULUCF) in 2010. 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 almost 2,6 times from 33787,4 Gg CO_2 eq. in 1990 to 12848,4 Gg CO_2 eq. in 2010 (Figure 2-6). Significant decrease of emissions was mainly due to economic slump in 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 9,1% in 2009. The closure of Ignalina NPP and GDP increase had impact on greenhouse gas increase by 7,6% in 2010.

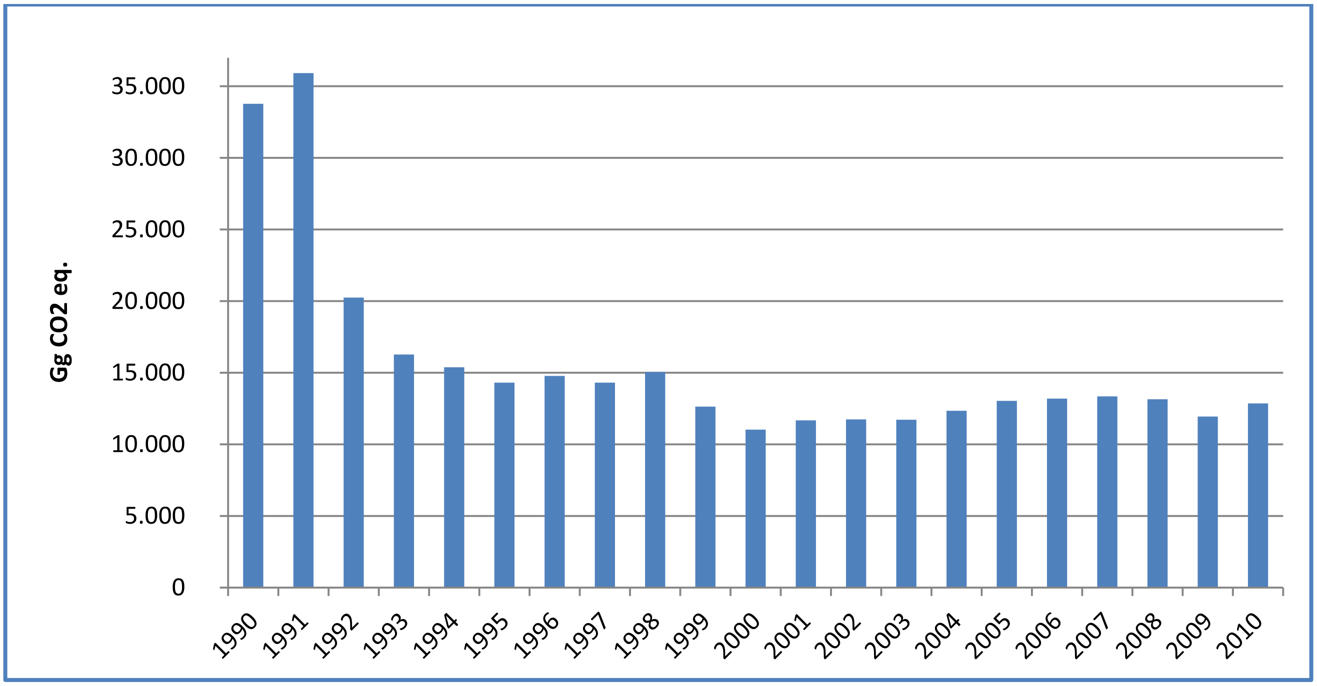


Figure 2-6. Trend of greenhouse gas emissions in energy sector

During the period 1990-2010 the share of transport sector significantly increased. In 1990, transport sector accounted for 23% of total greenhouse gas emission in energy sector whereas in 2010 – 35,5%. 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 is increasing by 3% per annum.

Industrial processes

The emissions from industrial processes (referred to as non-energy related ones) amount to 10,8% of total emissions (excl. LULUCF) in 2010. The emissions from industrial processes in 2010 include CO_2, N_2O and F-gases emissions. Emissions of total greenhouse gases from the industrial processes sector have decreased by almost 2 times from 4295,65 Gg CO_2 eq. in 1990 to 2.249,17 Gg CO_2 eq. in 2010 (Figure 2-7).

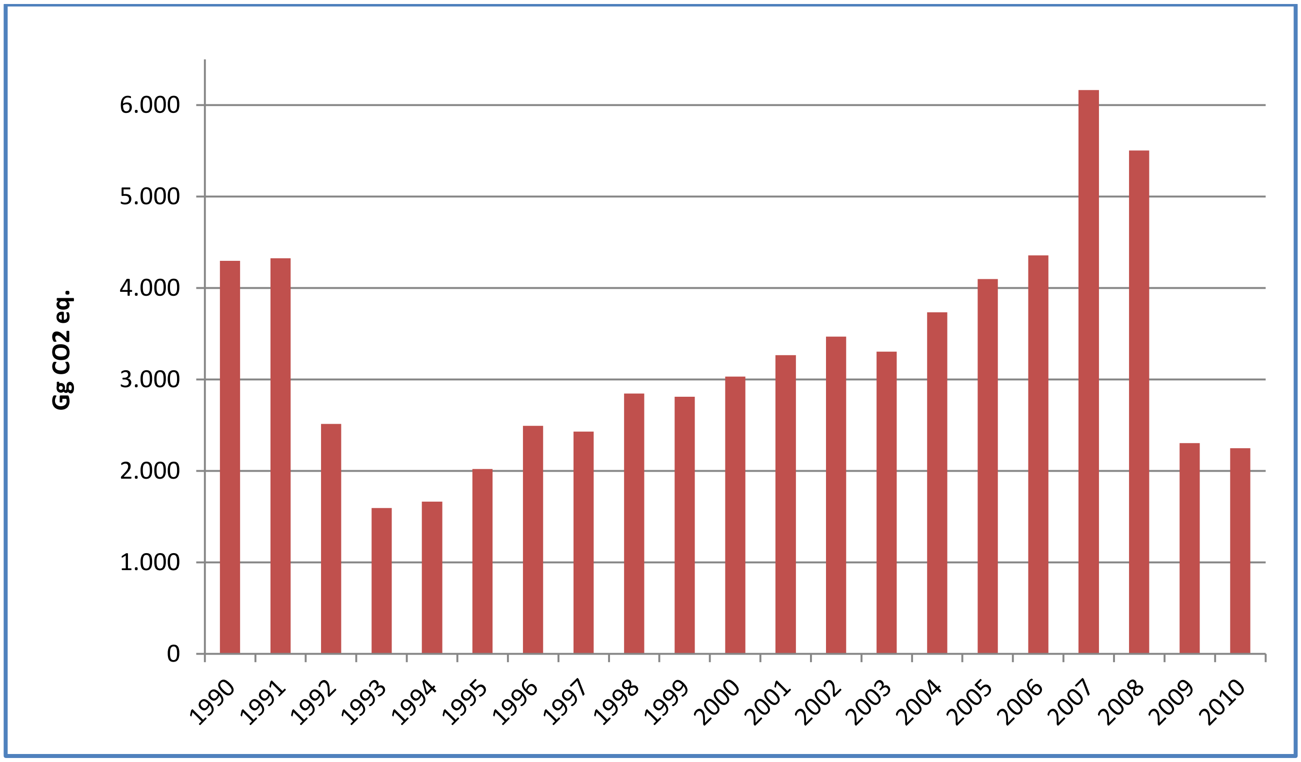


Figure 2-7. Trend of greenhouse gas emissions in industrial processes sector

CO_2 emissions from ammonia production contributing 5,5% to the total 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.

Nitric acid production is the single source of N_2O emissions in industrial processes sector and accounts for 2,8% in the national total emissions (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 and continue to decrease.

Solvents and other product use

The use of solvents in industries and households contribute 0,4% of the total greenhouse gas emissions (excl. LULUCF). The emissions from solvents and other product use in 2010 include CO_2 and N_2O emissions. The emissions of total greenhouse gases from the solvents and other product use sector have decreased by more than 2 times from 197,61 Gg CO_2 eq. in 1990 to 92,62 Gg CO_2 eq. in 2010 (Figure 2-8). The reduction is due to the population decrease. The main source of CO_2 emissions is paint application contributing 51,6% to the total solvent and other product use CO_2 emissions. Domestic solvent use is the second important source of CO_2 emissions (20,7%).

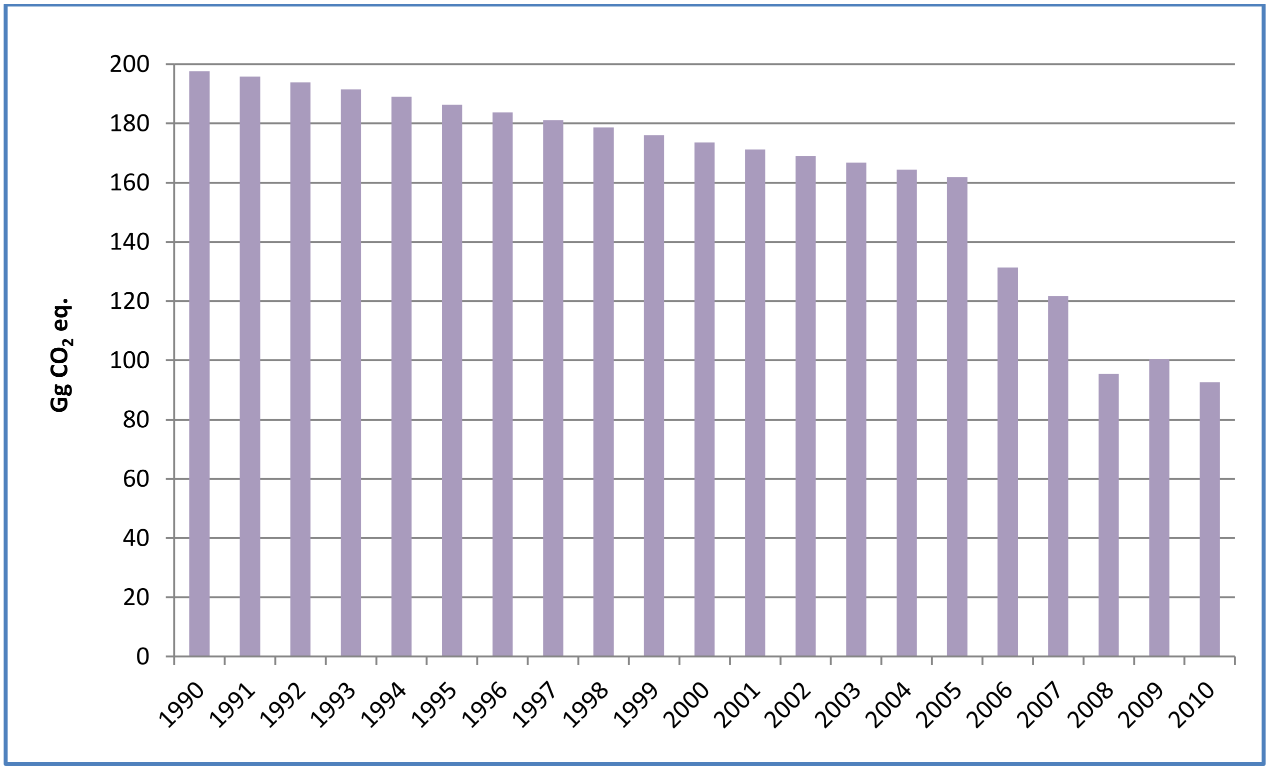


Figure 2-8. Trend of greenhouse gas emissions in solvents and other product use sector

Agriculture

Agriculture sector is the second most important source of greenhouse gas emissions in Lithuania contributing 21,4% to the total emissions (excl. LULUCF). The emissions from agriculture sector in 2010 include CH_4 and N_2O emissions. Emissions of total greenhouse gases from the agriculture sector have decreased by almost 2,3 times from 9986,44 Gg CO_2 eq. in 1990 to 4458,33 Gg CO_2 eq. in 2010 (Figure 2-9).

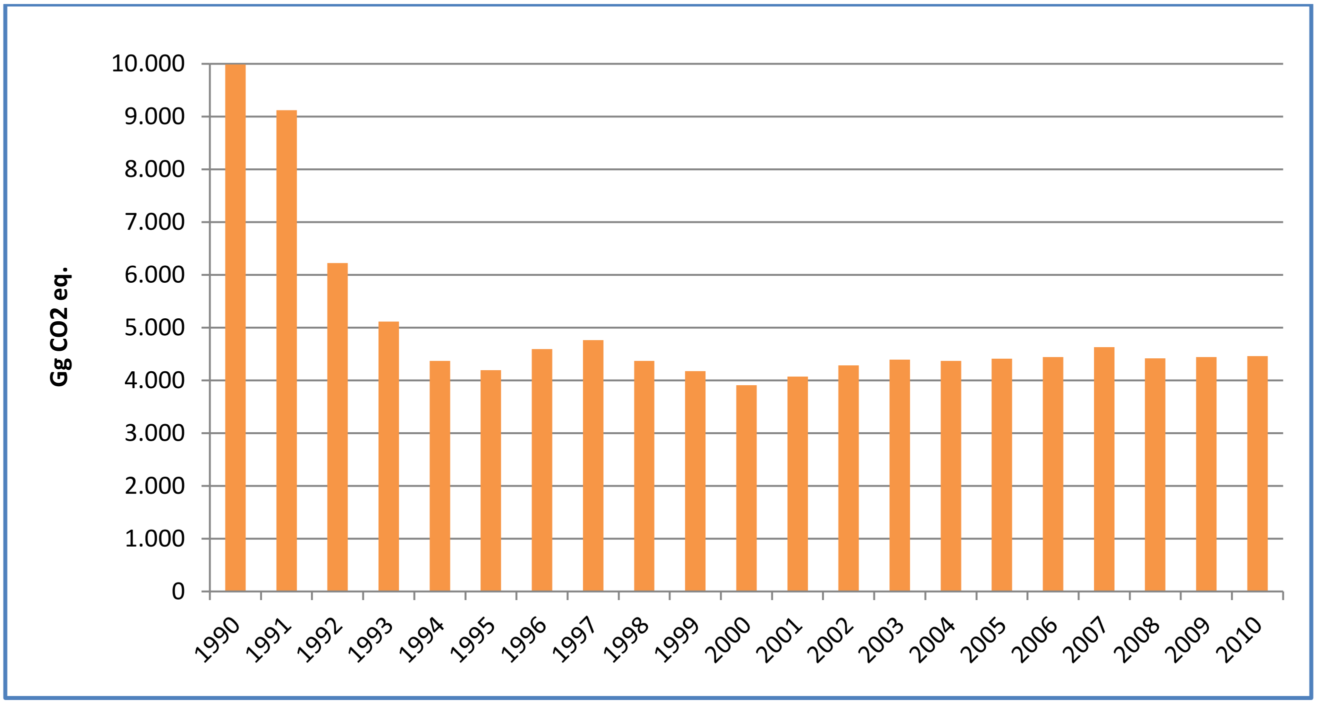


Figure 2-9. Trend of greenhouse gas emissions in agriculture sector

Agriculture sector is the most significant source of the CH_4 and N_2O emissions accounting for 51,8% and 78,2% in the total CH_4 and N_2O emissions, respectively. The emissions of CH_4 and N_2O decreased by 61,7% and 50,5% compare to the base year, respectively.

The major part of the agricultural CH_4 emission originates from digestive processes. Enteric fermentation contributes 72%, manure management - 28% to the total agricultural CH_4 emissions. The reduction of CH_4 emissions is caused by the decrease of total number of animals.

Agricultural soils are the most significant source of N_2O emissions accounting for 89,7% in the total agricultural N_2O emissions. N_2O emission from atmospheric deposition and nitrogen leaching and run-off in 2010 decreased by 52,6% and 48,7% 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 1990-2010 as a whole acted as a CO_2 sink except in 1996 when emission constituted to 1437,5 Gg of CO_2 (Figure 2-10). That is explained by sudden spruce dieback that caused huge loses in volume, in Lithuanias' spruce stands, which has direct impact on biomass calclations and on CO_2 balance from this sector.

The LULUCF sector during the 2007-2010 sinked from nearly 35% to 60% of the total CO_2 emissions of Lithuania. Largely this should be contributed to forest land which removes from 3 to 8 times more CO_2 from atmosphere comparing to overall LULUCF sector.

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 have been used. According to the IPCC GPG 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".

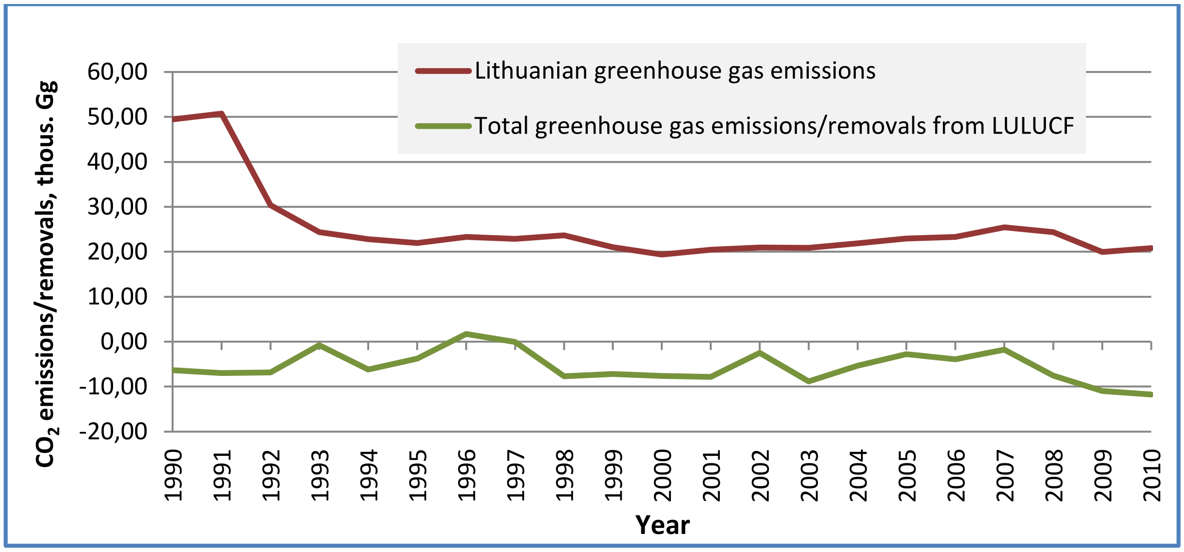


Figure 2-10. Lithuanian total greenhouse gases emissions and removals from LULUCF sector

Waste

The waste sectors accounted for 5,6% of the total greenhouse gas emissions in 2010 (excl. LULUCF). The emissions from waste sector in 2010 include CO_2, CH_4 and N_2O emissions. Emissions of total greenhouse gases from the waste sector have decreased from 1165,7 Gg CO_2 eq. in 1990 to 1161,25 Gg CO_2 eq. in 2010 (Figure 2-11).

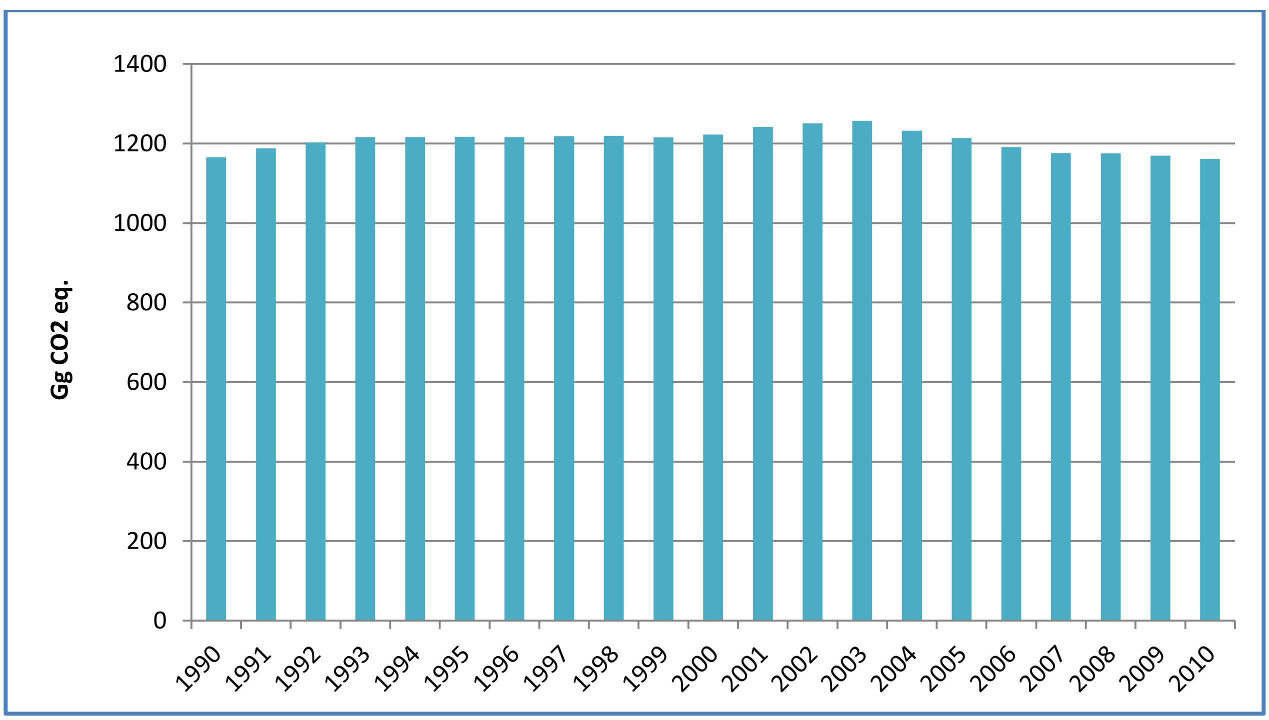


Figure 2-11. Trend of greenhouse gas emissions in waste sector

Solid waste disposal on land, including disposal of sewage sludge, was the most important source contributing from 77.8% to 82.7%, on average 80.6% 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 this waste over to farmers for use in agriculture and greenhouse gas emissions declined.

Total GHG emissions decreased approximately by 58% excluding LULUCF and by 79% 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 ($NOx=NO+NO_2$), non-methane volatile organic compounds (NMVOC) and carbon monoxide (CO) are not GHG, 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 effect 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[1]. 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 Convention on Long-range Transboundary Air Pollution (CLRTAP) in 1994. As a party to the CLRTAP Lithuania is bound 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) annually. To be able to meet this reporting requirement Lithuania compiles and updates air emission inventory of SO_2, NO_x, NMVOC, CO and NH_3, particulate matter (PM), 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 2-11). Air emission inventory is based mainly on statistical publications 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 others.

[1] Intergovernmental Panel on Climate Change, Climate Change 2001: The scientific Basis. Summary for Policymakers (Cambridge, UK: Cambridge University Press, 2001). P. 44.

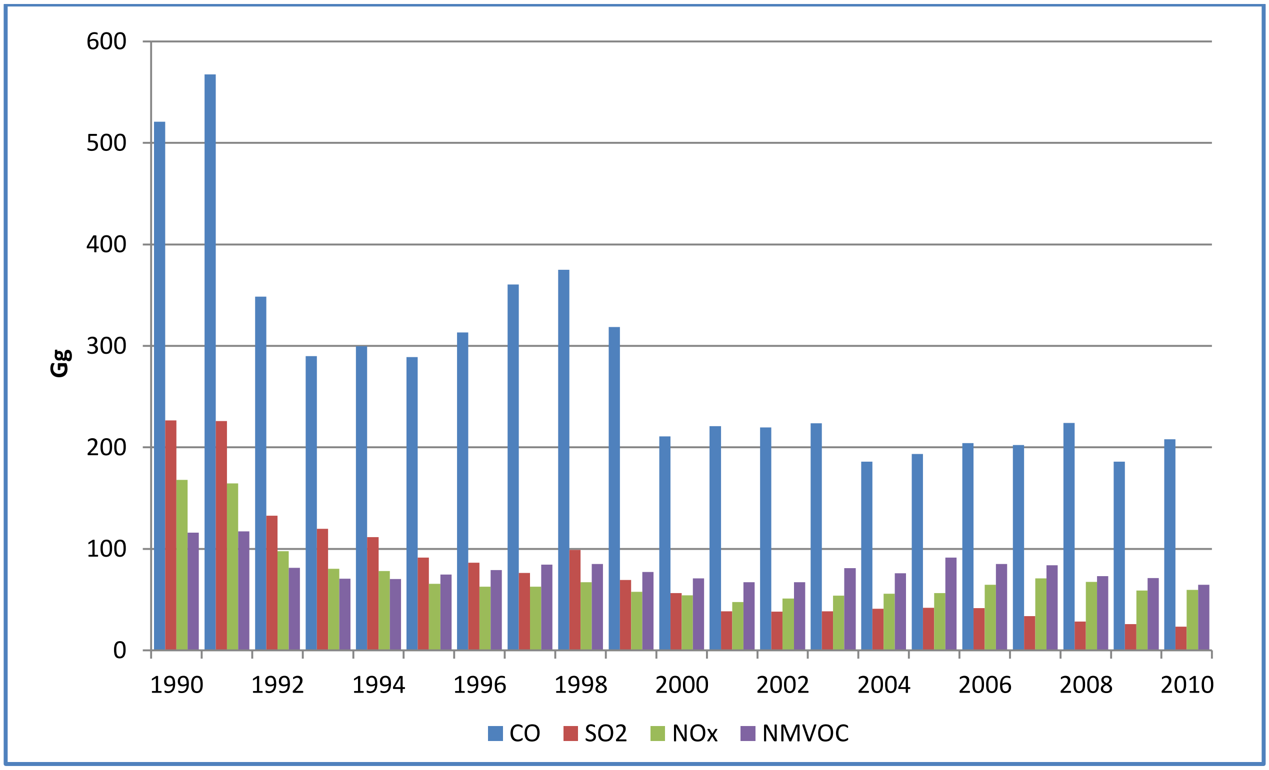


Figure 2-12. Development of indirect GHG gases and SO_2 emissions, 1990-2010

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 a 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.

Table 2-1. Key source analysis for the main pollutants 2010

Component	Key categories (Sorted from high to low and from left to right)								Total (%)
SO_x	Refining / storage	Residential Stationary plants	Mobile Combustion in manufacturing industries and construction	Manufacture of solid fuels and other energy industries	Public electricity and heat production	Commercial/ institutional: Stationary			86,7
	19,9%	17,7%	15,8%	14,2%	10,5%	8,6%			
NO_x	Road transport: Heavy duty vehicles	Road transport: Passenger cars	Public electricity and heat production	Manufacture of solid fuels and other energy industries	Railways	Mobile Combustion in manufacturing industries and construction	Residential: Stationary plants	Road transport: Light duty vehicles	83,7
	36,3%	14,2%	9,9%	5,6%	5,4%	4,6%	3,8%	3,8%	
NMVOC	Industrial coating application	Residential: Stationary plants	Food and drink	Refining/ storage	Road transport: Passenger cars	Stationary combustion in manufacturing industries and construction	Decreasing		81,5
	21,6%	21,3%	14,7%	11,0%	6,6%	3,3%	3,1%		
CO	Residential: Stationary plants	Road transport: Passenger cars							83,2
	62,9%	20,3%							

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

Component	Key categories (Sorted from high to low from left to right)						Total (%)
SO_x	Public electricity and heat production	Mobile Combustion in manufacturing industries and construction	Commercial / institutional: Stationary	Residential: Stationary plants			**82,5**
	36,7%	22,0%	13,6%	10,2%			
NO_x	Public electricity and heat production	Road transport: Passenger cars	Road transport: Heavy duty vehicles	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Mobile Combustion in manufacturing industries and construction		**81,8**
	25,3%	19,7%	18,1%	12,7%	5,9%		
NMVOC	Road transport: Passenger cars	Industrial coating application	Food and drink	Domestic solvent use including fungicides	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	Residential: Stationary plants	**83,5**
	34,1%	14,1%	11,0%	9,6%	8,7%	6,1%	
CO	Road transport: Passenger cars	Residential: Stationary plants	Commercial / institutional: Stationary				**86,5**
	55,0%	23,8%	7,6%				

A rapid decrease of indirect GHG emissions followed the decline of the country economy in the 1990s. Since 2000, the GDP has been growing continuously. Tables 2-1 and 2-2 present results from the Level Assessment of the key source for 1990 and 2010.

During the period 1990-2010, 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 mostly related to reduction in the consumption of heavy fuel oil for producing electricity and district heat. The share of natural gas, which is 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 (36,7%), followed by emissions occurring from Manufacturing Industry & Construction (22%) and in the Commercial, institutional and households (13,6%) sectors. 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 10,5% of Lithuanian's total emissions in 2010. Emissions are mostly comprised of emissions from activities related to Refining/Storage (19,9 %) and Residential combustion (17,7 %) sectors.

Emissions of NO_x have decreased by ~33% between 1990 and 2010. The Road transport (1A3bi-iii) and Energy industry (1A1) sectors are main sources of nitrogen oxides emissions ~50% and 16% respectively in 2010. 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 the closure of Ignalina NPP.

In 2010, the most significant sources of NMVOC emissions were Solvent and product use (21,6%), followed by *Manufacturing Industry & Construction* (21,3%). 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.

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 1,5% 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 (3,0%). In 2009, GDP decreased by 14,7% and in 2010 Lithuania's GDP grew slightly by 1,3% (Statistics Lithuania, 2011).

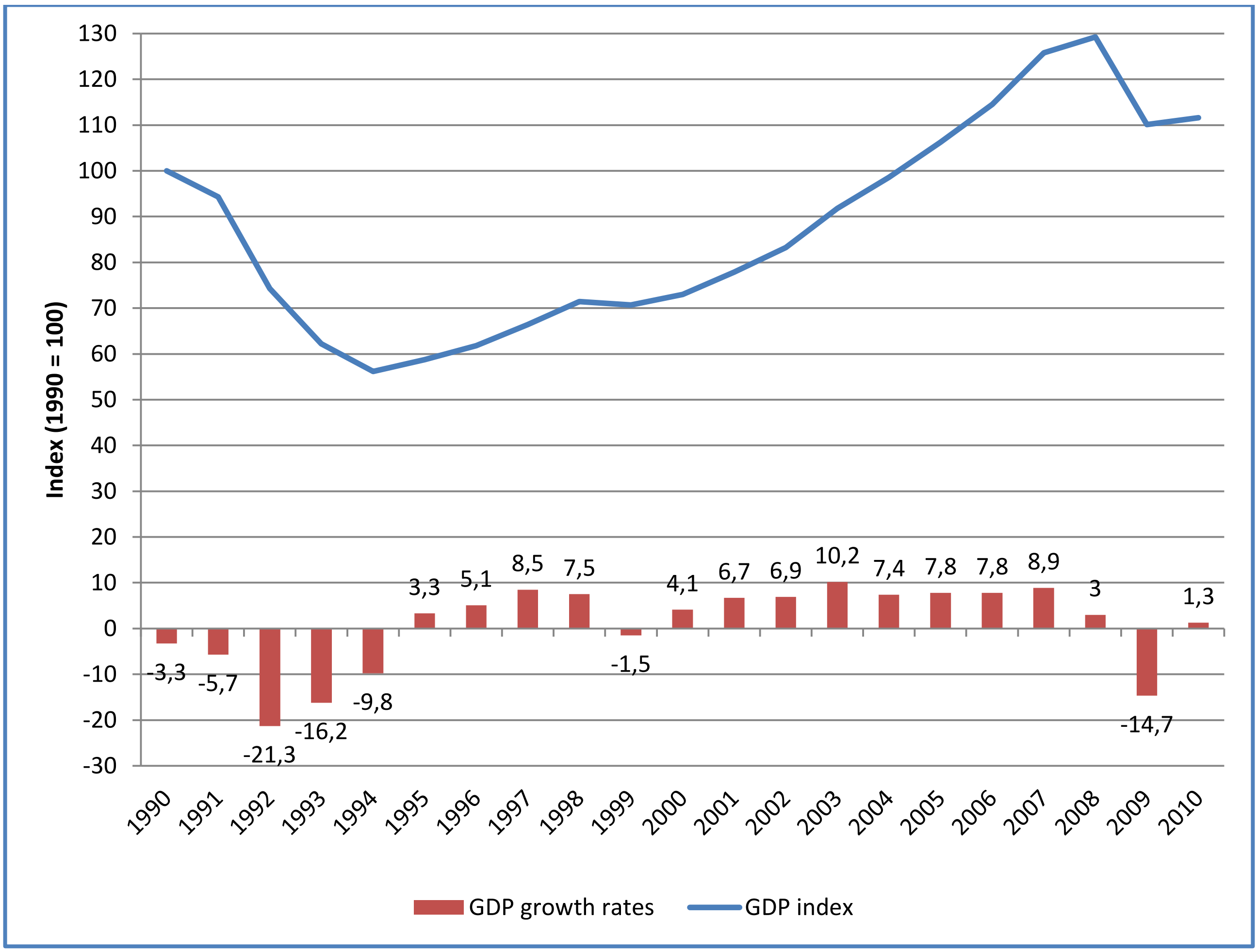


Figure 3-1. Changes of GDP annual growth rates and index in Lithuania

Dynamics of primary energy consumption in Lithuania during 1990-2010 is presented in Figure 3-2. Total primary energy consumption in 1990 amounted to 675,55 PJ (16,138 Mtoe) and in 2010 – 294,81 PJ (7,043 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 29% with the smallest portion of 25,6% in 2003 and the largest share of 31,7% in 2008. 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 28,7%, but in 2010 due to closure of Ignalina Nuclear Power Plant (NPP) the share of oil products increased to 36,3%.

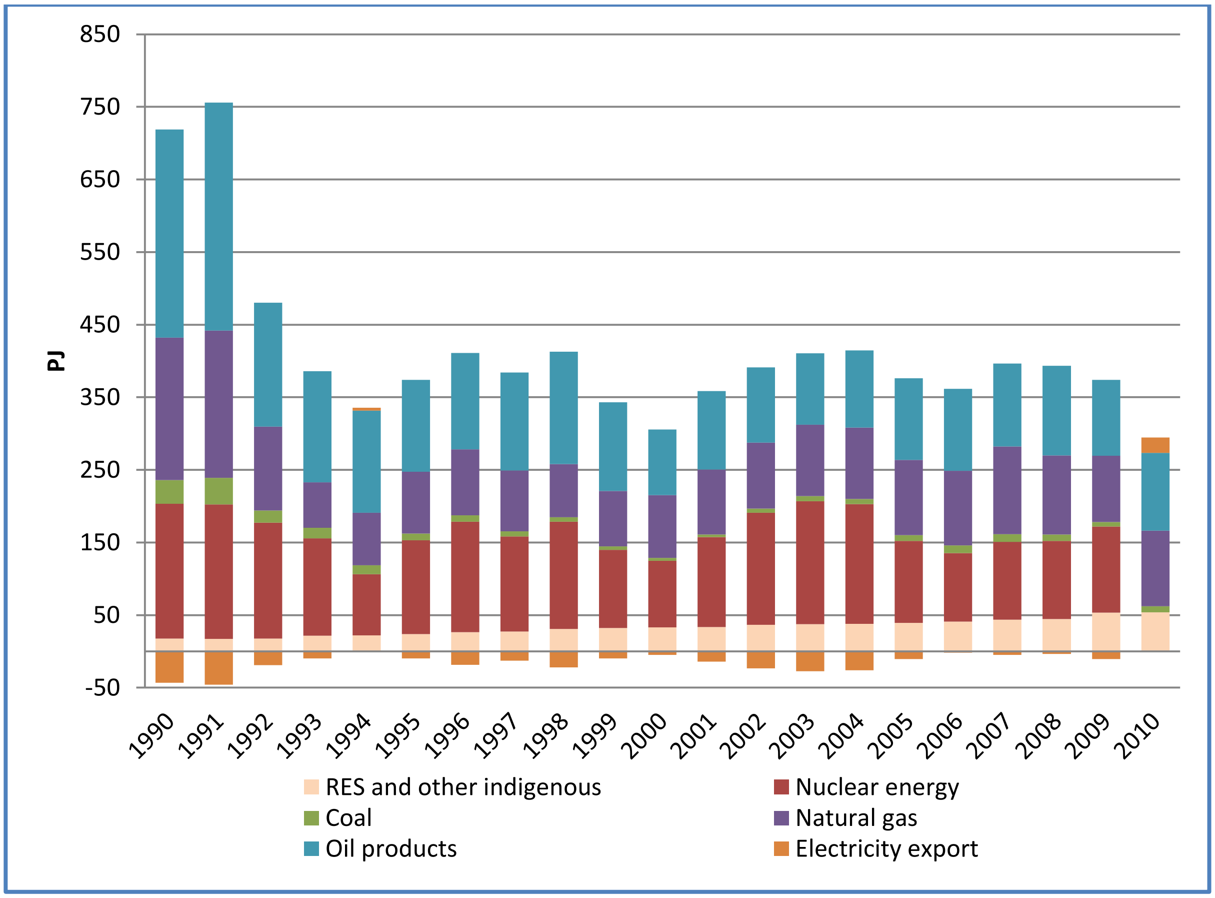


Figure 3-2. Primary energy consumption in Lithuania

At present natural gas is the most important fuel in the Lithuanian primary energy balance. The share of natural gas was fluctuating about 27% over the period 2000-2009 with the lowest contribution of 24,7% in 2002 and the largest share of 30,9% 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. However, in 2010 the share of natural gas increased in the balance of primary energy to 35,4%.

During the last decade the share of nuclear energy was very high and fluctuated about 30% with the lowest value of 25,8% in 2006 and the highest value of 37,0% 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 29,7%. 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 neighboring countries. In 2010, share of electricity generated by all Lithuanian power plants was about 49% in the balance of gross consumption and 51% of electricity necessary to meet internal requirements was covered by electricity import, mostly from Russia.

Over the period 2000-2010 the share of coal in the primary energy balance was fluctuating about 2%, and in 2010 contribution of this fuel was 2,8%.

Comparison of the primary energy consumption structure in 1990 and in 2010 is presented in Figure 3-3.

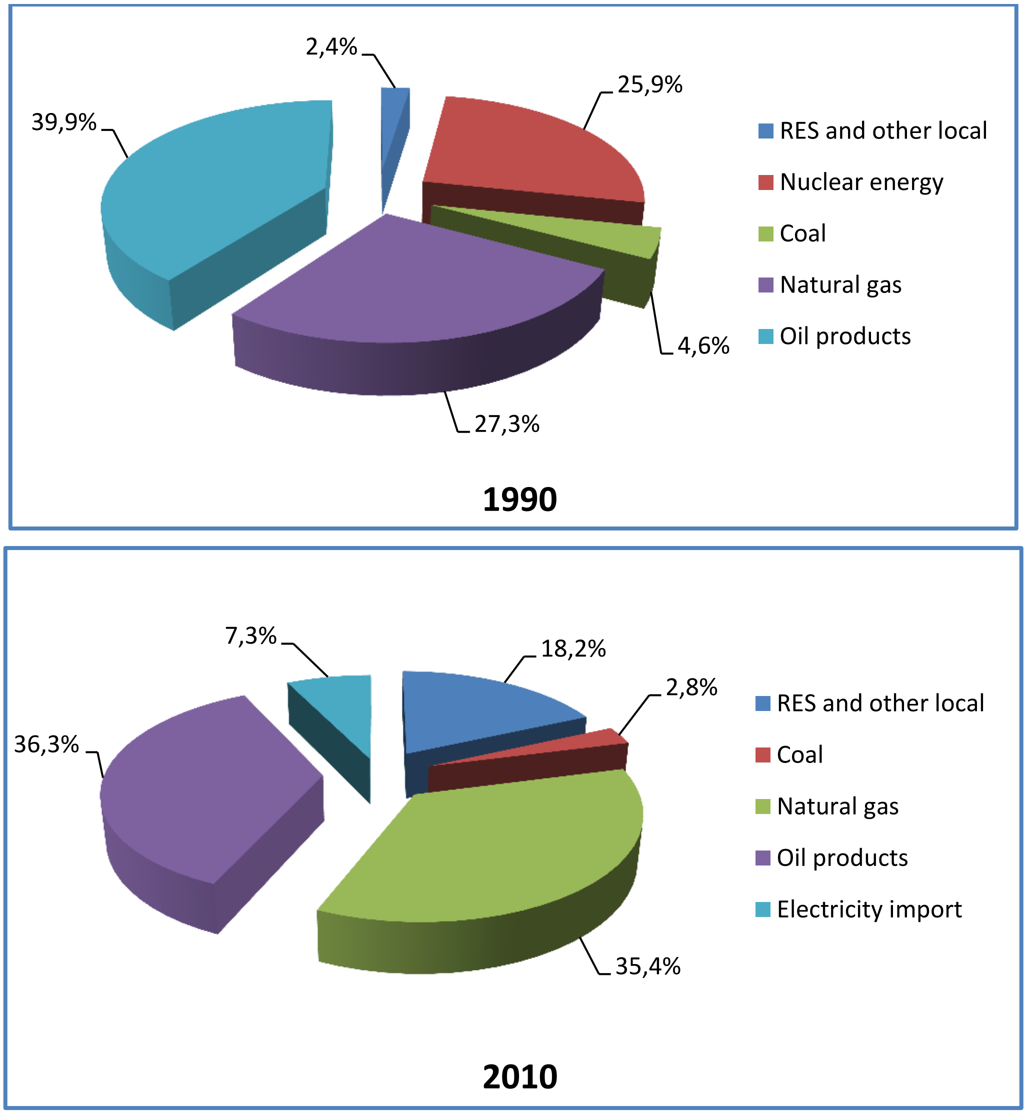


Figure 3-3. Structure of primary energy consumption in Lithuania

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 1990-2010 was increasing (Statistics Lithuania, 2004, 2006-2010). During the period 1990-2010 primary energy supply from renewable sources increased by 3,1 times with an average annual growth of 6,2%. 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 88,1% in the balance of renewable energy sources. The second largest renewable energy source is liquid biomass. In 2010, a share of bioethanol and biodiesel was 4,4%. Hydro power is fluctuating and currently provides 4,3% in the balance of renewable energy sources.

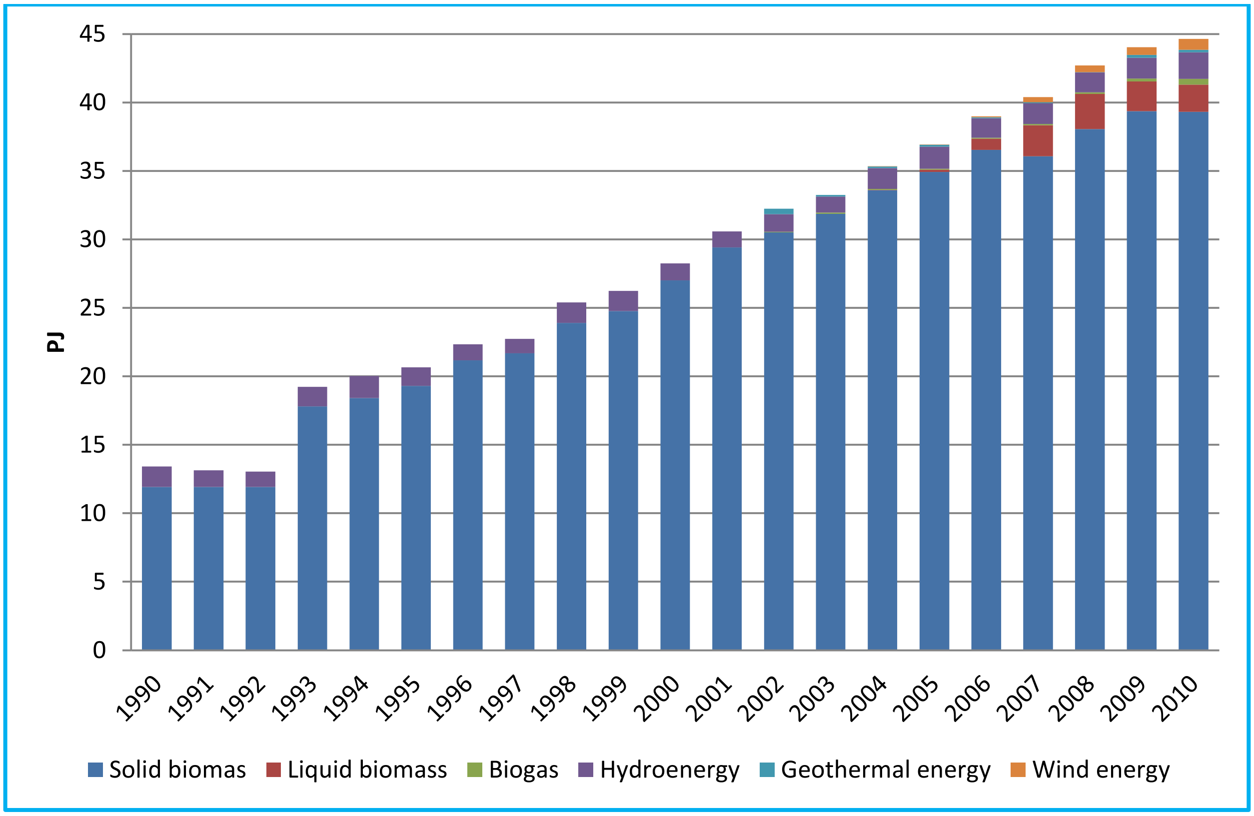


Figure 3-4. Consumption of renewable energy sources in Lithuania

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 neighboring countries (mostly from Russia).

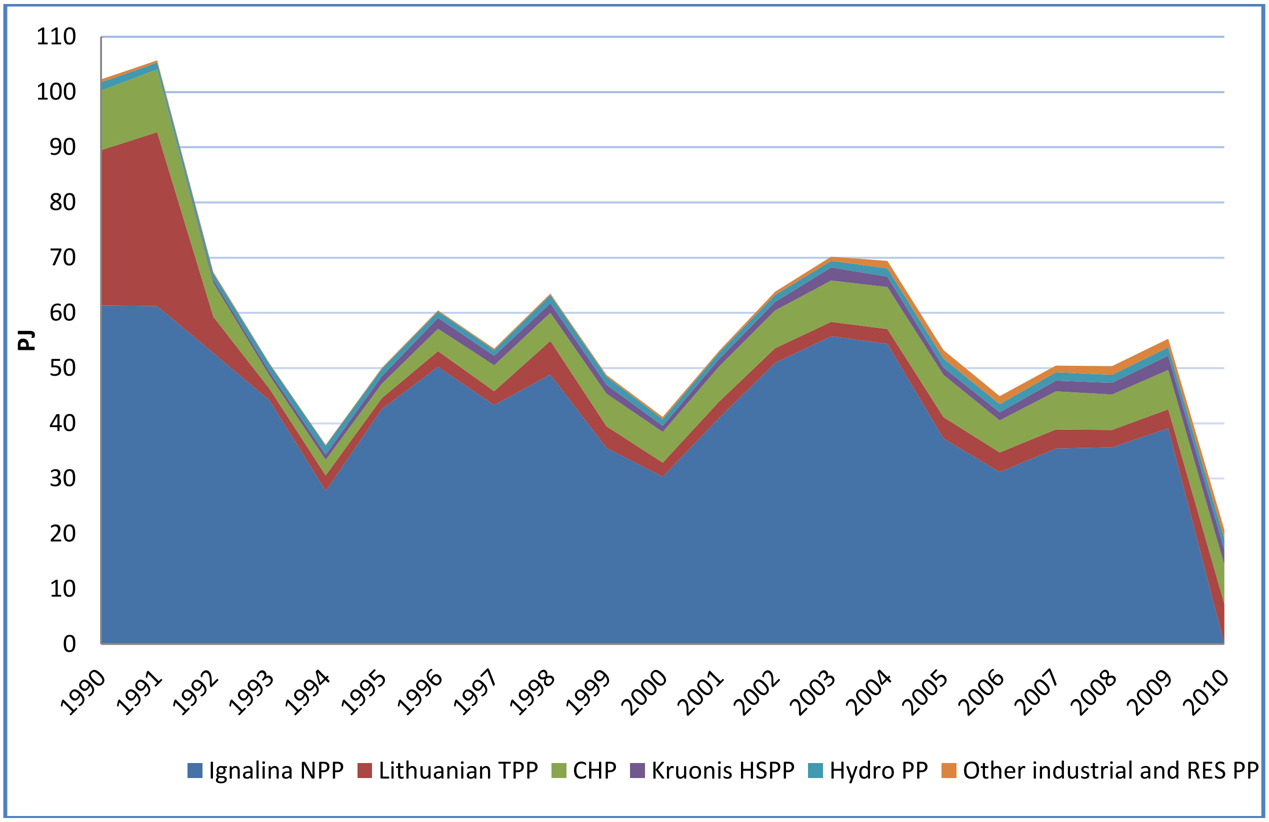


Figure 3-5. Structure of electricity generation in Lithuania

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 10% per year. Current electricity generation from renewable energy sources is still dominated by hydropower, generating about 59,2% of RES-E in 2010.

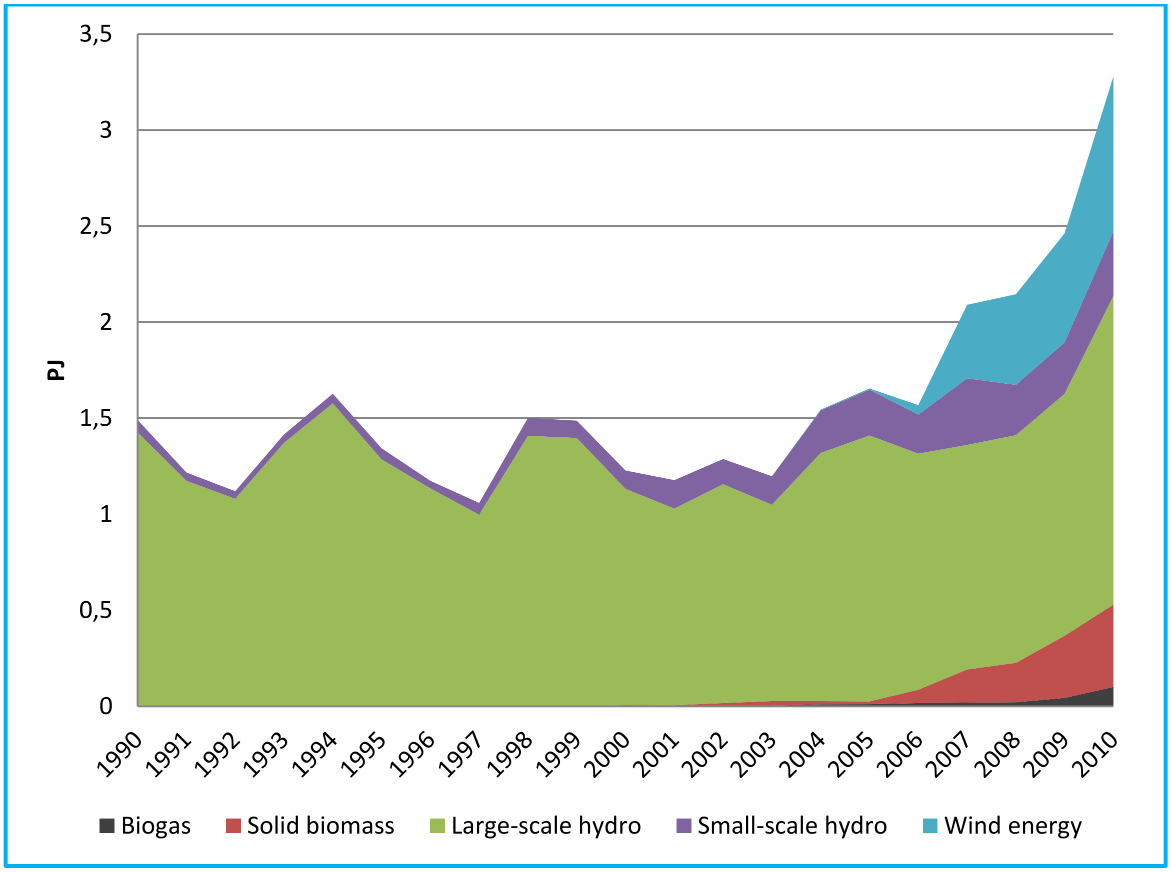


Figure 3-6. Green electricity production in Lithuania

Since 2006 the role of new renewable energy sources is growing rapidly in the Lithuanian electricity market. In 2010, about 24,6% of green electricity was covered by wind energy, 13,1% by biomass and about 3,1% by biogas.

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 405,28 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 3,4% per annum, and in 2008 it was 205 PJ (4,9 Mtoe) (Statistics Lithuania, 2004, 2006, 2010). During this period the final energy consumption was increasing in all sectors of the national economy.

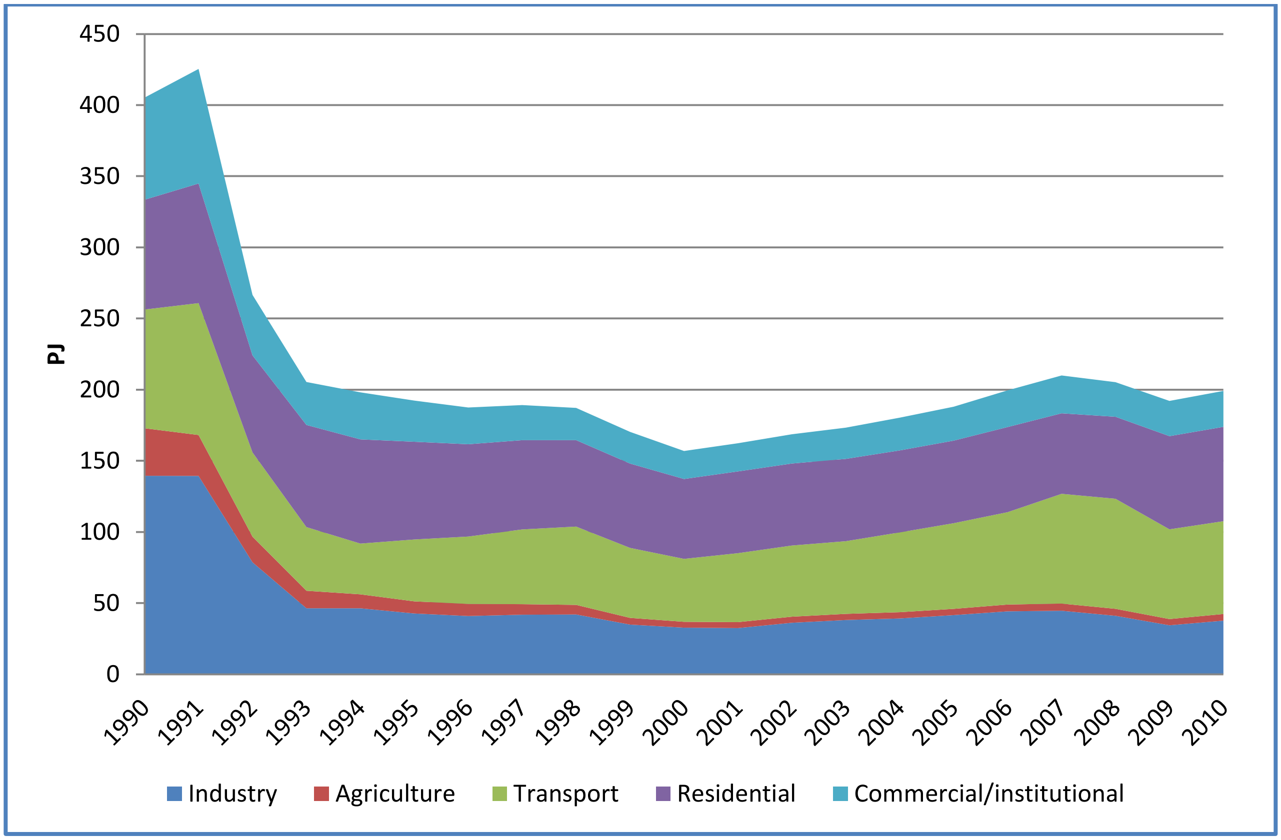


Figure 3-7. Final energy consumption in Lithuania

In 2009, total final energy consumption was by 6,4% 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 18,5%. In 2010, the final energy consumption increased by 3,7% and amounted to 199,1 PJ (4,76 Mtoe). This increase was stipulated by growing activities in all sectors but the major impact was from the manufacturing and transport sectors. In the households as well as in the trade and services sector changes were minor.

Several emission sources in the Energy Sector are key categories. Key categories in 2010 by level (L) and trend (T), excluding LULUCF are listed in Table 3-1.

Table 3-1. Key category from Energy Sector in 2010

IPCC source categoty	Gas	Identification criteria
1.AA.1.A Public electricity and heat production, gaseous fuel	CO_2	L, T
1.AA.1.A Public electricity and heat production, liquid fuel	CO_2	L, T
1.AA.1.B Petroleum refining, liquid fuel	CO_2	L, T
1.AA.2 Manufacturing and construction, gaseous fuels	CO_2	L, T
1.AA.2 Manufacturing and construction, liquid fuels	CO_2	T
1.AA.2 Manufacturing and construction, solid fuels	CO_2	L, T

1.AA.3.B Road transportation, diesel	CO_2	L, T
1.AA.3.B Road transportation, gasoline	CO_2	L, T
1.AA.3.B Road transportation, LPG	CO_2	L, T
1.AA.3.C Railways	CO_2	L
1.AA.3.E Off-road vehicles and machinery	CO_2	T
1.AA.4 Other sectors, biomass	CH_4	L, T
1.AA.4.A Commercial/Institutional	CO_2	L, T
1.AA.4.B Residential	CO_2	L, T
1.AA.4.C Agriculture/Forestry/Fisheries	CO_2	T
1.B. Fugitive Emissions from Fuels	CH_4	L, T

3.2 Fuel combustion (CRF 1.A)

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

- Fuel Combustion – Sectoral Approach (CRF 1.A.A)
  - Energy Industries (CRF 1.A.A.1)
  - Manufacturing Industries and Construction (CRF 1.A.A.2)
  - Transport (CRF 1.A.A.3)
  - Other Sectors (CRF 1.A.A.4)
  - 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.

In the Energy sector emissions of CO_2 contribute about 89% of total greenhouse gas emissions CO_2 eq. in 2010. Trends of total GHG emissions calculated as CO_2 equivalents from the energy sector are presented in figure 3-8. Emissions of total greenhouse gases (GHG) from the energy sector have decreased by almost 2,6 times from 33787,38 Gg CO_2 eq. in 1990 to 12848,36 Gg CO_2 eq. in 2010. 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 has impact on GHG reduction in energy sector by 9,1% in 2009. The closure of Ignalina NPP and GDP increase had impact on GHG increase by 7,6% in 2010.

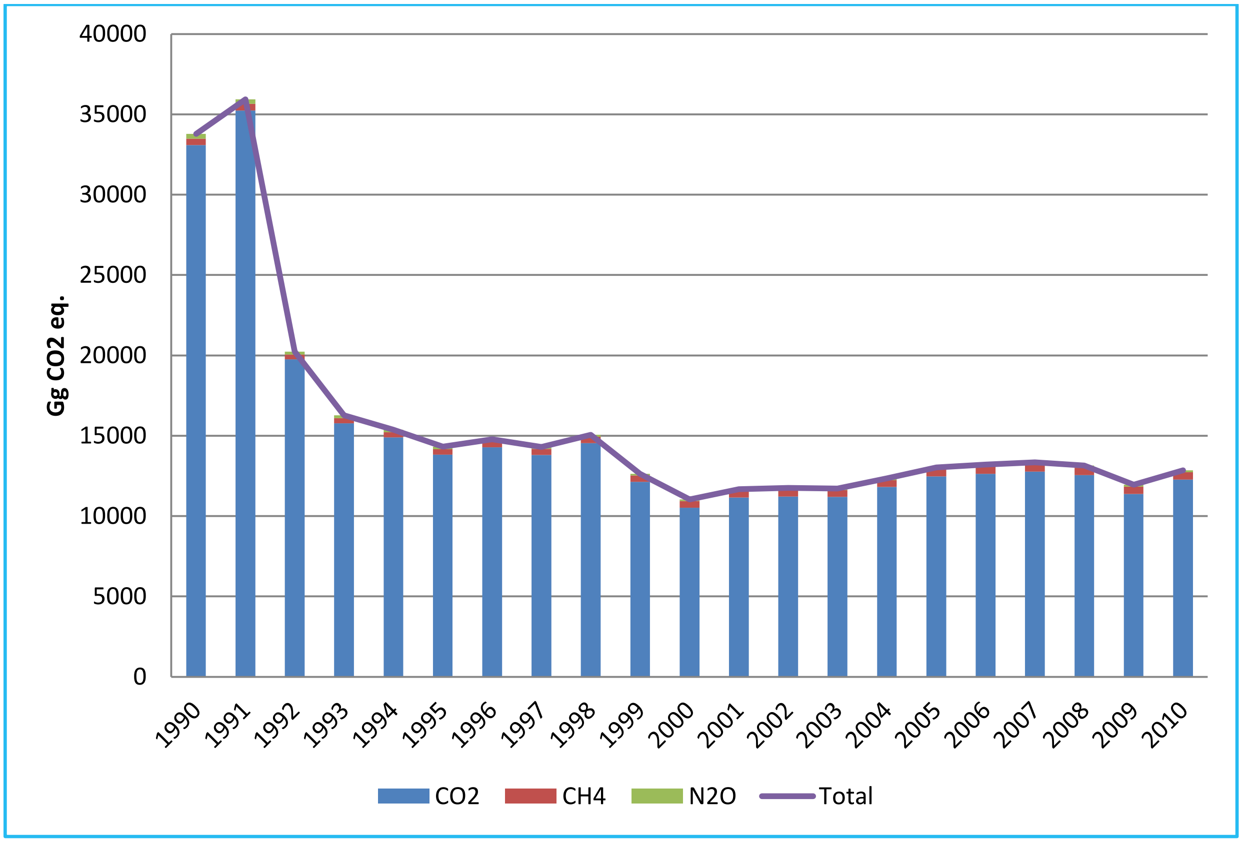
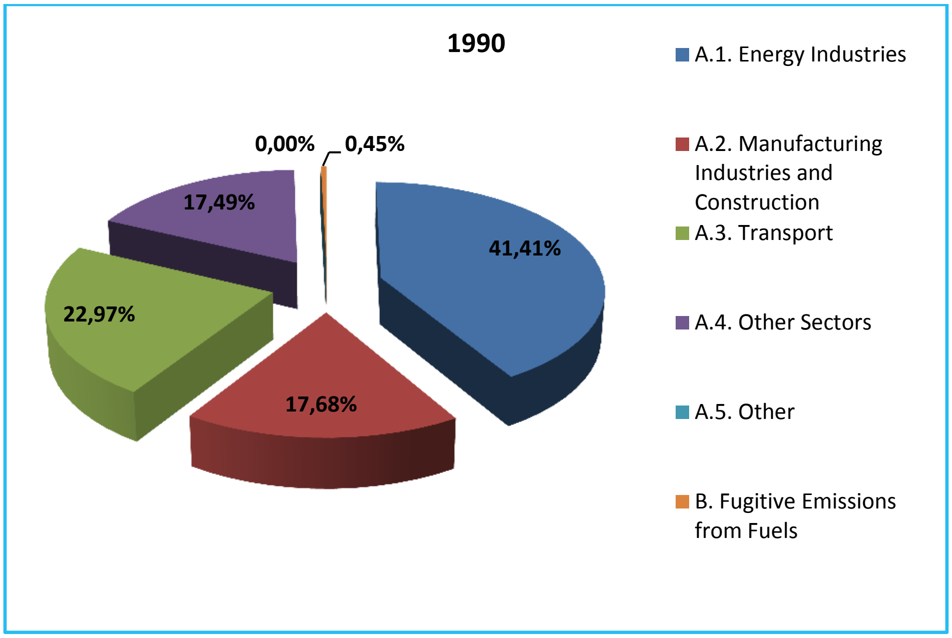


Figure 3-8. Total GHG emission from the Energy Sector (CRF 1), Gg CO_2 eq.

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 2010 this source category amounted about 42,4% of total GHG emission from energy sector. During the period 1990-2010 significantly increased share of the transport sector. In 1990 transport sector accounted for 23% of total GHG emission from Energy Sector and in 2010 - 35,5%.



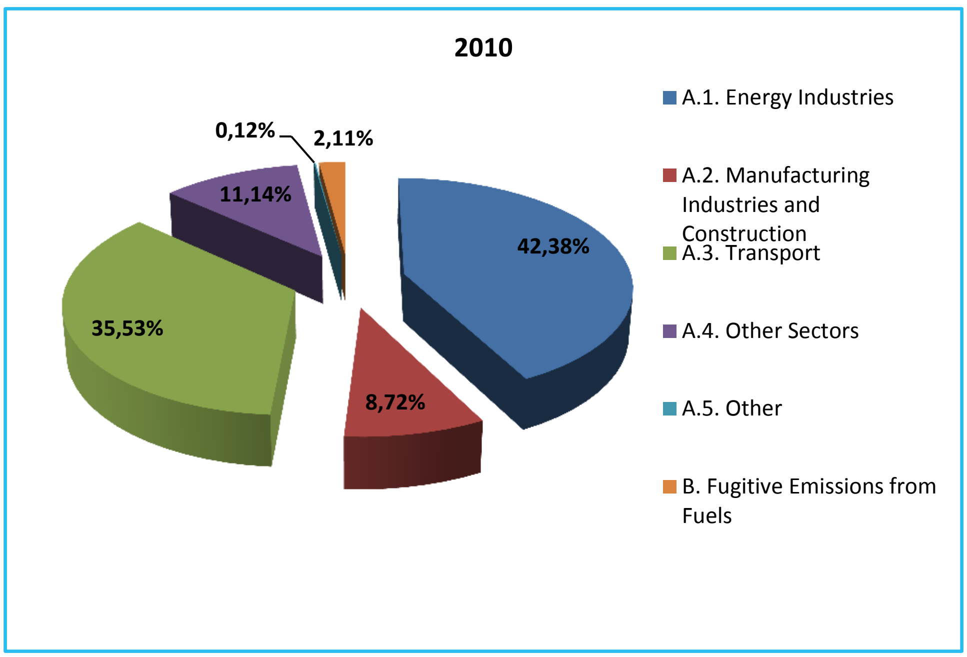


Figure 3-9. Structure of GHG emission from Energy Sector in 1990 and 2010

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 the most important. The closure of Ignalina NPP in 2010 had impact on GHG emission increase in this subsector. In 2010 GHG emission increased by approximately 10.6% in energy industries. Growing activities in the manufacturing and transport sectors stipulated increase in GHG emissions in these subsectors during 2010. An increase took place in Other sectors (1.A.4). Since 2000 GHG emissions in this subsector was growing about 2,5% 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 is increasing by 3% per annum.

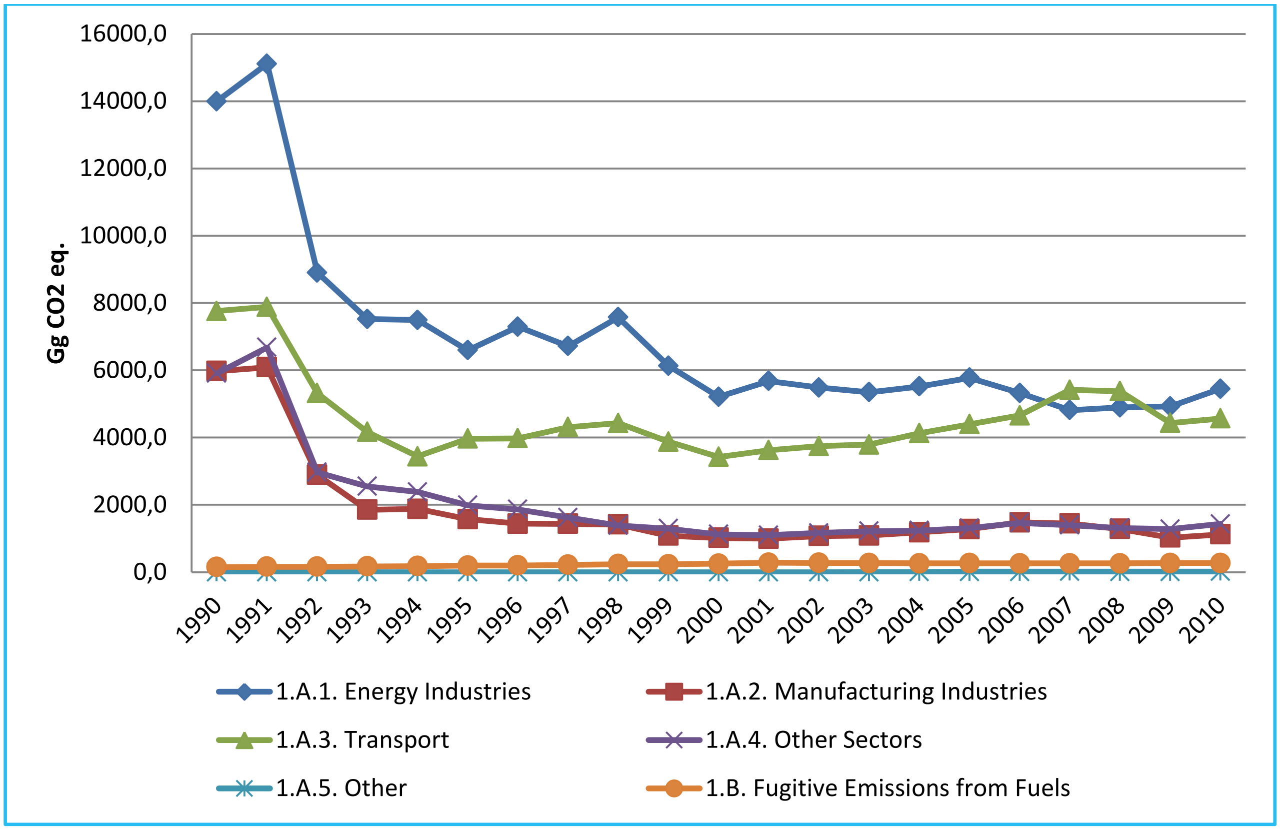


Figure 3-10. Total GHG emissions from the different subsectors within the Energy Sector, (CRF 1), Gg CO_2 eq.

3.2.1 Comparison of sectoral approach with the reference approach

CO_2 emissions from energy sector were calculated using both sectoral and reference approach. 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 1990–2010.

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

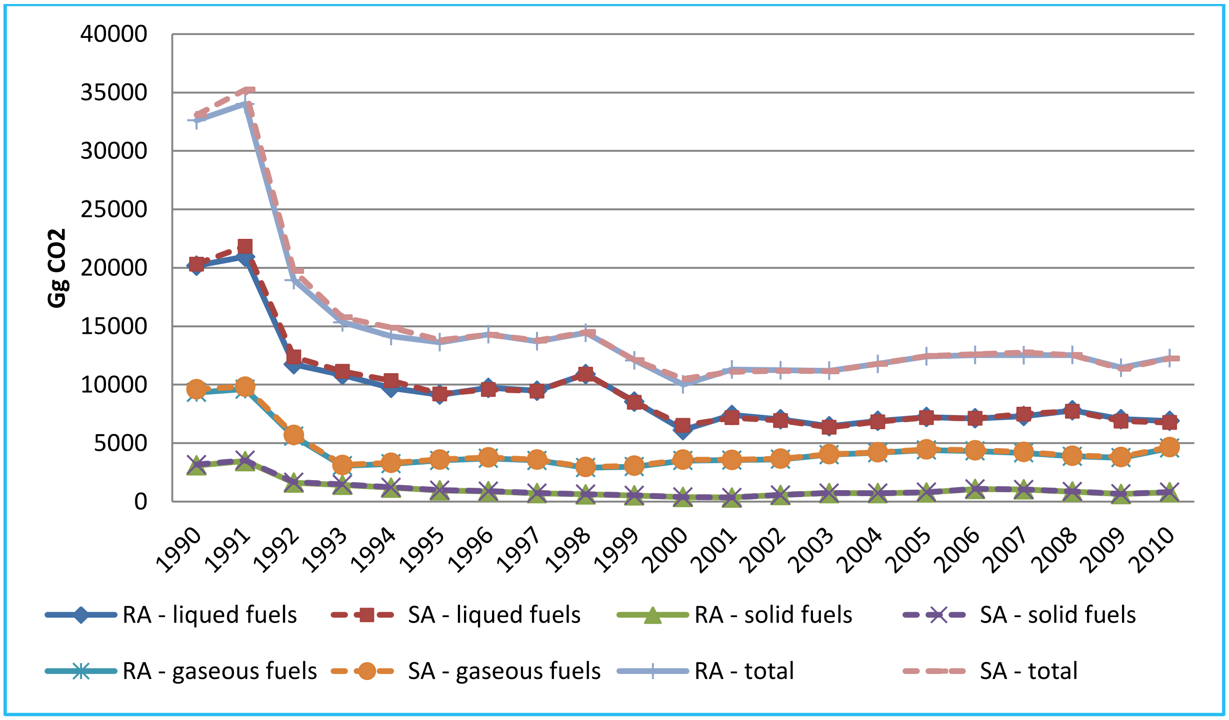


Figure 3-11. Comparison of CO_2 emissions between sectoral and reference approach

Figure 3-11 shows that the differences for CO_2 emissions are very closely correlated. This indicates that emission factors used in the reference approach are appropriate for the inventory.

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

Year	Reference approach				Sectoral approach			
	Liqued, Gg CO_2	Solid, Gg CO_2	Gaseous, Gg CO_2	Total, Gg CO_2	Liqued, Gg CO_2	Solid, Gg CO_2	Gaseous, Gg CO_2	Total, Gg CO_2
1990	20181	3099	9335	32615	20319	3163	9604	33086
1991	20946	3461	9624	34031	21853	3538	9846	35236
1992	11737	1626	5587	18950	12366	1659	5716	19741
1993	10835	1435	3074	15345	11146	1467	3145	15758
1994	9716	1197	3236	14149	10348	1221	3312	14880
1995	9148	959	3525	13631	9218	977	3610	13805
1996	9736	880	3697	14312	9602	891	3779	14272
1997	9482	715	3520	13717	9465	727	3594	13787
1998	10913	623	2900	14436	10912	635	2964	14511
1999	8559	530	2990	12079	8498	539	3065	12102
2000	6121	384	3511	10015	6517	387	3596	10500
2001	7405	346	3552	11303	7177	349	3582	11108
2002	7040	570	3624	11234	6939	574	3668	11181
2003	6452	729	4013	11194	6359	734	4062	11154
2004	6897	712	4175	11783	6838	719	4222	11779

2005	7223	790	4409	12422	7192	801	4464	12457
2006	7125	1071	4335	12530	7125	1088	4396	12609
2007	7310	1043	4165	12518	7490	1027	4245	12762
2008	7809	857	3875	12541	7732	871	3933	12536
2009	7058	645	3750	11452	6884	658	3816	11358
2010	6900	805	4578	12283	6768	820	4666	12255

Table 3-3 presents percentage differences of CO_2 emissions between reference and sectoral approach. Statistical differences of energy balances contribute to a large share of differences especially in the early 90's. Large differences for 1991, 1992, 1993, 1994 and 2000 are mainly attributed to liquid fuels. If new data become available, this will be reviewed and, if appropriate, will be revised in next submission. 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.

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

Year	Liqued fuels, %	Solid fuels, %	Gaseous fuels, %	Total, %
1990	-0,68	-2,05	-2,80	-1,42
1991	-4,15	-2,16	-2,25	-3,42
1992	-5,09	-2,00	-2,25	-4,00
1993	-2,79	-2,13	-2,26	-2,62
1994	-6,10	-1,97	-2,29	-4,91
1995	-0,75	-1,91	-2,36	-1,26
1996	1,39	-1,31	-2,17	0,28
1997	0,18	-1,68	-2,06	-0,50
1998	0,01	-1,86	-2,15	-0,51
1999	0,72	-1,73	-2,44	-0,19
2000	-6,07	-0,93	-2,37	-4,62
2001	3,17	-0,85	-0,84	1,75
2002	1,45	-0,67	-1,21	0,47
2003	1,46	-0,58	-1,20	0,36
2004	0,87	-0,98	-1,13	0,04
2005	0,42	-1,42	-1,23	-0,29
2006	0,00	-1,57	-1,40	-0,62
2007	-2,41	1,57	-1,87	-1,91
2008	0,99	-1,57	-1,47	0,04
2009	2,52	-1,96	-1,75	0,82
2010	1,95	-1,85	-1,90	0,23

In reference approach emissions are estimated by subtracting carbon stored in the final products from the total carbon content calculated from the apparent consumption. Carbon stored in the reference approach uses IPCC default values for "fraction of carbon stored". For the reference approach non energy consumption according to the energy balance has been subtracted. The share of natural gas allocated for non-energy use, i.e. process emissions from ammonia production, are included in category 2.B.1 Ammonia Production.

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 1990-2010

Year	CO_2, Gg	CH_4, Gg	N_2O, Gg	Activity data, TJ
1990	316,5	0,012	0,002	3894
1991	522,1	0,019	0,004	6423
1992	969,1	0,036	0,007	11922
1993	535,1	0,020	0,004	6583
1994	505,8	0,019	0,004	6222
1995	469,9	0,017	0,003	5780
1996	437,3	0,016	0,003	5379
1997	200,4	0,007	0,001	2496
1998	162,4	0,006	0,001	2094
1999	236,8	0,009	0,002	3019
2000	303,3	0,011	0,002	3828
2001	326,8	0,012	0,002	4112
2002	362,2	0,014	0,003	4554
2003	362,1	0,014	0,003	4532
2004	374,2	0,014	0,003	4692
2005	475,8	0,018	0,004	5933
2006	456,5	0,017	0,003	5681
2007	396,7	0,015	0,003	4944
2008	297,4	0,011	0,002	3722
2009	423,8	0,016	0,003	5285
2010	463,6	0,017	0,003	5781

Tier 1 is used for GHG emissions estimates 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/TJt
Gas/diesel oil	72,89	0,003	0,0006
Residual fuel oil	81,29	0,003	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 1990–2010

Year	CO_2, Gg	CH_4, Gg	N_2O, Gg	Activity data, TJ
1990	399,3	0,008	0,012	5527
1991	480,5	0,010	0,015	6652
1992	194,7	0,004	0,006	2695
1993	107,9	0,002	0,003	1494
1994	114,6	0,002	0,003	1586
1995	118,0	0,002	0,004	1634
1996	96,7	0,002	0,003	1338
1997	90,8	0,002	0,003	1257
1998	81,8	0,002	0,002	1133
1999	76,1	0,002	0,002	1053
2000	73,4	0,002	0,002	1016
2001	98,2	0,002	0,003	1360
2002	83,4	0,002	0,003	1155
2003	93,5	0,002	0,003	1294
2004	105,9	0,002	0,003	1466
2005	139,1	0,003	0,004	1926
2006	158,1	0,003	0,005	2189
2007	198,1	0,004	0,006	2742
2008	229,4	0,005	0,007	3176
2009	109,9	0,002	0,003	1522
2010	145,3	0,003	0,004	2012

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 Satistics Lithuania distinguish 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 quidelines activite 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	0,0015	0,0022

In this category following recalculations has been done: CO_2 emission factors for jet kerosene, gas/diesel oil and residual fuel oil were reviewed and corrected; activity data were corrected and reallocated between domestic and international flights. In this submission country specific emission factors based on research protocols of UAB ORLEN Lietuva Quality Research Center have been used (as presented in tables 3-6 and 3-7). 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 2011, Gg CO_2 eq.	Submission 2012, Gq CO_2 eq.	Absolute difference, Gg CO_2 eq.	Relative difference, %
1990	712,1	720,7	8,60	1,21
1991	990,9	1009,0	18,11	1,83
1992	1135,1	1168,7	33,64	2,96
1993	630,2	645,8	15,54	2,47
1994	608,2	623,0	14,86	2,44
1995	576,7	590,5	13,80	2,39
1996	523,5	536,2	12,69	2,42
1997	290,5	292,7	2,20	0,76
1998	247,2	245,5	-1,66	-0,67
1999	313,0	314,4	1,39	0,44
2000	373,6	378,3	4,72	1,26
2001	418,5	427,0	8,47	2,02
2002	437,4	447,6	10,26	2,34
2003	446,0	457,7	11,70	2,62
2004	471,7	482,3	10,61	2,25
2005	600,3	617,8	17,55	2,92
2006	600,1	617,6	17,51	2,92
2007	582,4	598,0	15,58	2,68
2008	518,1	530,0	11,88	2,29
2009	520,7	536,1	15,46	2,97

3.2.3 Feedstocks and non-energy use of fuels

The data on feedstocks and non-energy use of fuels are provided by the Statistics Lithuania in Energy balances (see Annex III). Use of fuels for feedstocks and non-energy use is dominated by natural gas (Figure 3-12). In 2010, natural gas amounted about 83% in the structure of feedstocks and non-energy use of fuels.

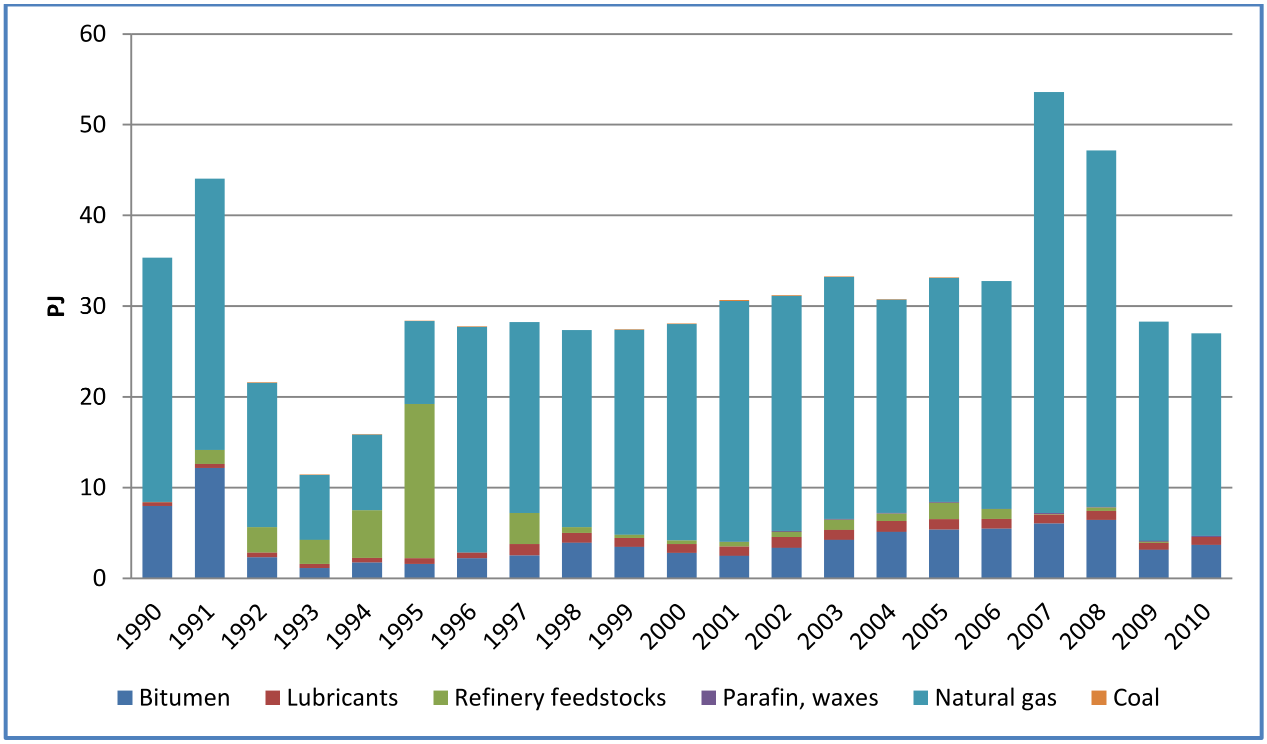


Figure 3-12. Feedstocks and non energy use of fuels in Lithuania

The amounts of non-emitted CO_2 were calculated in accordance with the methodology provided in 1996 IPCC Guidelines. The IPCC default values for fraction of carbon stored are applied for all fuels. Explanations for the reported non-energy use is provided:

- Lubricants, bitumen, refinery feedstocks and paraffin/waxes emissions are assumed to be included in total emissions from category 1.A.1.b Petroleum refinery.
- Natural gas emissions from the use of natural gas as a feedstock in ammonia production are accounted in the Industrial Processes Sector (category 2.B.1).
- Coking coal emissions are assumed to be included in category 1.A.2.f Other.

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	NO	NO	NO
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	NO	NO	NO
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	NO	NO	NO
1.A.2.b Gaseous fuels	NO	NO	NO
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	NO	NO	NO
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 48% of the overall available electrical capacity is covered by this power plant. Characteristics of the Lithuanian power plants for 2010 are presented in Table 3-10.

Table 3-10. Characteristics of the Lithuanian power plants in 2010 (LEI, 2010)

Power plant	Fuel	Available capacity, MW
Lithuanian TPP	Residual fuel oil, natural gas, orimulsion	1732
Vilnius CHP	Residual fuel oil, natural gas	342
Kaunas CHP	Residual fuel oil, natural gas	168
Klaipeda CHP	Residual fuel oil, natural gas	9
Mazeikiai CHP	Residual fuel oil	148
Panevezys CHP	Natural gas	33

Kaunas hydro PP	-	90
Kruonis hydro pumped storage PP	-	760
Small hydro PP	-	25
Wind PP	-	161
Biofuel PP	Biomass, biogas	44
Industrial PP	Residual fuel oil, natural gas, energy from chemical processes	93
Total	-	3605

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 2010 44% of heat supplied to district heating systems was produced at Combined Heat and Power plants(CHP) and 35% - at heat only boilers.

Natural gas is the main fuel used in the district heating sector. In 2010 natural gas covered about 74,4% of fuel consumption. Since 2000 the share of renewable energy increased significantly from 2% in 2000 to 19,3% in 2010. 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. The share in total GHG emissions from sector 1.A was 37% for the 1990 and 30% for the 2010.

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. Applying a Tier 1 the following equation has been used:

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

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.

Emission factors

Emission factors 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 for category *Public electricity and heat production* (1.A.1.a)

Fuel	CO_2, kg/GJ	EF source	CH_4, kg/TJ	Comments	N_2O, kg/TJ	EF source
Crude oil	78,00	CS*	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Shale oil	74,00	CS*	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Residual fuel oil	81,29	CS	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
LPG	65,42	CS	1,0	D - 2006 IPCC	0,1	D - 2006 IPCC
Not liquefied petroleum gas	54,86	CS	1,0	D - 2006 IPCC	0,6	D - 2006 IPCC
Orimulsion	81,00	CS*	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Gasoil	72,89	CS	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Diesel oil	72,89	CS	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Waste oils	73,30	D - 1996 IPCC	30,0	D - 2006 IPCC	4,0	D - 2006 IPCC
Peat	106,0	D - 1996 IPCC	1,0	D - 2006 IPCC	4,0	D - 2006 IPCC
Coking coal	95,00	CS*	1,0	D - 1996 IPCC	1,4	D - 1996 IPCC
Natural gas	56,90	CS*	1,0	D - 1996 IPCC	0,1	D - 1996 IPCC
Wood/ wood waste	109,6	D - 1996 IPCC	30,0	D - 1996 IPCC	4,0	D - 1996 IPCC
Other solid biomass	109,6	D - 1996 IPCC	30,0	D - 1996 IPCC	4,0	D - 1996 IPCC
Biogas	54,6	D - 2006 IPCC	1,0	D - 2006 IPCC	0,1	D - 2006 IPCC

Abbreviations: CS - country specific emission factors were developed in 2009 based on research data from the Lithuanian oil refinery (Research protocols of UAB ORLEN Lietuva Quality Research Center); CS* - country specific emission factors 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[2]; D - default emission factors (1996 IPCC or 2006 IPCC).

[2] 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

In the 2011 submission, CO_2 emission factors developed on the basis of international experience and used in Lithuanian GHG inventory have been compared with 1996 IPCC default values and with other emission factors provided in the literature. This comparative analysis showed that used CO_2 emission factors are within the range of data provided in the literature. Bearing in mind that emission factors values reported in the literature are scattered in a quite wide range, currently used CO_2 emission factors for stationary emission sources could be considered as satisfactory.

Activity data

In the Energy Sector all activity data for calculation of GHG emissions has been obtained from the Lithuanian Statistics 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 3-12a. 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

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).

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 3-12b. 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 refueled 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 2000-2010 are provided in the Annex III. The entire time series (1990-2010) are publically available at the databases of the Statistics of Lithuania[3]. In the Annex III the energy balance data are provided in Terajoule (TJ).

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.

CO_2 emission factors uncertainty in public electricity and heat production are ±7% based on IPCC 1996 guidelines. Country specific CO_2 emission factors (which were developed in 2009 based on research data from the Lithuanian oil refinery) for residual fuel oil, LPG, not liquefied petroleum gas, gasoil and diesel oil uncertainty are ±5%.

CH_4 and N_2O emission factors used in estimation of emissions were taken from IPCC 1996, IPCC 2006 and EMEP/CORINAIR 2006 so uncertainty was assigned as very high about 50% according 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] http://www.stat.gov.lt/lt/

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 recomendations:

- correction of activity data of peat consumption for the period 2006-2008 based on information provided by Lithuanian Statistics;
- correction of CO_2 emission factor for wood/wood waste and other solid biomass based on default values provided in 1996 IPCC and for biogas - default value provided in 2006 IPCC;
- correction of N_2O emission factor for LPG, not liquefied petroleum gas and biogas based on default value provided in 2006 IPCC.

Impact of these recalculations on GHG emissions from 1.A.1.a Public electricity and heat sector is presented in Table 3-13.

Table 3-13. Impact of recalculation on GHG emissions from 1.A.1a Public electricity and heat

Year	Submission 2011, Gg CO_2 eq.	Submission 2012, Gq CO_2 eq.	Absolute difference, Gg CO_2 eq.	Relative difference, %
1990	12483,4	12483,4	-0,02	-0,0002
1991	13389,3	13389,3	-0,02	-0,0001
1992	7911,8	7911,8	-0,02	-0,0003
1993	6211,3	6211,3	0,00	0,0000
1994	6573,5	6573,5	0,00	0,0000
1995	5847,3	5847,3	0,00	0,0000
1996	6386,1	6386,0	-0,02	-0,0003
1997	5661,8	5661,8	0,00	0,0000
1998	6301,7	6301,7	0,00	0,0000
1999	5199,2	5199,1	-0,02	-0,0004
2000	4058,4	4058,3	-0,02	-0,0005
2001	4212,7	4212,7	-0,03	-0,0006
2002	3995,7	3995,7	-0,04	-0,0011
2003	3877,2	3877,1	-0,05	-0,0013
2004	3818,1	3818,0	-0,06	-0,0016
2005	3968,4	3968,3	-0,06	-0,0016
2006	3792,4	3789,9	-2,43	-0,0640
2007	3383,6	3351,1	-32,47	-0,9598
2008	3032,4	3031,6	-0,74	-0,0244
2009	3195,2	3195,1	-0,12	-0,0039

3.2.6.6 Source-specific planned improvements

The following improvements are foreseen:

- To investigate the possibility of using data provided in the EU ETS, reported by the operators for the energy sector emission estimates.
- A study on the revision of the emission factors used for energy sector will be implemented during 2012. Procurement tender for this study was announced in March 2012. Study results are to be ready in August 2012.

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[4] 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 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

GHG emissions were calculated applying Tier 1 equation (see chapter 3.2.6).

Emission factors

Emission factors used in the calculation of emissions from Petroleum refinery (1.A.1.b) are presented in the Table 3-14.

Table 3-14. Emission factors for category Petroleum refinery (1.A.1.b)

Fuel	CO_2, kg/GJ	EF source	CH_4, kg/TJ	EF source	N_20, kg/TJ	EF source
Crude oil	78,00	CS*	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Residual fuel oil	81,29	CS	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
LPG	65,42	CS	1,0	D - 2006 IPCC	0,1	D - 2006 IPCC
Petroleum coke	101,00	D - 1996 IPCC	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Diesel oil	72,89	CS	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Not liquefied petroleum gas	54,86	CS	1,0	D - 2006 IPCC	0,6	D - 2006 IPCC
Natural gas	56,90	CS*	1,0	D - 1996 IPCC	0,1	D - 1996 IPCC

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

***** country specific emission factors 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 [1,2]

Activity data

For calculation of GHG emissions in category Petroleum refinery (1.A.1.b) activity data had been obtained from the Lithuanian Statistics yearly publications "Energy balance". Activity data is provided in the Annex III.

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.

CO_2 emission factors uncertainty in Petroleum refinery are ±7% based on IPCC 1996 guidelines. Country specific CO_2 emission factors (which were developed in 2009 based on research data from the Lithuanian oil refinery) for residual fuel oil, LPG, not liquefied petroleum gas and diesel oil uncertainties are ±5%.

CH_4 and N_2O emission factors used in estimation of emissions were taken from IPCC 1996, IPCC 2006 and EMEP/CORINAIR 2006 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.

3.2.7.4 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 recomendations:

- correction of N_2O emission factor for LPG and not liquefied petroleum gas based on default value provided in 2006 IPCC.

Impact of these recalculations on GHG emissions from 1.A.1.b Petroleum refining are presented in Table 3-15.

Table 3-15. Impact of recalculation on GHG emissions from 1.A.1b Petroleum refining

Year	Submission 2011, Gg CO_2 eq.	Submission 2012, Gq CO_2 eq.	Absolute difference, Gg CO_2 eq.	Relative difference, %
1990	1503,5	1500,1	-3,32	-0,2207
1991	1717,2	1713,6	-3,56	-0,2074
1992	987,6	985,6	-1,96	-0,1989
1993	1306,7	1303,8	-2,92	-0,2236
1994	922,1	920,1	-2,09	-0,2267
1995	745,6	744,0	-1,54	-0,2070
1996	905,4	903,7	-1,73	-0,1914
1997	1052,6	1050,9	-1,75	-0,1660
1998	1261,2	1258,8	-2,39	-0,1897
1999	918,4	916,9	-1,56	-0,1697
2000	1136,1	1133,8	-2,32	-0,2041
2001	1453,2	1450,1	-3,06	-0,2107
2002	1472,9	1469,6	-3,36	-0,2278
2003	1456,4	1452,8	-3,61	-0,2475
2004	1691,0	1686,8	-4,17	-0,2466
2005	1792,4	1788,1	-4,25	-0,2374
2006	1520,9	1517,4	-3,59	-0,2363
2007	1450,9	1448,3	-2,61	-0,1796
2008	1853,0	1849,2	-3,89	-0,2098
2009	1716,4	1712,7	-3,72	-0,2167

3.2.7.6 Source-specific planned improvements

A study on the revision of the emission factors used for energy sector will be implemented during 2012. Procurement tender for this study was announced in March 2012. Study results are to be ready in August 2012.

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

GHG emissions were calculated applying Tier 1 according to the (1) equation(see chapter 3.2.6).

Emission factors

Emission factors used in the calculations of emissions from Manufacture of solid fuels and other energy industries (1.A.1.c) are presented in Table 3-16.

Table 3-16. Emission factors for category Manufacture of solid fuels and other energy industries (1.A.1.c)

Fuel	CO_2, kg/GJ	EF source	CH_4, kg/TJ	EF source	N_20, kg/TJ	EF source
Motor gasoline	72,97	CS	20,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Residual fuel oil	81,29	CS	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
LPG	65,42	CS	1,0	D - 2006 IPCC	0,1	D - 2006 IPCC
Diesel oil	72,89	CS	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Natural gas	56,90	CS*	1,0	D - 1996 IPCC	0,1	D - 1996 IPCC
Wood/wood waste	109,6	D - 1996 IPCC	30,0	D - 1996 IPCC	4,0	D - 1996 IPCC

***** country specific emission factors 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 [1,2]

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 yearly publications "Energy balance". Activity data are provided in the Annex III.

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.

CO_2 emission factors uncertainty in Manufacture of solid fuels and other energy industries are ±7% based on IPCC 1996 guidelines. Country specific CO_2 emission factors (which were developed in 2009 based on research data from the Lithuanian oil refinery) for motor gasoline, residual fuel oil, LPG and diesel oil uncertainty are ±5%.

CH_4 and N_2O emission factors used in estimation of emissions were taken from IPCC 1996, IPCC 2006 and EMEP/CORINAIR 2006 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.

3.2.8.4 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:

- In the last submission coking coal used for non-energy use was accounted in a category Manufacture of solid fuels and other energy industries. Therefore in this submission coking coal used for non-energy use was reallocated for feedstock and non-energy use category. These reallocations were done for period 1999-2005 according to the coking coal use;
- correction of CO_2 emission factor for wood/wood waste based on default values provided in 1996 IPCC;
- correction of N_2O emission factor for LPG based on default value provided in 2006 IPCC.

Impact of these recalculations on GHG emissions from 1.A.1.c Manufacture of solid fuels and other energy industries is presented in Table 3-17.

Table 3-17. Impact of recalculation on GHG emissions from 1.A.1.c Manufacture of solid fuels and other energy industries

Year	Submission 2011, Gg CO_2 eq.	Submission 2012, Gq CO_2 eq.	Absolute difference, Gg CO_2 eq.	Relative difference, %
1999	22,8	18,1	-4,77	-20,8890
2000	24,3	19,1	-5,25	-21,5867
2001	27,2	18,6	-8,59	-31,5810
2002	25,5	19,2	-6,30	-24,7292
2003	22,5	17,1	-5,44	-24,1882
2004	20,6	16,1	-4,59	-22,2258
2005	21,1	20,7	-0,48	-2,2651
2006	18,5	18,5	0,00	-0,0047
2007	14,8	14,8	0,00	-0,0088

3.2.8.6 Source-specific planned improvements

A study on the revision of the emission factors used for energy sector will be implemented during 2012. Procurement tender for this study was announced in March 2012. Study results are to be ready in August 2012.

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 industry 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)

There is non-ferrous metals industry in Lithuania. All emissions are reported as not occurring/not applicable therefore there are no “not estimated” sectors.

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 2010, chemical industry has created 11,9% 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 11,9% 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 35,4% in 2009 (compared to value in 2008) and increased by 30,0% in 2010 (compared to 2009). 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

GHG emissions were calculated applying Tier 1 according to the (1) equation(see chapter 3.2.6).

Emission factors

Emission factors used in the calculation of emissions from Chemical industries (1.A.2.c) are presented in table 3-18.

Table 3-18. Emission factors for category Chemical industries (1.A.2.c)

Fuel	CO_2, kg/GJ	EF source	CH_4, kg/TJ	EF source	N_20, kg/TJ	EF source
Residual fuel oil	81,29	CS	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
LPG	65,42	CS	1,0	D - 2006 IPCC	0,1	D - 2006 IPCC
Gasoil	72,89	CS	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Coking coal	95,0	CS*	10,0	D - 1996 IPCC	1,4	D - 1996 IPCC
Natural gas	56,9	CS*	5,0	D - 1996 IPCC	0,1	D - 1996 IPCC
Wood/ wood waste	109,6	D - 1996 IPCC	30,0	D - 1996 IPCC	4,0	D - 1996 IPCC

*****country specific emission factors 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 [1,2]

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 3-19.

Table 3-19. Energy consumption by fuel type in Chemicals industries, TJ

Year	Residual fuel oil	LPG	Gasoil	Coking coal	Natural gas	Wood/ wood waste	Total
1990	883	0	0	0	6001	0	**6884**
1995	281	0	0	0	1563	0	**1844**
2000	62	0	0	0	1454	0	**1516**
2001	56	0	0	0	1096	0	**1152**
2002	31	1	0	1	250	1	**284**
2003	18	0	3	0	356	0	**377**
2004	4	0	4	0	1874	0	**1882**
2005	0	7	0	0	2020	0	**2027**
2006	23	8	0	0	3419	2	**3452**
2007	0	21	0	0	2398	0	**2419**
2008	0	22	0	0	2438	0	**2460**
2009	0	16	0	0	3470	0	**3486**
2010	47	17	0	0	3284	0	**3348**

Natural gas is the main fuel used in chemical industry in Lithuania. During 1990-2010 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 54,9% a year with a large decrease of natural gas consumption (table 3-16). Since 2002, when economy has started to grow at very fast rates, energy consumption in chemical industry began to increase by 43,3% per year. During 2008-2009, the growth rates of fuel consumption in chemical industry went slow and 4,0% fuel consumption decrease has been noticed in 2010.

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.

CO_2 emission factors uncertainty in Chemical industries are ±7% based on IPCC 1996 guidelines. Country specific CO_2 emission factors (which were developed in 2009 based on research data from the Lithuanian oil refinery) for residual fuel oil, LPG and gasoil uncertainty are ±5%.

CH_4 and N_2O emission factors used in estimation of emissions were taken from IPCC 1996, IPCC 2006 and EMEP/CORINAIR 2006 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.

3.3.3.4 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 CO_2 emission factor for wood/wood waste based on default values provided in 1996 IPCC;
- correction of N_2O emission factor for LPG based on default value provided in 2006 IPCC.

Impact of these recalculations on GHG emissions from 1.A.2.c Chemical industries is presented in Table 3-20.

Table 3-20. Impact of recalculation on GHG emissions from 1.A.2.c Chemical industries

Year	Submission 2011, Gg CO_2 eq.	Submission 2012, Gq CO_2 eq.	Absolute difference, Gg CO_2 eq.	Relative difference, %
2002	17,0	16,9	0,000	-0,0026
2003	22,0	22,0	0,000	0,0000
2004	107,5	107,5	0,000	0,0000
2005	115,7	115,7	-0,003	-0,0026
2006	197,4	197,4	-0,003	-0,0018
2007	138,2	138,1	-0,009	-0,0066
2008	140,5	140,5	-0,010	-0,0068
2009	199,0	199,0	-0,007	-0,0035

3.3.3.6 Source-specific planned improvements

A study on the revision of the emission factors used for energy sector will be implemented during 2012. Procurement tender for this study was announced in March 2012. Study results are to be ready in August 2012.

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

3.3.4.1 Source category description

The pulp, paper and print industry is an important branch of manufacturing industry in Lithuania. With reference to data of 2010, this industry makes 6,2% in the structure of manufacturing industry. The pulp, paper and print industry has been growing by 8,1% in 1995-2008, but the growth rates have been by 3,0 percentage points lower 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 25,3%, the pulp, paper and print industry has remained the second sector (after food processing, beverage and tobacco) with the lowest decline rates.The decline rate of value added in this industry has been 15,0% in 2009.

3.3.4.2 Methodological issues

GHG emissions were calculated applying Tier 1 according to the (1) equation(see chapter 3.2.6).

Emission factors

Emission factors used in the calculation of emissions from Pulp, paper and print industry (1.A.2.c) is presented in Table 3-21.

Table 3-21. Emission factors for category Pulp, paper and print industries (1.A.2.d)

Fuel	CO_2, kg/GJ	EF source	CH_4, kg/TJ	EF source	N_20, kg/TJ	EF source
Residual fuel oil	81.29	CS	3.0	D - 1996 IPCC	0.6	D - 1996 IPCC
LPG	65.42	CS	1.0	D - 2006 IPCC	0.1	D - 2006 IPCC
Coking coal	95.0	CS*	10.0	D - 1996 IPCC	1.4	D - 1996 IPCC
Natural gas	56.9	CS*	5.0	D - 1996 IPCC	0.1	D - 1996 IPCC
Wood/ wood waste	109.6	D - 1996 IPCC	30.0	D - 1996 IPCC	4.0	D - 1996 IPCC

*country specific emission factors 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 [1,2]

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 3-22.

Table 3-22. Energy consumption by fuel type in pulp, paper and print industry, TJ

Year	Residual fuel oil	LPG	Coking coal	Natural gas	Wood/ wood waste	Total
1990	883	0	0	3388	3	**4274**
1995	401	0	75	749	5	**1230**
2000	42	15	22	813	7	**899**
2001	37	10	17	920	7	**991**
2002	21	11	0	918	25	**975**
2003	0	6	0	397	7	**410**
2004	0	8	0	17	0	**25**
2005	0	4	0	64	0	**68**
2006	0	6	0	43	0	**49**
2007	0	4	0	48	0	**52**
2008	0	3	0	593	0	**596**
2009	0	2	0	884	85	**971**
2010	0	3	0	1173	128	**1304**

Natural gas is the main fuel used in pulp, paper and print industries. During 2008-2010 natural gas and wood/wood waste consumption increased significantly (Table 3-19). Fuel consumption in pulp, paper and print industry had tendency to decrease during 1990-2007 by 38,7% per year. However, the volume of energy consumed has tripled during 2008-2010.

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.

CO_2 emission factors uncertainty in Pulp, paper and print industries are ±7% based on IPCC 1996 guidelines. Country specific CO_2 emission factors (which were developed in 2009 based on research data from the Lithuanian oil refinery) for residual fuel oil and LPG uncertainties are ±5%.

CH_4 and N_2O emission factors used in estimation of emissions were taken from IPCC 1996, IPCC 2006 and EMEP/CORINAIR 2006 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.

3.3.4.4 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:

- correction of CO_2 emission factor for wood/wood waste based on default values provided in 1996 IPCC;
- correction of N_2O emission factor for LPG based on default value provided in 2006 IPCC.

Impact of these recalculations on GHG emissions from 1.A.2.d Pulp, paper and print industries is presented in Table 3-23.

Table 3-23. Impact of recalculation on GHG emissions from 1.A.2.d Pulp, paper and print industries

Year	Submission 2011, Gg CO_2 eq.	Submission 2012, Gq CO_2 eq.	Absolute difference, Gg CO_2 eq.	Relative difference, %
1999	58,5	58,5	-0,01	-0,0111
2000	52,9	52,9	-0,01	-0,0123
2001	57,8	57,8	0,00	-0,0075
2002	54,8	54,8	-0,005	-0,0087
2003	23,1	23,0	-0,003	-0,0113
2004	1,5	1,5	-0,003	-0,2320
2005	3,9	3,9	-0,002	-0,0444
2006	2,8	2,8	-0,003	-0,0914
2007	3,0	3,0	-0,002	-0,0578
2008	34,0	34,0	-0,001	-0,0038
2009	50,7	50,7	-0,001	-0,0017

3.3.4.6 Source-specific planned improvements

A study on the revision of the emission factors used for energy sector will be implemented during 2012. Procurement tender for this study was announced in March 2012. Study results are to be ready in August 2012.

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 industry 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 industry meet a slow decrease in the structure of value added created, i.e. from 30,8% (1995) till 18,8% (2008), but remained the largest manufacturing industry in Lithuania. During economic crisis the decline rates have been the lowest (3,9% 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).

3.3.5.2 Methodological issues

GHG emissions were calculated applying Tier 1 according to the (1) equation(see chapter 3.2.6).

Emission factors

Emission factors used in the calculation of emissions from Food processing, beverages and tobacco industries (1.A.2.e) are presented in Table 3-24.

Table 3-24. Emission factors for category Food processing, beverages and tobacco industries (1.A.2.e)

Fuel	CO_2, kg/GJ	EF source	CH_4, kg/TJ	EF source	N_20, kg/TJ	EF source
Shale oil	74,0	CS*	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Residual fuel oil	81,29	CS	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
LPG	65,42	CS	1,0	D - 2006 IPCC	0,1	D - 2006 IPCC
Gasoil	72,89	CS	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Peat	106,0	D – 1996 IPCC	2,0	D - 2006 IPCC	4,0	D - 2006 IPCC
Coking coal	95,0	D – 2006 IPCC	10,0	D - 1996 IPCC	1,4	D - 1996 IPCC
Natural gas	56,9	CS*	5,0	D - 1996 IPCC	0,1	D - 1996 IPCC
Wood/ wood waste	109,6	D - 1996 IPCC	30,0	D - 1996 IPCC	4,0	D - 1996 IPCC
Biogas	54,6	D - 2006 IPCC	1,0	D - 2006 IPCC	0,1	D - 2006 IPCC

*country specific emission factors 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 [1,2]

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 3-25.

Table 3-25. Energy consumption by fuel type in food processing, beverages and tobacco, TJ

Year	Shale oil	Residual fuel oil	LPG	Gasoil	Peat	Coking coal	Natural gas	Wood/ wood waste	Biogas	Total
1990	0	2248	0	0	0	352	8498	36	0	**11134**
1995	0	1606	0	0	0	151	2077	57	0	**3891**
2000	0	1141	80	14	0	56	2537	71	0	**3899**
2001	0	1031	67	6	0	44	3219	63	0	**4430**
2002	0	577	64	4	1	165	3792	49	0	**4652**
2003	0	632	94	36	1	123	4075	72	0	**5032**
2004	0	588	102	48	1	115	3756	112	0	**4722**
2005	13	335	158	148	6	119	3695	297	0	**4771**
2006	40	291	210	90	2	107	3865	140	0	**4745**
2007	22	392	237	52	2	100	4214	82	0	**5101**
2008	27	301	205	93	2	65	3932	102	10	**4737**
2009	0	234	186	74	1	88	3644	78	17	**4322**
2010	0	212	193	94	2	99	4004	92	10	**4706**

Fuel consumed in food processing, beverages and tobacco industries has become more diversified in 2010 compared to the structure that have existed in 1990. Instead of two fuels (residual fuel oil and natural gas) that have been widely used in industry in early 1990s, currently LPG, gasoil, wood, wood waste and biogas penetrate the market (Table 3-21). The share of residual fuel oil in the structure of energy consumed in industry has reduced from 41,3% (1995) till 4,5% (2010). The share of natural gas has a tendency to increase, i.e. it has increased by 31.7 percentage points during 1995-2010.

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.

CO_2 emission factors uncertainty in Food processing, beverages and tobacco industries are ±7% based on IPCC 1996 guidelines. Country specific CO_2 emission factors (which were developed in 2009 based on research data from the Lithuanian oil refinery) for residual fuel oil, LPG and gasoil uncertainty are ±5%.

CH_4 and N_2O emission factors used in estimation of emissions were taken from IPCC 1996, IPCC 2006 and EMEP/CORINAIR 2006 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.

3.3.5.4 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 recomendations:

- correction of CO_2 emission factor for wood/wood waste based on default values provided in 1996 IPCC and for biogas - default value provided in 2006 IPCC;
- correction of N_2O emission factor for LPG and biogas based on default value provided in 2006 IPCC.

Impact of these recalculations on GHG emissions from 1.A.2.e Food processing, beverages and tobacco industries is presented in Table 3-26.

Table 3-26. Impact of recalculation on GHG emissions from 1.A.2.e Food processing, beverages and tobacco industries

Year	Submission 2011, Gg CO_2 eq.	Submission 2012, Gq CO_2 eq.	Absolute difference, Gg CO_2 eq.	Relative difference, %
1992	508,6	508,6	-0,020	-0,004
1993	228,8	228,8	0,000	0,000
1994	288,8	288,8	-0,020	-0,007
1995	264,0	264,0	0,000	0,000
1996	374,7	374,7	-0,015	-0,004
1997	349,8	349,7	-0,020	-0,006
1998	363,4	363,4	-0,040	-0,011
1999	242,1	242,0	-0,032	-0,013
2000	249,5	249,5	-0,035	-0,014
2001	276,8	276,8	-0,029	-0,011
2002	283,8	283,8	-0,028	-0,010
2003	304,8	304,7	-0,041	-0,013
2004	283,7	283,7	-0,044	-0,016
2005	272,8	272,8	-0,069	-0,025
2006	278,3	278,2	-0,091	-0,033
2007	303,3	303,2	-0,103	-0,034
2008	277,8	277,7	-0,095	-0,034
2009	253,3	253,2	-0,090	-0,036

3.3.5.6 Source-specific planned improvements

A study on the revision of the emission factors used for energy sector will be implemented during 2012. Procurement tender for this study was announced in March 2012. Study results are to be ready in August 2012.

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.

Other non-specified industries in Lithuania have accounted 50,1% of value added in 2010. Textile goods industry is the largest industry prescribed to other non-specified industries and the third largest (after food processing, beverages and tobacco and chemicals) manufacturing industry in Lithuania. Since 1999 its structural share has been reducing from 19,0% (1999) till 7,2% (2009) and with a 0,3 percentage points increase in 2010. 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 1995-2008 added value created increase by 26,3% a year with a sharp decrease in 2009 (28,3%).

3.3.6.2 Methodological issues

GHG emissions were calculated applying Tier 1 according to the (1) equation (see chapter 3.2.6).

Emission factors (1.A.2.f)

Emission factors used in the calculation of emissions from Other industries (1.A.2.f) are presented in the Table 3-27.

Table 3-27. Emission factors for category Other industries (1.A.2.f)

Fuel	CO_2, kg/GJ	EF source	CH_4, kg/TJ	EF source	N_20, kg/TJ	EF source
Residual fuel oil	81,29	CS	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
LPG	65,42	CS	1,0	D - 2006 IPCC	0,1	D – 2006 IPCC
Gasoil	72,89	CS	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Jet kerosene	72,24	CS	2,0	D - 2006 IPCC	2,0	D - 2006 IPCC
Shale oil	74,0	CS*	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Petroleum coke	101,0	D - 1996 IPCC	3,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Peat	106,0	D – 1996 IPCC	2,0	D - 2006 IPCC	4,0	D - 2006 IPCC
Coking coal	95,0	CS*	10,0	D - 1996 IPCC	1,4	D - 1996 IPCC
Natural gas	56,9	CS*	5,0	D - 1996 IPCC	0,1	D - 1996 IPCC
Wood/ wood waste	109,6	D – 1996 IPCC	30,0	D - 1996 IPCC	4,0	D - 1996 IPCC
Other solid biomass	109,6	D – 1996 IPCC	30,0	D - 1996 IPCC	4,0	D - 1996 IPCC
Biogas	54,6	D – 2006 IPCC	1,0	D - 2006 IPCC	0,1	D – 2006 IPCC

***country specific emission factors 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 [1,2]

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 3-28.

Table 3-28. Energy consumption by fuel type in Other industries, TJ

Year	Residual fuel oil	LPG	Gasoil	Jet kerose ne	Shale oil	Petroleum coke	Peat	Coking coal	Natural gas	Wood/ wood waste	Other solid biomass	Biogas	Total
1990	41023	92	0	0	0	0	169	1324	19209	465	0	0	**62282**
1995	9433	46	0	0	0	0	232	458	4746	799	0	0	**15714**
2000	4378	180	0	10	0	0	43	367	3747	1239	0	0	**9964**
2001	3957	166	0	5	0	0	35	306	3855	1861	0	0	**10185**
2002	2538	172	14	5	0	0	12	2060	5200	3261	47	0	**13309**
2003	875	140	74	5	0	0	16	3407	5565	4003	84	0	**14169**
2004	1295	161	105	0	5	17	14	3438	5720	4112	91	0	**14958**
2005	1481	137	282	0	0	46	10	3755	6354	3895	41	0	**16001**
2006	1016	161	172	0	0	325	13	5474	5739	3676	10	6	**16592**
2007	186	156	177	0	0	793	26	5671	5814	3615	76	13	**16527**
2008	215	195	173	0	0	218	22	4902	5040	3349	19	0	**14133**
2009	113	144	140	0	0	685	12	2611	2966	2593	8	0	**9272**
2010	111	183	173	0	0	111	11	3474	3540	2843	11	0	**10457**

In Other Industries sector largest reductions have been noticed in residual fuel oil consumption during the period 1990-2010 (table 3-23). The share of residual fuel oil has decreased from 66% (1990) till 1% (2010). Although, volume of natural gas has been reducing, however its share has remained rather stable during 1990-2010. 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 3% (2002) till 33% (2007). During 2008-2010 consumption of coking coal has been reducing, however the share has remained stable – 28-35%. The share of wood/wood waste fluctuates around 25% in the structure of fuel consumption during 2002-2010.

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.

CO_2 emission factors uncertainty in Other industries are ±7% based on IPCC 1996 guidelines. Country specific CO_2 emission factors (which were developed in 2009 based on research data from the Lithuanian oil refinery) for residual fuel oil, LPG, gasoil and jet kerosene uncertainty are ±5%.

CH_4 and N_2O emission factors used in estimation of emissions were taken from IPCC 1996, IPCC 2006 and EMEP/CORINAIR 2006 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.

3.3.6.4 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 recomendations:

- correction of CO_2 emission factor for wood/wood waste and other solid biomass based on default values provided in 1996 IPCC and for biogas - default value provided in 2006 IPCC;
- correction of N_2O emission factor for LPG and biogas based on default value provided in 2006 IPCC;
- correction of activity data for 2008 and 2009 taking into consideration updated information provided by Lithuanian Statistics.

Impact of these recalculations on GHG emissions from 1.A.2.f Other industries is presented in Table 3-29.

Table 3-29. Impact of recalculation on GHG emissions from 1.A.1.f Other industries

Year	Submission 2011, Gg CO_2 eq.	Submission 2012, Gq CO_2 eq.	Absolute difference, Gg CO_2 eq.	Relative difference, %
1990	4592,3	4592,3	-0,040	-0,001
1991	4578,7	4578,6	-0,120	-0,003
1992	2000,7	2000,7	-0,020	-0,001
1993	1435,4	1435,4	-0,020	-0,001
1994	1388,1	1388,0	-0,020	-0,001
1995	1113,1	1113,1	-0,020	-0,002
1996	844,9	844,9	-0,005	-0,001
1997	854,9	854,9	-0,020	-0,002
1998	831,1	831,0	-0,040	-0,005
1999	676,4	676,3	-0,042	-0,006
2000	625,3	625,2	-0,078	-0,012
2001	590,3	590,3	-0,072	-0,012
2002	720,8	720,7	-0,075	-0,010
2003	739,0	738,9	-0,061	-0,008
2004	790,4	790,3	-0,070	-0,009
2005	885,1	885,0	-0,059	-0,007
2006	998,1	998,0	-0,073	-0,007
2007	1002,3	1002,3	-0,075	-0,007
2008	791,5	830,0	38,529	4,868
2009	498,9	523,3	24,355	4,881

3.3.6.6 Source-specific planned improvements

A study on the revision of the emission factors used for energy sector will be implemented during 2012. Procurement tender for this study was announced in March 2012. Study results are to be ready in August 2012.

3.4 Transport (1.A.3)

The source category 1A.3 comprises the following sources (Table 3-30):

Table 3 -30. Description of categories in the 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 3-31).

Table 3-31. GHG emissions (Gg) by subcategories from transport sector in 1990 – 2010

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.5.B** *Transprt via pipelines*			**1.AA.4.C** *Agricultural, forestry, fisheries*		
	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	9,0076	0,0004	0,0003	5247,1788	1,6943	0,1289	349,9449	0,0240	0,0144	15,4527	0,0006	0,0001	88,0812	0,0077	0,0002	418,7074	0,5499	0,0041
1991	8,6464	0,0004	0,0003	5794,1128	2,0067	0,1652	378,5178	0,0260	0,0156	27,0422	0,0011	0,0002	84,7810	0,0075	0,0001	436,2007	0,5656	0,0040
1992	8,2152	0,0003	0,0002	3777,7167	1,2861	0,1151	278,3669	0,0191	0,0115	19,8990	0,0008	0,0002	48,6495	0,0043	0,0001	165,0001	0,1232	0,0015
1993	7,9218	0,0004	0,0002	2903,2042	0,9733	0,0766	201,6137	0,0138	0,0083	14,4322	0,0006	0,0001	27,2551	0,0024	0,0000	100,5216	0,1251	0,0014
1994	7,4206	0,0003	0,0002	2287,8973	0,8005	0,0588	150,4450	0,0103	0,0062	10,7877	0,0004	0,0001	29,7587	0,0026	0,0001	96,7453	0,1309	0,0016
1995	7,0594	0,0003	0,0002	2855,9020	0,7059	0,0802	147,8209	0,0101	0,0061	10,5691	0,0004	0,0001	34,7659	0,0031	0,0001	92,2079	0,0865	0,0012
1996	6,6959	0,0003	0,0002	3050,4131	0,9613	0,0807	251,4705	0,0173	0,0104	15,5256	0,0006	0,0001	38,9765	0,0034	0,0001	87,7900	0,1140	0,0014
1997	6,4747	0,0004	0,0002	3445,1541	1,0982	0,0924	240,5370	0,0165	0,0099	15,5985	0,0006	0,0001	36,5867	0,0032	0,0001	90,9352	0,1107	0,0015
1998	6,1835	0,0004	0,0002	3638,2976	1,0639	0,0952	233,1022	0,0160	0,0096	17,9309	0,0007	0,0001	28,3362	0,0025	0,0000	85,3299	0,1313	0,0018
1999	5,8201	0,0004	0,0002	3243,6929	0,9633	0,0824	206,7160	0,0142	0,0085	9,2570	0,0004	0,0001	32,2054	0,0028	0,0001	68,8923	0,1326	0,0019
2000	5,4589	0,0004	0,0002	2859,9292	0,7508	0,0688	218,0869	0,0150	0,0090	8,9178	0,0004	0,0001	39,4886	0,0035	0,0001	71,2188	0,0927	0,0013
2001	6,6690	0,0005	0,0002	3137,5832	0,7733	0,0824	191,4820	0,0131	0,0079	10,4485	0,0004	0,0001	19,2322	0,0017	0,0000	78,7101	0,1253	0,0017
2002	9,1252	0,0006	0,0003	3238,4010	0,7715	0,0818	206,7160	0,0142	0,0085	11,8811	0,0005	0,0001	21,3375	0,0019	0,0000	77,9597	0,1369	0,0019
2003	2,6236	0,0005	0,0001	3282,1480	0,7885	0,0837	226,7608	0,0156	0,0093	13,2267	0,0005	0,0001	18,3218	0,0016	0,0000	79,4392	0,1757	0,0024
2004	3,9962	0,0005	0,0001	3610,2954	0,8163	0,0876	225,7403	0,0155	0,0093	17,0086	0,0007	0,0001	18,3787	0,0016	0,0000	95,3940	0,1118	0,0016
2005	1,7769	0,0003	0,0001	3832,1187	0,8582	0,0928	228,4373	0,0157	0,0094	16,7983	0,0007	0,0001	36,8143	0,0032	0,0001	97,0830	0,0986	0,0015
2006	2,0658	0,0003	0,0001	4084,8706	0,8240	0,1097	217,6495	0,0149	0,0090	19,1419	0,0008	0,0002	62,1348	0,0055	0,0001	122,7475	0,1081	0,0016
2007	3,8651	0,0004	0,0001	4824,7708	0,7582	0,1482	226,0319	0,0155	0,0093	17,8608	0,0007	0,0001	65,1505	0,0057	0,0001	123,9836	0,1306	0,0020
2008	4,3551	0,0005	0,0001	4777,9496	0,7235	0,1600	228,4373	0,0157	0,0094	18,9457	0,0008	0,0002	57,1276	0,0050	0,0001	110,4823	0,1376	0,0021
2009	2,5603	0,0004	0,0001	3965,4063	0,6666	0,1051	175,0089	0,0120	0,0072	16,4927	0,0007	0,0001	57,7535	0,0051	0,0001	88,7412	0,1499	0,0022
2010	1,6212	0,0004	0,0000	4077,1347	0,6387	0,1106	185,1406	0,0127	0,0076	17,1292	0,0007	0,0001	58,4932	0,0051	0,0001	105,0283	0,1523	0,0023

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, 2011). Meteorological data is obtained from Lithuanian Hydrometeorological Service under the Ministry of Environment of the Republic of Lithuania (LHMS). For Lithuania from 2004 through 2010 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.

Domestic civil aviation is essentially narrow (0,01 %) in Lithuania.The number of take-offs and landings at Lithuanian airports by aircraft of both Lithuanian and foreign airlines amounted to 37,7 thousands in 2010, which is by 20,6 % more than in 2009. The number of take-offs and landings by aircraft on commercial flights totalled 35,4 thousands, or 93,8 % of all flights.

Aviation gasoline is used for piston-type powered aircraft engines, while the jet fuel used in turbine engines for aircraft and diesel engines. 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 3-32[5].

Table 3-32. 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

3.4.1.2 Methodological issues

The 2006 *IPCC Guidelines* Tier 1 approaches have been applied. 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 aviation sources used in the Lithuanian national GHG inventory are provided in Table 3-27. 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.

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

[5] IPCC 2006 Guidelines. Energy. Mobile Combustion. P. 3.16
[6] IDR Lithuania 17-21 May, 2004, Branca Americano (Brazil); consultant Domas Balandis (Lithuania).

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*).

Data on jet kerosene used for military in Lithuania is available starting from 2003, therefore GHG emissions are reported for 2003-2010.

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 2010 the air flight statistics is provided by the statistical data fromVilnius International Airport.

Emission factors

The emission factors used in the calculation of emissions from *Civil aviation* transportation are presented in Tables 3-33 – 3-35:

Table 3-33. CO_2 emission factors for Civil aviation sector used in the Lithuanian HG inventory

Fuel	**Emission factor [kg/GJ]**	**Source / Comments**
Aviation gasoline	70	2006 *IPCC Guidelines*
Jet kerosene	72,24	Country specific EF based on producer data (research protocols of UAB ORLEN Lietuva Quality Research Center)

Table 3-34. CH_4 emission factors for Civil aviation sector used in the Lithuanian GHG inventory

Fuel	**Emission factor [kg/TJ]**	**Source / Comments**
Aviation gasoline	20	Revised 1996 *IPCC Guidelines*
Jet kerosene	1,5	EF used in earlier submissions close to the EU average

Table 3-35. N_2O emission factors for Civil aviation sector used in the Lithuanian GHG inventory

Fuel	**Emission factor [kg/TJ]**	**Source / Comments**
Aviation gasoline	2	EF used in earlier submissions close to EU average (*IPCC Guidelines* 2006)

Jet kerosene	2,2	EF used in earlier submissions close to Revised 1996 *IPCC Guidelines*

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. 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). CH_4 emission factor used in estimation of emissions was taken from EMEP/CORINAIR (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.

3.4.1.4 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

The estimates of aviation gasoline consumption were linearly interpolated for the period 1996-1999 and trend extrapolation of GHG from jet kerosene for 1990-2000 years was evaluated.

3.4.1.6 Source-specific planned improvements

Civil aviation emission recalculations using Tier 2 methodology based on detailed activity data on Take-off/Landing cycle with more detailed information on aircraft types (EMEP/EEA, 2009).

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 (1,258 km/km²) network (2010). 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 2010, the length of roads amounted to 82.1 thous. kilometres and, compared to 2009, increased by 1,0 %; the length of E-roads amounted to 1666 kilometres, that of motorways – 309 km (Statistics Lithuania, 2011).

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 3-36). 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.

Table 3-36. 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	895,9
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	1322,9
2003	21,9	1256,9	126,1	1404,8
2004	22,9	1315,9	130,1	1468,8
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	1906,3
2010	56,3	1691,9	147,2	1895,3

*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 2009 increased by 2,7% in 2010. This increase is primarily caused by a 12,4% increase (4,55 TJ) in diesel fuel consumption by road transportation, while consumption of motor gasoline decreased by 2,9 TJ and liquefied petroleum gases – 1,7% (0,12 TJ) (Table 3-31). 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 3-37.

Table 3-37. Fuel consumption, [TJ]

Year	Motor gasoline	Transport diesel	LPG	Bioethanol*	Biodiesel*
1990	41840	29276	920	-	-
1991	47290	31530	690	-	-
1992	28568	23187	46	-	-
1993	22722	16794	322	-	-
1994	18547	12532	322	-	-
1995	25887	12316	1058	-	-

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

1996	28347	12398	1196	-	-
1997	28347	17731	1288	-	-
1998	27117	21158	1794	-	-
1999	21140	20448	3220	-	-
2000	16337	18365	5032	-	-
2001	16169	22127	5272	-	-
2002	15710	22977	6378	-	-
2003	15662	22769	7332	-	-
2004	14970	26595	8857	3	29
2005	14686	29262	9593	35	119
2006	15433	31787	9810	219	589
2007	18587	38872	9708	482	1762
2008	18251	39547	8615	656	1916
2009	15293	32199	7681	590	1581
2010	12396	36746	7554	436	1454

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 3-38[7].

Table 3-38. 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
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[8]. From 2000-2007, these emissions increased, since growth in mileage traveled 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 3-30). 90% of the fuel in transportation sector is consumed by road transport.

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

[8] CO_2 emissions can be estimated from the mileage, however, it is usually best to estimate the total emission 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.

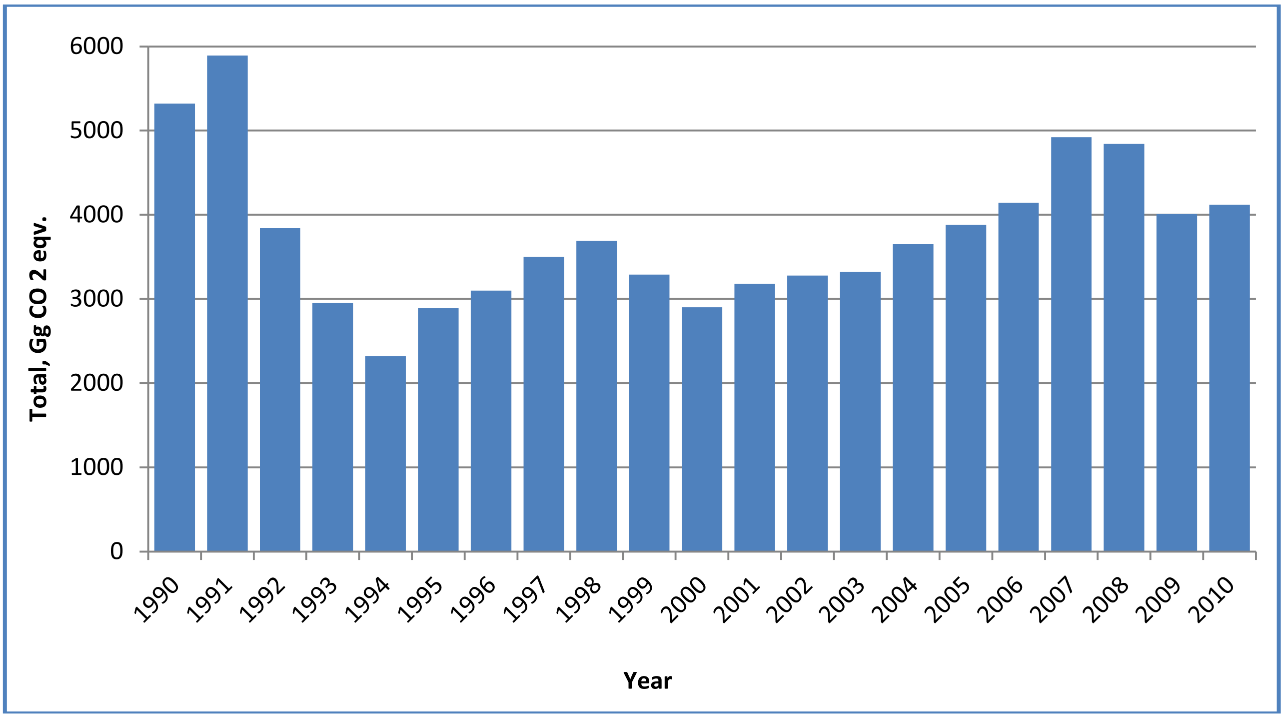


Figure 3-13. Development of greenhouse-gas emissions from road transport, Gg CO_2 eq. in 1990-2010

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 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.

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:

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

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.

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

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):

$$Emission = \sum [Fuel_a \cdot EF_a] \quad (4)$$

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 by 44/12;
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:

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

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

Fuel consumption calculated on the basis of appropriate assumptions for annual mileage of the different vehicle categories can be balanced with available fuel statistics. By applying a trial-and-error approach, it was possible to reach acceptable estimates of mileage.

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 3-39 – 3-41.

Table 3-39. 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 3-40. CH_4 emission factors for *Road transportation* sector used in the Lithuanian GHG inventory

Fuel	Emission factor [kg/TJ]	Source / Comments
LPG	19,2	EF used in earlier submissions close to EU average
Biodiesel	10,0	2006 *IPCC Guidelines*
Bioethanol	10,0	2006 *IPCC Guidelines*

Table 3-41. N_2O emission factors for *Road transportation* sector used in the Lithuanian GHG inventory

Fuel	Emission factor, [kg/TJ]	Source / Comments
LPG	0,2	2006 *IPCC Guidelines*
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 neighbors, 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[9], 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

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

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%.

The fuel consumption slightly decreased in 2009, 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[10] .

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.

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 9.0 (October, 2011). Changes with respect to the 2009 report year include recalculation of CH_4 and N_2O at new Tier 3 method (Table 3-42).

Table 3-42. Recalculated GHG emissions from road transportation

Year	Submission 2011 [Gg CO_2 eq.]	Submission 2012 [Gg CO_2 eq.]	Absolute difference	Relative difference [%]
1990	5329,45	5322,73	-6,72	-0,13
1991	5884,90	5887,48	2,58	0,04
1992	3837,81	3840,42	2,61	0,07
1993	2948,97	2947,39	-1,58	-0,05
1994	2323,74	2322,94	-0,81	-0,03
1995	2899,44	2894,41	-1,91	-0,07
1996	3096,68	3096,34	-0,34	-0,01
1997	3498,45	3496,87	-1,58	-0,05
1998	3695,04	3690,16	-4,87	-0,13
1999	3293,95	3289,48	-4,47	-0,14
2000	2903,31	2900,37	-2,93	-0,10
2001	3185,82	3179,37	-6,45	-0,20
2002	3287,79	3279,97	-7,82	-0,24
2003	3331,66	3324,64	-7,02	-0,21

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

2004	3664,82	3654,58	-10,25	-0,28
2005	3890,23	3878,90	-11,39	-0,29
2006	4147,42	4136,19	-11,55	-0,28
2007	4900,40	4886,64	-24,23	-0,49
2008	4853,74	4842,76	-12,00	-0,25
2009	4027,90	4012,00	-16,77	-0,42

3.4.2.6 Source-specific planned improvements

Refine activity data for LPG fuel cars evaluates emissions at the Tier 3 level improving time series consistency.

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

3.4.3.1 Source category description

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 2010, the number of passengers carried by rail totalled 4,4 million, which is by 0,3% less than in 2009. In 2010, passenger-kilometres amounted to 373,1 million, which is by 4,5% more than in 2009 (Statistics Lithuania).

3.4.3.2 Methodological issues

CO_2 emission calculations are based on the Tier 2 and CH_4 and N_2O on Tier 1 method with country specific emission factors. 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):

$$Emission = \sum_j (Fuel_j \cdot EF_j) . \qquad (6)$$

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 3-43 – 3-45.

Table 3-43. 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 3-44. CH_4 emission factors for *Railways* sector used in the Lithuanian GHG inventory

Fuel	Emission factor, [kg/TJ]	Source / Comments
Diesel oil	5,0	EF used in earlier submissions corresponding to Revised 1996 *IPCC Guidelines*

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

Fuel	Emission factor, [kg/TJ]	Source / Comments
Diesel oil	3,0	EF used in earlier submissions close to 2006 *IPCC Guidelines*

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 2010, it was only 4,3% of the *Transport* sector emissions. The emissions were 0,36 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

No recalculations have been done for the specific sector.

3.4.3.6 Source-specific planned improvements

Investigate a possibility for implementation of Tier 2 approach in year 2013.

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

Length of inland waterways regularly used for transport in Lithuania equalled 448 km in 2010. Transport of goods by inland waterways amounted to 996,3 thous. tonnes in 2010, which is by 9,7% more than in 2009. Compared to 2009, passenger transport by inland waterways decreased by 7,2% in 2010.

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 0,017 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 3-40-42). The existing default Tier 2 approach provided in the *IPCC Guidelines* provides only limited benefits over the Tier 1 approach:

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

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 3-46 – 3-48.

Table 3-46. 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	81,29	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 3-47. 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	3,0	EF used in earlier submissions
Diesel Oil	3,0	EF used in earlier submissions close to EU average

Table 3-48. 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	2006 *IPCC Guidelines*
Diesel Oil	0,6	2006 *IPCC Guidelines*

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

No recalculations have been done for the sector.

3.4.4.6 Source-specific planned improvements

No improvements are planned.

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

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

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 *Water-borne navigation* are presented in Table 3-49 – 3-51.

Table 3-49. 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[11] 2006 *IPCC Guidelines*

Table 3-50. 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 3-51. N_2O 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	0,1	*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 this submission.

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[11] 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).

3.4.5.1.6 Source-specific planned improvements

No improvements are planned.

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

IPCC 1996 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 3-52 – 3-54.

Table 3-52. CO_2 emission 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 3-53. CH_4 emission 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	26	*2006 IPCC Guidelines*
Diesel oil	1,67	*2006 IPCC Guidelines*

Table 3-54. N_2O emission 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	2	*2006 IPCC Guidelines*
Diesel oil	28,6	*2006 IPCC Guidelines*

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

No recalculations have been done for the sector.

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 approache have been applied. Emission factors for aviation sources used in the Lithuanian national GHG inventory are provided in Table 3-33, 3-34, 3-35. 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 3-39 – 3-41.

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

No recalculations have been done for the sector.

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 defense, 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 49,3% (1995) till 53,5% (2010). Retail, wholesale trade, real estate management and rent are the largest sectors prescribed to this category. With reference to data of 2010, they correspondingly made 17,1% and 13,7%. The structural shares of these sectors year by year are increasing.

3.5.1.2 Methodological issues

GHG emissions were calculated applying Tier 1 according to the (1) equation(see chapter 3.2.6).

Emission factors

Emission factors used in the calculation of emissions from Commercial/institutional sector (1.A.4.a) are presented in Table 3-55.

Table 3-55. Emission factors for category Commercial/institutional sector (1.A.4.a)

Fuel	CO_2, [kg/GJ]	EF source	CH_4, [kg/TJ]	EF source	N_20, [kg/TJ]	EF source
Shale oil	74,0	CS*	10,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Residual fuel oil	81,29	CS	10,0	D - 1996 IPCC	0,6	D - 1996 IPCC
LPG	65,42	CS	5,0	D - 2006 IPCC	0,1	D - 2006 IPCC
Gasoil	72,89	CS	10,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Peat	106,0	D – 1996 IPCC	10,0	D - 2006 IPCC	4,0	D - 2006 IPCC
Coking coal	95,0	D – 1996 IPCC	10,0	D - 1996 IPCC	1,4	D - 1996 IPCC
Lignite	101,2	D - 1996 IPCC	10,0	D - 1996 IPCC	1,5	D - 1996 IPCC
Natural gas	56,9	CS*	5,0	D - 1996 IPCC	0,1	D - 1996 IPCC
Wood/ wood waste	109,6	D - 1996 IPCC	300,0	D - 1996 IPCC	4,0	D - 1996 IPCC
Charcoal	102,0	CS*	200,0	D - 1996 IPCC	1,0	D - 1996 IPCC
Biogas	54,6	D - 2006 IPCC	5,0	D - 2006 IPCC	0,1	D - 2006 IPCC

*country specific emission factors 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 [1,2]

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 yearly publications "Energy balance". Activity data are provided in the Annex III.

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.

CO_2 emission factors uncertainty in Commercial/ institutional sector are ±7% based on IPCC 1996 guidelines. Country specific CO_2 emission factors (which were developed in 2009 based on research data from the Lithuanian oil refinery) for residual fuel oil, LPG and gasoil uncertainty are ±5%.

CH_4 and N_2O emission factors used in estimation of emissions were taken from IPCC 1996, IPCC 2006 and EMEP/CORINAIR 2006 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.

3.5.1.4 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 recomendations:

- correction of CO_2 emission factor for lignite and wood/wood waste based on default values provided in 1996 IPCC and for biogas - default value provided in 2006 IPCC;
- correction of N_2O emission factor for LPG and biogas based on default value provided in 2006 IPCC;

Impact of these recalculations on GHG emissions from 1.A.4.a Commercial/institutional sector is presented in Table 3-56.

Table 3-56. Impact of recalculation on GHG emissions from 1.A.4.a Commercial/institutional sector

Year	Submission 2011, Gg CO_2 eq.	Submission 2012, Gq CO_2 eq.	Absolute difference, Gg CO_2 eq.	Relative difference, %
1990	2920,4	2920,2	-0,200	-0,007
1991	3299,7	3299,5	-0,140	-0,004
1992	1329,4	1329,3	-0,080	-0,006
1993	1056,2	1056,1	-0,040	-0,004
1994	1100,5	1100,5	-0,040	-0,004
1995	948,9	948,9	-0,040	-0,004
1996	813,9	813,9	-0,020	-0,002
1997	581,0	581,5	0,526	0,090
1998	513,7	514,0	0,253	0,049
1999	460,2	460,5	0,346	0,075
2000	319,0	319,0	0,072	0,023
2001	270,1	270,2	0,127	0,047
2002	311,9	311,9	0,028	0,009
2003	323,3	323,3	-0,015	-0,005
2004	337,3	337,3	0,039	0,012
2005	362,3	362,4	0,134	0,037
2006	446,9	447,1	0,149	0,033
2007	415,4	415,4	-0,014	-0,003
2008	345,5	345,5	-0,021	-0,006
2009	393,0	393,0	-0,034	-0,009

3.5.1.6 Source-specific planned improvements

A study on the revision of the emission factors used for energy sector will be implemented during 2012. Procurement tender for this study was announced in March 2012. Study results are to be ready in August 2012.

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 2010 – 65,9 m^2. Two thirds 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

GHG emissions were calculated applying Tier 1 according to the (1) equation (see chapter 3.2.6).

Emission factors

Emission factors used in the calculation of emissions from Residential sector (1.A.4.b) are presented in Table 3-57.

Table 3-57. Emission factors for category Residential sector (1.A.4.b)

Fuel	CO_2, [kg/GJ]	EF source	CH_4, [kg/TJ]	EF source	N_20, [kg/TJ]	EF source
Residual fuel oil	81,29	CS	10,0	D - 1996 IPCC	0,6	D - 1996 IPCC
LPG	65,42	CS	5,0	D - 1996 IPCC	0,1	D – 2006 IPCC
Gasoil	72,89	CS	10,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Peat	106,0	D – 1996 IPCC	300,0	D - 2006 IPCC	4,0	D - 2006 IPCC
Coking coal	95,0	CS*	300,0	D - 1996 IPCC	1,4	D - 1996 IPCC
Lignite	101,2	D – 1996 IPCC	300,0	D - 1996 IPCC	1,5	D - 2006 IPCC
Natural gas	56,9	CS*	5,0	D - 1996 IPCC	0,1	D - 1996 IPCC

Wood/ wood waste	109,6	D – 1996 IPCC	300,0	D - 1996 IPCC	4,0	D - 1996 IPCC
Other solid biomass	109,6	D – 1996 IPCC	300,0	D - 1996 IPCC	4,0	D - 1996 IPCC

*country specific emission factors 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 [1,2]

Activity data

For calculation of GHG emissions in category Residential sector (1.A.4.b) activity data had been obtained from the Lithuanian Statistics yearly publications "Energy balance". Activity data are provided in the Annex III.

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.

CO_2 emission factors uncertainty in Residential sector are ±7% based on IPCC 1996 guidelines. Country specific CO_2 emission factors (which were developed in 2009 based on research data from the Lithuanian oil refinery) for residual fuel oil, LPG and gasoil uncertainty are ±5%.
CH_4 and N_2O emission factors used in estimation of emissions were taken from IPCC 1996, IPCC 2006 and EMEP/CORINAIR 2006 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.

3.5.2.4 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:

- correction of CO_2 emission factor for lignite, wood/wood waste and other solid biomass based on default values provided in 1996 IPCC;
- correction of CH_4 emission factor for residual fuel oil and gasoil based on default value provided in 1996 IPCC;
- correction of N_2O emission factor for LPG based on default value provided in 2006 IPCC;
- update of wood/wood waste activity data for the period 2000-2009. The Lithuanian Statistics updated wood and wood waste consumption data on November 2011, therefore this new data has been taken into consideration in 2012 submission.

Impact of these recalculations on GHG emissions from 1.A.4.b Residential sector is presented in Table 3-58.

Table 3-58. Impact of recalculations on GHG emissions from 1.A.4.b Residential sector

Year	Submission 2011, Gg CO_2 eq.	Submission 2012, Gq CO_2 eq.	Absolute difference, Gg CO_2 eq.	Relative difference, %
1990	2558,0	2556,8	-1,266	-0,049
1991	2932,7	2931,3	-1,399	-0,048
1992	1472,9	1472,0	-0,907	-0,062
1993	1391,5	1390,6	-0,873	-0,063
1994	1184,2	1183,3	-0,950	-0,080
1995	944,5	943,7	-0,783	-0,083
1996	958,3	957,8	-0,508	-0,053
1997	949,0	948,3	-0,764	-0,081
1998	787,0	786,2	-0,770	-0,098
1999	761,5	760,7	-0,770	-0,101
2000	722,4	729,7	7,301	1,011
2001	729,2	743,6	14,347	1,967
2002	750,0	770,2	20,246	2,700
2003	785,4	811,7	26,231	3,340
2004	769,5	801,7	32,248	4,191
2005	807,6	845,9	38,303	4,743
2006	847,5	892,1	44,613	5,264
2007	806,0	853,5	47,452	5,887
2008	796,9	850,5	53,573	6,723
2009	736,2	792,0	55,847	7,586

3.5.2.6 Source-specific planned improvements

A study on the revision of the emission factors used for energy sector will be implemented during 2012. Procurement tender for this study was announced in March 2012. Study results are to be ready in August 2012.

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 2,7% a year. The global economic crisis adjusted growth rates at very negative direction. With reference to data of 2009-2010, value added created has decreased by 25,4% in 2009 and increased by 4,6% in 2010.

3.5.3.2 Methodological issues

GHG emissions were calculated applying Tier 1 according to the (1) equation (see chapter 3.2.6).

Emission factors

Emission factors used in the calculation of emissions from Agriculture/forestry/fisheries sector (1.A.4.c) are presented in Table 3-59.

Table 3-59. Emission factors for category Agriculture/forestry/fisheries sector (1.A.4.c)

Fuel	CO_2, kg/GJ	EF source	CH_4, kg/TJ	EF source	N_20, kg/TJ	EF source
Shale oil	74,0	CS*	10,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Residual fuel oil	81,29	CS	10,0	D - 1996 IPCC	0,6	D - 1996 IPCC
LPG	65,42	CS	5,0	D - 2006 IPCC	0,1	D – 2006 IPCC
Gasoil	72,89	CS	10,0	D - 1996 IPCC	0,6	D - 1996 IPCC
Peat	106,0	D – 1996 IPCC	300,0	D - 2006 IPCC	4,0	D - 2006 IPCC
Coking coal	95,0	CS*	300,0	D - 1996 IPCC	1,4	D - 1996 IPCC
Natural gas	56,9	CS*	5,0	D - 1996 IPCC	0,1	D - 1996 IPCC
Wood/ wood waste	109,6	D – 1996 IPCC	300,0	D - 1996 IPCC	4,0	D - 1996 IPCC
Other solid biomass	109,6	D – 1996 IPCC	300,0	D - 1996 IPCC	4,0	D - 1996 IPCC
Biogas	54,6	D – 2006 IPCC	5,0	D - 2006 IPCC	0,1	D – 2006 IPCC

*country specific emission factors 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 [1,2]

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 yearly publications "Energy balance". Activity data are provided in the Annex III.

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.

CO_2 emission factors uncertainty in Agriculture/forestry/fisheries sector are ±7% based on IPCC 1996 guidelines. Country specific CO_2 emission factors (which were developed in 2009 based on research data from the Lithuanian oil refinery) for residual fuel oil, LPG and gasoil uncertainty are ±5%.

CH_4 and N_2O emission factors used in estimation of emissions were taken from IPCC 1996, IPCC 2006 and EMEP/CORINAIR 2006 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.

3.5.3.4 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:

- correction of CO_2 emission factor for wood/wood waste and other soild biomass based on default values provided in 1996 IPCC and for biogas - default value provided in 2006 IPCC;
- correction of CH_4 emission factor for shale oil, residual fuel oil and gasoil based on default value provided in 1996 IPCC;
- correction of N_2O emission factor for LPG and biogas based on default value provided in 2006 IPCC;
- corrected activity data of gasoil consumption for the period 2005-2009 as in the last submission gasoil consumption in fishing sector has not been taken into account.

Impact of these recalculations on GHG emissions from 1.A.4.c Agriculture/forestry/fisheries sector is presented in Table 3-60.

Table 3-60. Impact of recalculations on GHG emissions from 1.A.4.c Agriculture/forestry/fisheries sector

Year	Submission 2011, Gg CO_2 eq.	Submission 2012, Gq CO_2 eq.	Absolute difference, Gg CO_2 eq.	Relative difference, %
1990	431,4	431,5	0,095	0,022
1991	449,2	449,3	0,054	0,012
1992	168,0	168,0	0,039	0,023
1993	103,6	103,6	-0,002	-0,002
1994	100,0	100,0	0,011	0,011
1995	94,4	94,4	0,017	0,018
1996	90,6	90,6	0,047	0,052
1997	93,7	93,7	0,041	0,044
1998	88,6	88,6	0,047	0,053
1999	72,2	72,3	0,041	0,057
2000	73,6	73,6	0,017	0,023
2001	81,9	81,9	0,014	0,018
2002	81,4	81,4	0,012	0,015
2003	83,8	83,9	0,007	0,009
2004	98,2	98,2	0,010	0,010
2005	95,2	99,6	4,341	4,558
2006	114,0	125,5	11,515	10,104
2007	119,4	127,3	7,927	6,640
2008	106,6	114,0	7,414	6,957
2009	86,8	92,5	5,794	6,679

3.5.3.6 Source-specific planned improvements

A study on the revision of the emission factors used for energy sector will be implemented during 2012. Procurement tender for this study was announced in March 2012. Study results are to be ready in August 2012.

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;

$A_{industry segment}$ - activity value, units of activity;

$EF_{industry segmentl}$ - 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 3-61. 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 3-61. 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	9,5E-05	0	Gg per year per km of transmission pipeline
Oil production	Conventional oil	Fugitives	1,45E-05	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 yearly publications "Energy balance" (see Annex III), number of drilling, testing, servicing wells from the Lithuanian Geological Survey, length of transmission and distribution pipelines from UAB Lietuvos dujos. In addition to energy balance the data on transportation of crude oil and oil products in pipelines from database of the Lithuanian Statistics[12] 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: number of drilling, testing and servicing wells was corrected. The Lithuanian Geological Survey provided updated data for the period 2000-2009 therefore this new data has been taken into consideration in 2012 submission. The impact of this recalculation on total fugitive GHG emissions from oil and natural gas sector (1.B.2) for 2000-2009 period is insignificant as presented in Table 3-62.

Table 3-62. Impact of recalculations on GHG emissions from 1.B.2 Oil and natural gas sector

Year	Submission 2011, [Gg CO_2 eq.]	Submission 2012, [Gq CO_2 eq.]	Absolute difference, [Gg CO_2 eq.]	Relative difference, [%]
2000	250,2	250,2	0,001	0,001
2001	279,6	279,6	-0,007	-0,003
2002	274,1	274,1	0,001	0,000
2003	269,1	269,1	0,009	0,003
2004	259,3	259,3	-0,007	-0,003
2005	263,4	263,4	-0,001	-0,001
2006	262,2	262,2	-0,014	-0,005
2007	258,9	258,9	0,003	0,001
2008	262,7	262,7	0,001	0,001
2009	269,8	269,8	0,000	0,000

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

3.6.2.6 Source-specific planned improvements

No improvements are 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 reestablished 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 2010 the Fund provided information on verified CO_2 emissions for 101 fuel combustion installations[13] (see Annex IV). 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).

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 (fuel combustion by sectoral approach). Comparison of the verified CO_2 emissions and NIR is provided in Table 3-56.

Table 3-56. Comparison of the verified CO_2 emissions and NIR (fuel combustion from sectoral approach), 2010

	Verified CO_2 emissions, [Gg]	**Calculated CO_2 emissions, [Gg]**	**Absolute difference, [Gg]**	**Relative difference, [%]**
1.AA.1.A Public electricity and heat production	3398,24	3832,92	434,68	11,34
1.AA.1.B Petroleum Refining	1564,00	1568,98	4,98	0,32
1.AA.2.C Chemicals	150,78	191,80	41,02	21,39
1.AA.2.D Pulp, Paper and Print	69,33	66,93	-2,40	-3,59
1.AA.2.E Food processing, Beverages and Tobacco	50,99	274,12	223,13	81,40
1.AA.2.F Other	392,75	577,41	184,66	31,98
1.AA.4.C Agriculture/ Forestry/ Fisheries	45,34	105,03	59,69	56,83
Total	5671,44	6617,19	945,75	14,29

[13] http://www.laaif.lt/index.php?-130096284

Total CO_2 emissions calculated in NIR sectoral approach are 14.29% higher (945,75 Gg) 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 2008. Dominating industry in Lithuania is manufacturing. Manufacturing constituted 87% of the total industrial production (except construction) in 2010 (Figure 4-1). Four most important sectors within Manufacturing cumulatively produced 78% of production:

- Manufacture of refined petroleum products (28%);
- Manufacture of food products and beverages (19%);
- Manufacture of wood products and furniture (11%);
- Manufacture of chemicals and chemical products (10%).

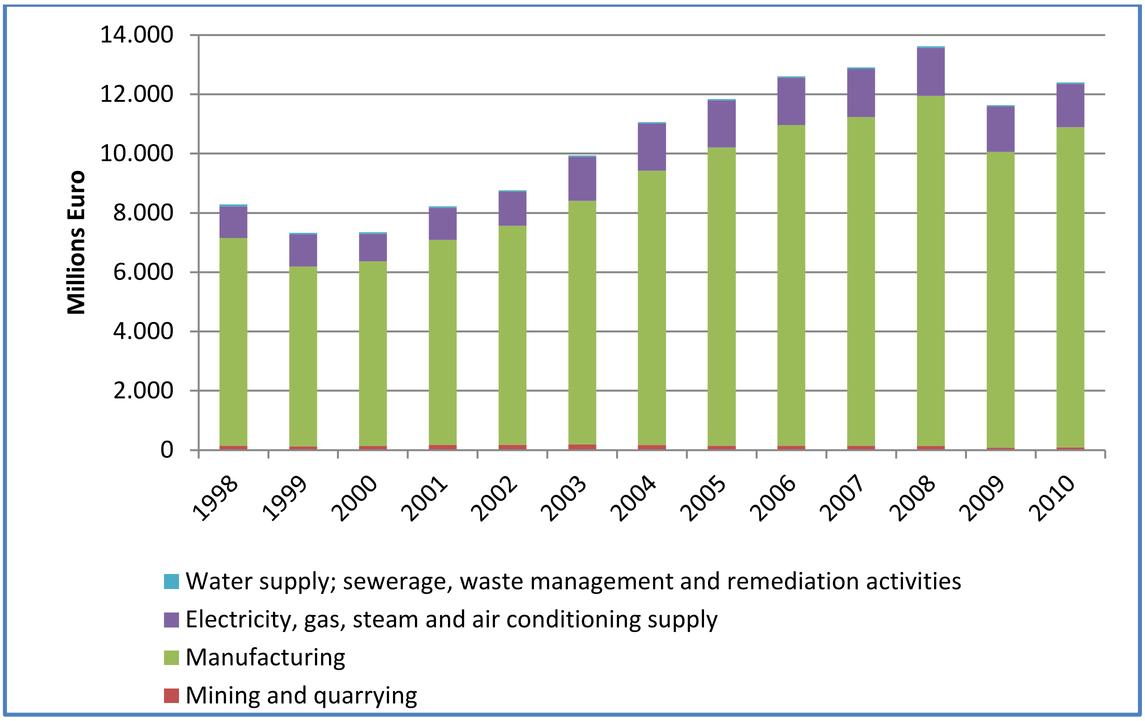


Figure 4-1. Industrial production at constant prices (except construction) in millions Euro

Share of the main sectors in production of manufacturing products in Lithuania is presented in Figure 4-2.

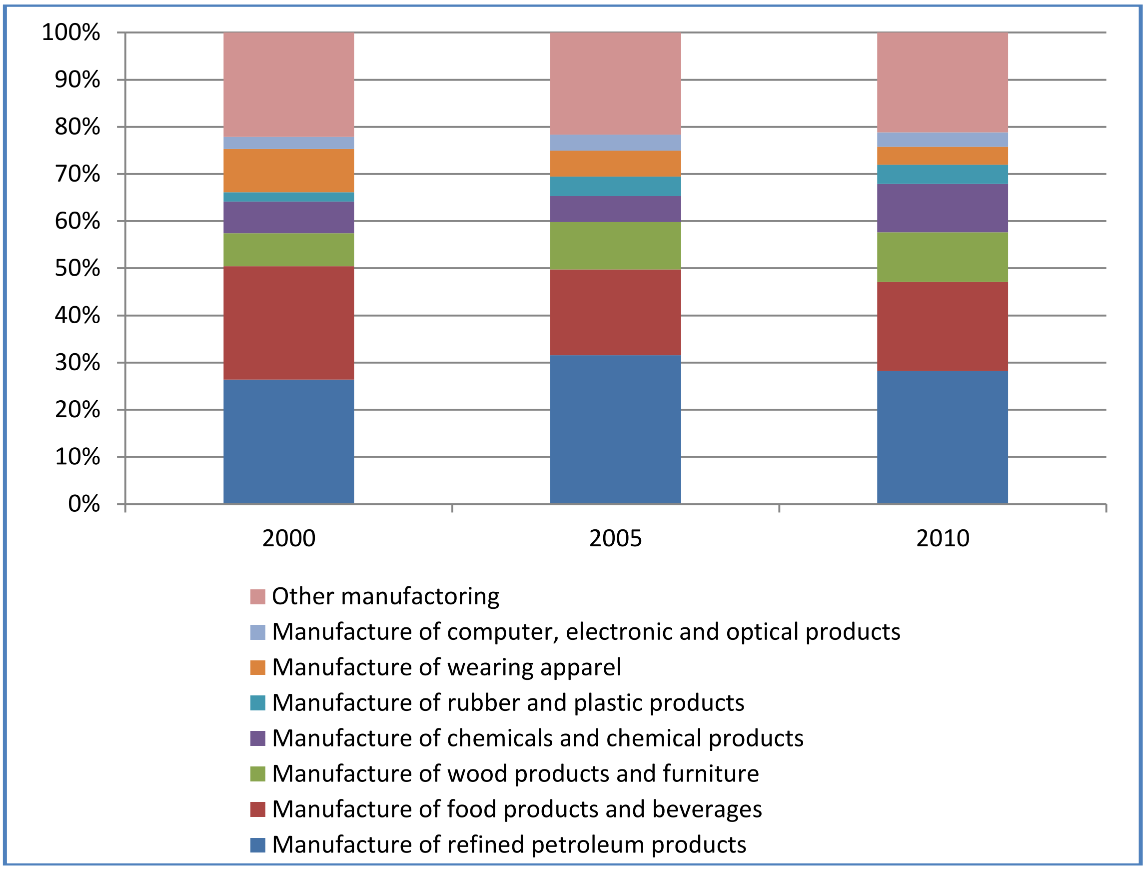


Figure 4-2. Share of the main sectors in production of manufacturing products in Lithuania (at constant prices)

Greenhouse gas emissions from Industrial processes contributed 11% to the total anthropogenic greenhouse gas emissions in Lithuania in 2010, totalling 1488,14 Gg CO_2 equivalent (Figure 4-3.).

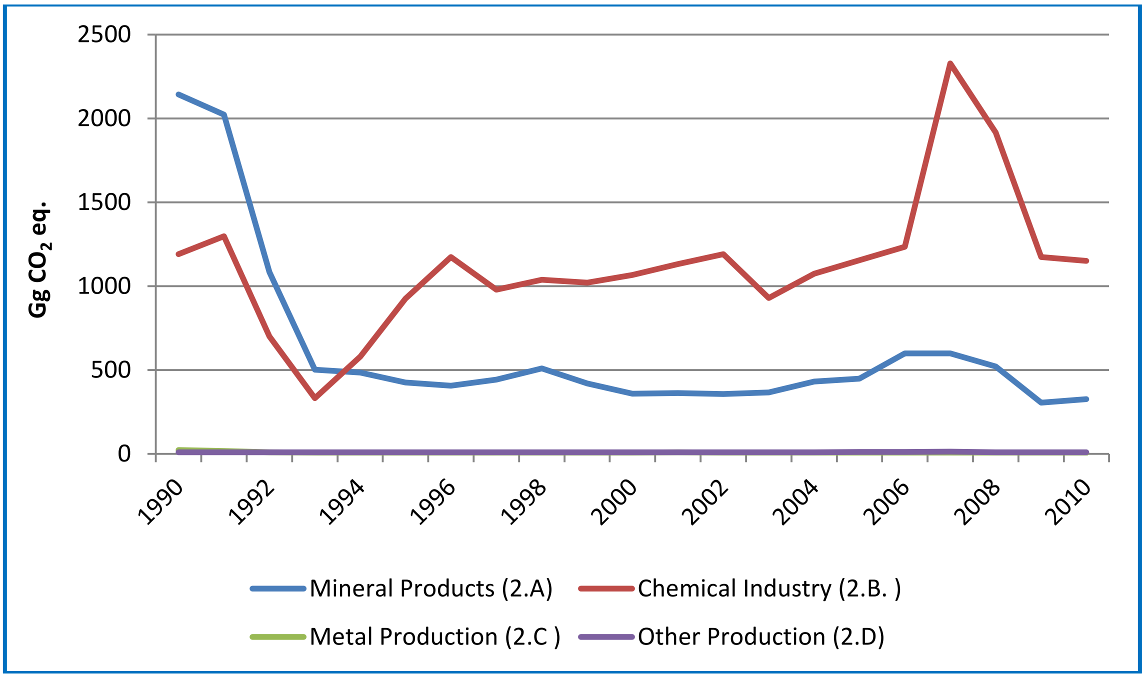


Figure 4-3. CO_2 emissions from industrial processes, Gg CO_2 eq. in 1990-2010

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 SF6 (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);
  - electrical equipment (CRF 2.F.8).

Several emission sources in the Industrial processes sector are key categories. The key categories in 2010 by level and trend, excluding LULUCF are listed in Table 4-1.

Table 4-1. Key categories in Industrial Processes Sector in 2010

IPCC source categoty	Gas	Identification criteria
2.A.1. Cement Production	CO_2	L, T
2.A.2 Lime Production	CO_2	T
2.A.7 Bricks and Tiles (decarbonizing)	CO_2	T
2.B.1. Ammonia Production	CO_2	L, T
2.B.2. Nitric Acid Production	N_2O	L, T
2. F Consumption of Halocarbons and SF6, 1995	HFCs	L, T

4.2 Mineral Products (CRF 2.A)

Non-fuel 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 source category in Lithuanian 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 in 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 49,9% of the emissions of the Industrial processes sector in 1990 and 14,5% in 2010. Amount of emissions were 2141.6 Gg (CO_2 eq.) in 1990 and 325,5 Gg in 2010 (Figure 4-4, 4-5).

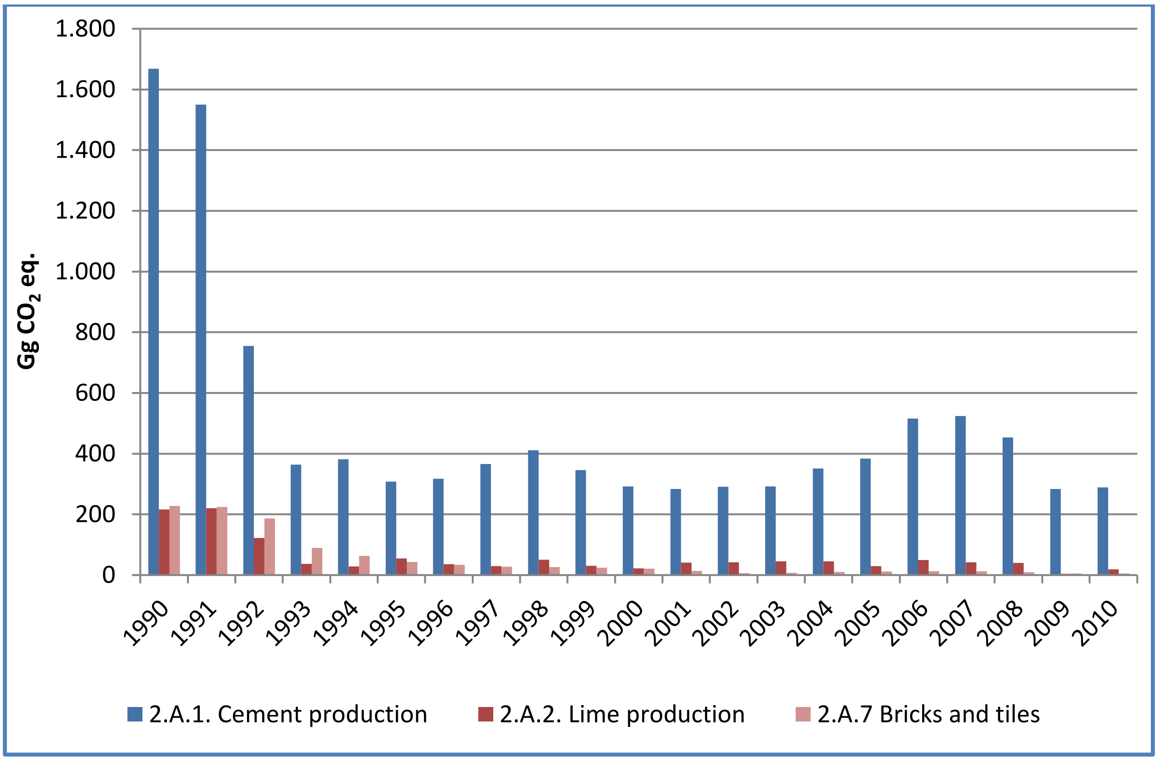


Figure 4-4. Greenhouse gas emission from Mineral products, Gg CO_2 eq. in 1990-2010: production of cement, lime and bricks and tiles

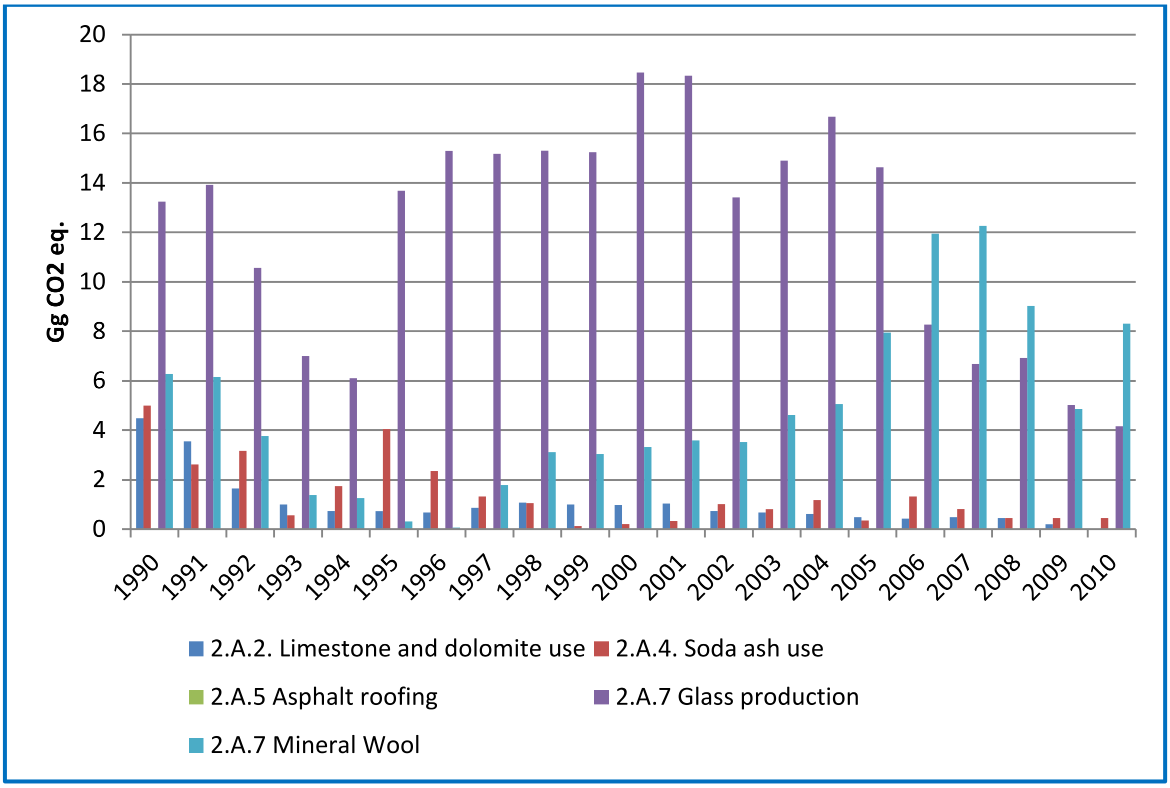


Figure 4-5. Greenhouse gas emission from Mineral products, Gg CO_2 eq. in 1990-2010: limestone and dolomite use, soda ash use, asphalt roofing, glass and mineral wool production

Cement production is the biggest source of greenhouse gas emissions in the Mineral products category, being 289,05 Gg in 2010 (88,8%). Emissions from cement production were 38,8% in 1990 and 14,5% in 2010 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. In 2010 cement production comprised only 19,5% of that at the beginning of the time series. 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.

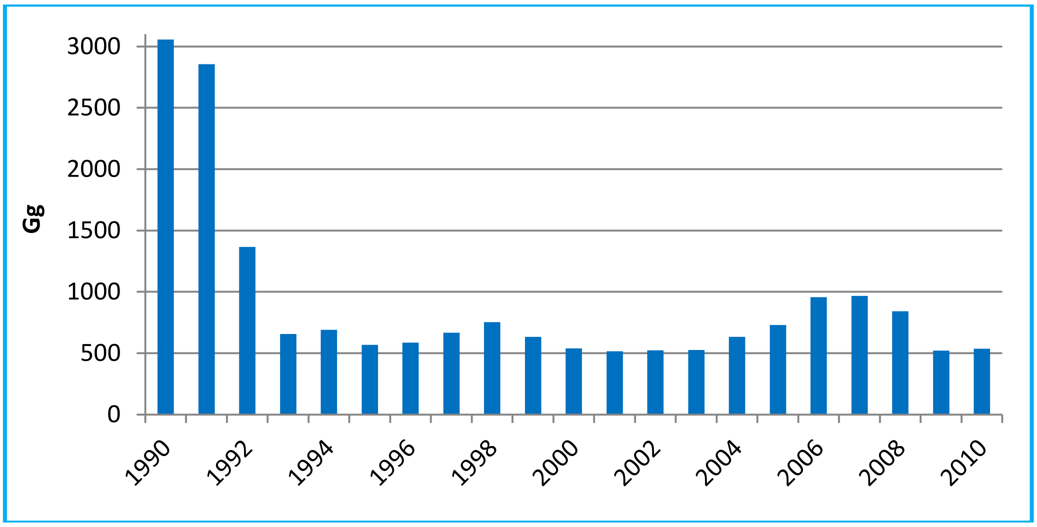


Figure 4-6. Clinker production, Gg in 1990-2010

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 2005-2010 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 %

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 2005-2010 (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.

In 2011 submission, emissions for years 2005-2008 were recalculated using verified activity and EF data provided in EU ETS reports. Before applying the verified data, both sources of the data were evaluated and compared. The difference between previously calculated 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%.

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 was fluctuating about this value until 2008 but have contracted again in 2009 and 2010 (Figure 4-7.). Data on lime production were provided by Statistics Lithuania[14].

Data on hydrated lime production are provided by Statistics Lithuania from 2002. The fraction of hydrated lime was about 0,001% in 2002 to 2006. In 2007 its production reached maximum at about 900 tonnes declining again to approximately 200 tonnes in 2009 and 2010.

Actual hydrated lime production data were used for emission calculation in 2002-2010 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[15].

[14] http://db1.stat.gov.lt/statbank/default.asp?w=1440
[15] IPCC GPG 2000, p. 3.22-23

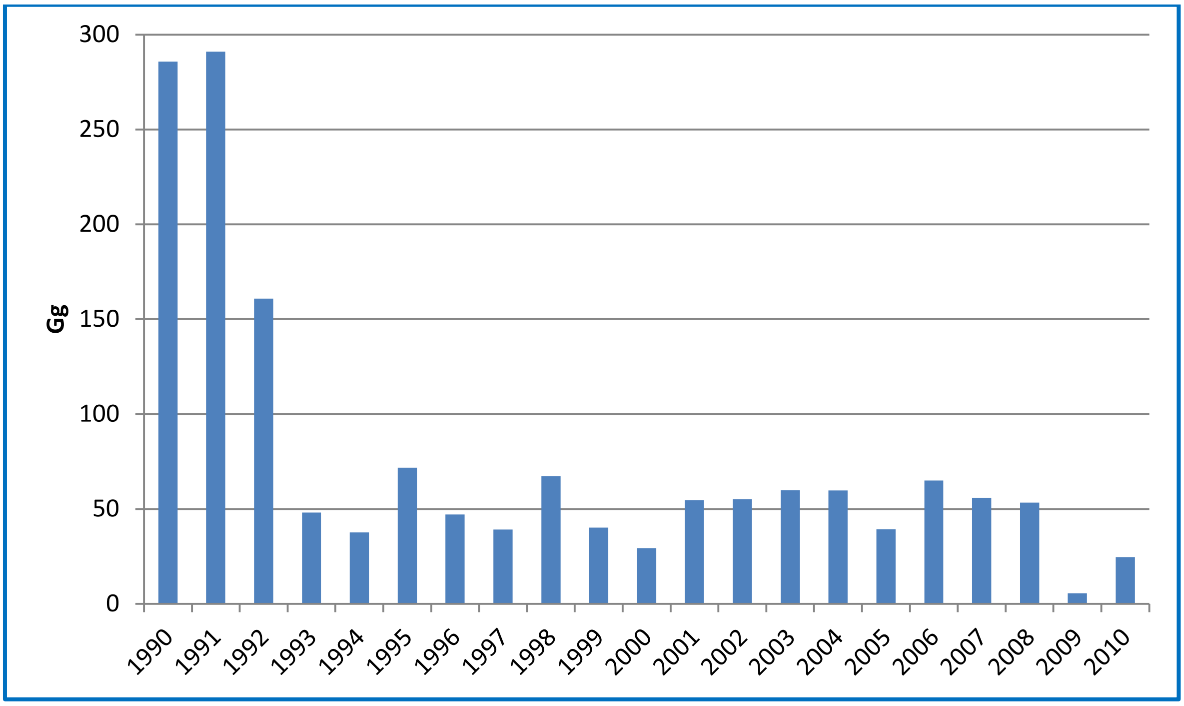


Figure 4-7. Lime production, Gg in 1990-2010 in Lithuania

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.

4.2.2.2 Methodological issues

CO_2 emission was calculated by Tier 2 method using production data provided by Statistics Lithuania and limestone composition data provided by AB Naujasis Kalcitas. 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.

As it was mentioned above, hydrated lime data were converted to quicklime using default water content correction factor 0.28. 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.

Estimated CO_2 emissions from lime production are provided in Table 4-5.

Table 4-5. Estimated CO_2 emissions (Gg/year) from lime production

Year	Emission
1990	216,4
1991	220,4
1992	121,9
1993	36,4
1994	28,5
1995	54,3
1996	35,6
1997	29,6
1998	51,0
1999	30,5
2000	22,2
2001	41,4
2002	41,7
2003	45,3
2004	45,3
2005	29,7
2006	49,2
2007	42,3
2008	40,3
2009	4,2
2010	18,6

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 2008-2010 have been verified with EU ETS data. For all three years calculated emissions are significantly higher than reported in EU ETS (23% in 2008 and 25% in 2010). This difference in estimated CO_2 emission is due to difference in 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

No source-specific recalculations were done.

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 4-6.

Table 4-6. 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

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 use were calculated taking into account separately soda ash consumption in glass production (covered under CRF 2.A.7) and other use of soda ash. The data on overall use of soda ash were taken from the publications of Statistics Lithuania[16]. The data on the

[16] Statistic Lithuania publication "Raw Materials"

use of soda ash was not available for 2010 and was extrapolated (average consumption in 2008–2009). Data provided by glass manufacturing companies included soda ash consumption by AB Warta Glass Panevėžys from 1999 and by UAB Kauno Stiklas from 2004. Relative soda ash consumption was calculated from available data as factor expressing soda ash consumption per production of on tonne glass and used for evaluation of soda ash consumption for glass production during the remaining period. Keeping in mind that speciality cathode ray tube (CRT) glass contains substantially less sodium, soda ash consumption factor for CRT producer AB Ekranas was divided by half.

Variations of soda ash use are shown in Figure 4-8.

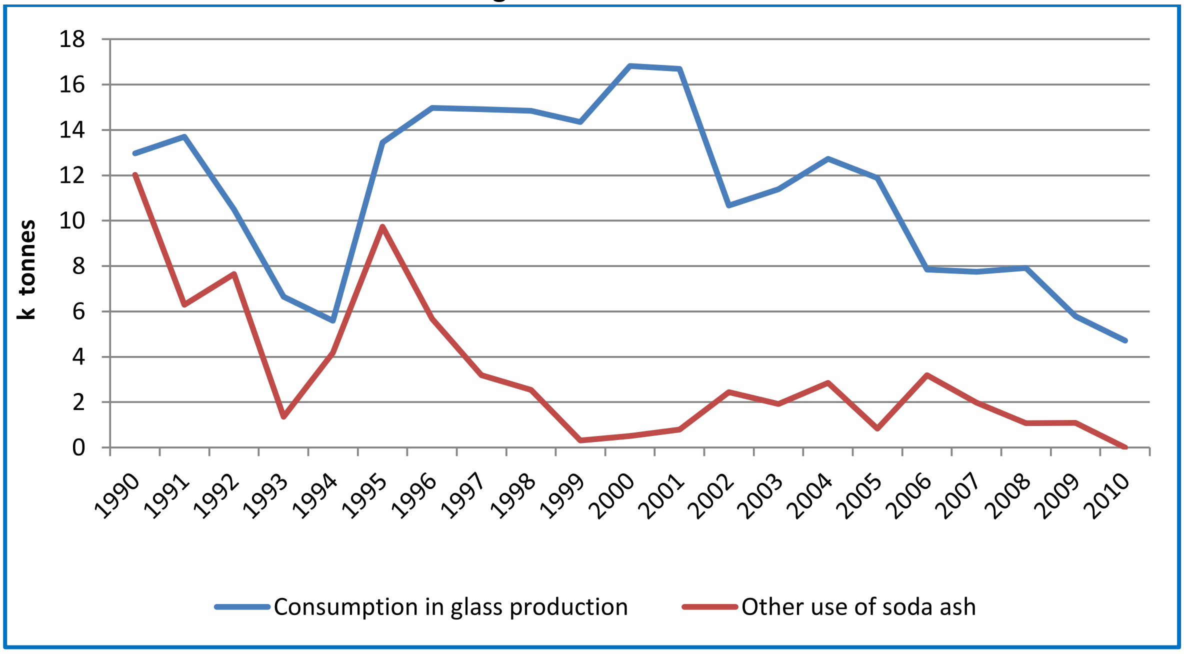


Figure 4-8. Evaluated use of soda ash, k tonnes in 1990-2010

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 4-7.

Table 4-7. Estimated CO_2 emissions (Gg/year) from soda ash use

Year	Emission
1990	5,0
1991	2,6
1992	3,2
1993	0,6
1994	1,7
1995	4,0
1996	2,4
1997	1,3
1998	1,1
1999	0,1
2000	0,2
2001	0,3
2002	1,0
2003	0,8
2004	1,2
2005	0,3
2006	1,3
2007	0,8
2008	0,4
2009	0,4
2010	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[17]. Data on use of soda ash was not available for 2010 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.

[17] Statistic Lithuania publication "Raw Materials"

4.2.4.5 Source-specific recalculations

No source-specific recalculations were done.

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 was 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 2001-2010 (Table 4-8).

Table 4-8. Production of asphalt roofing materials in Lithuania 2001-2010 (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

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.

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. Asphalt roofing production is provided in Figure 4-9.

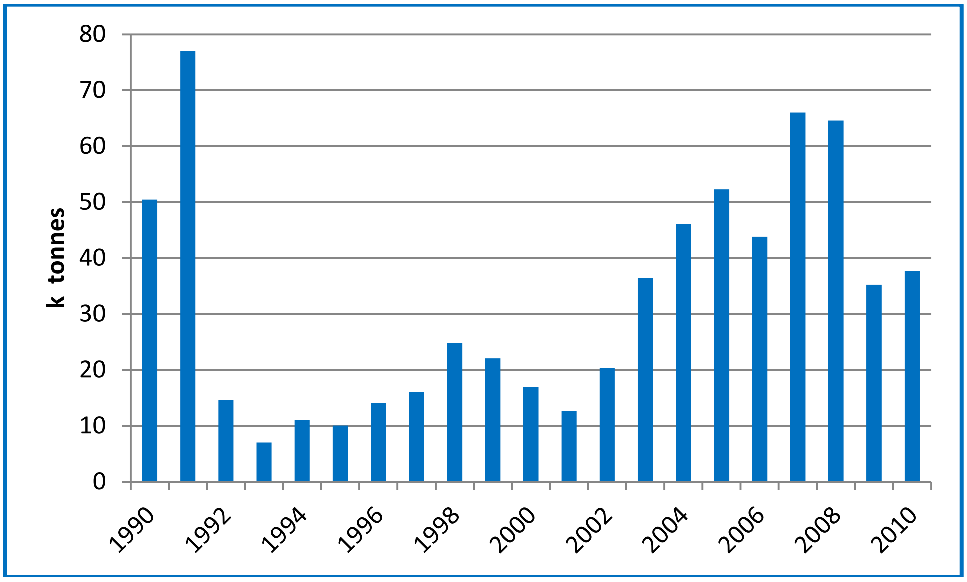


Figure 4-9. Production of asphalt roofing in 1990-2010, k tonnes

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.

Emissions of nonmethane 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 was converted to CO_2 equivalent assuming that NMVOC contain 80% carbon by weight (IPCC Guidelines 2006). Estimated NMVOC and CO_2 eq. emissions from asphalt roofing production are shown in Table 4-9.

Table 4-9. 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

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 contain errors. 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

Emissions from asphalt roofing were calculated for the first time in Lithuanian inventory. Emissions were estimated for the whole time period.

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 only two plants are in operation currently.

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 2010, 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 1990-2010 is shown in Figure 4-10.

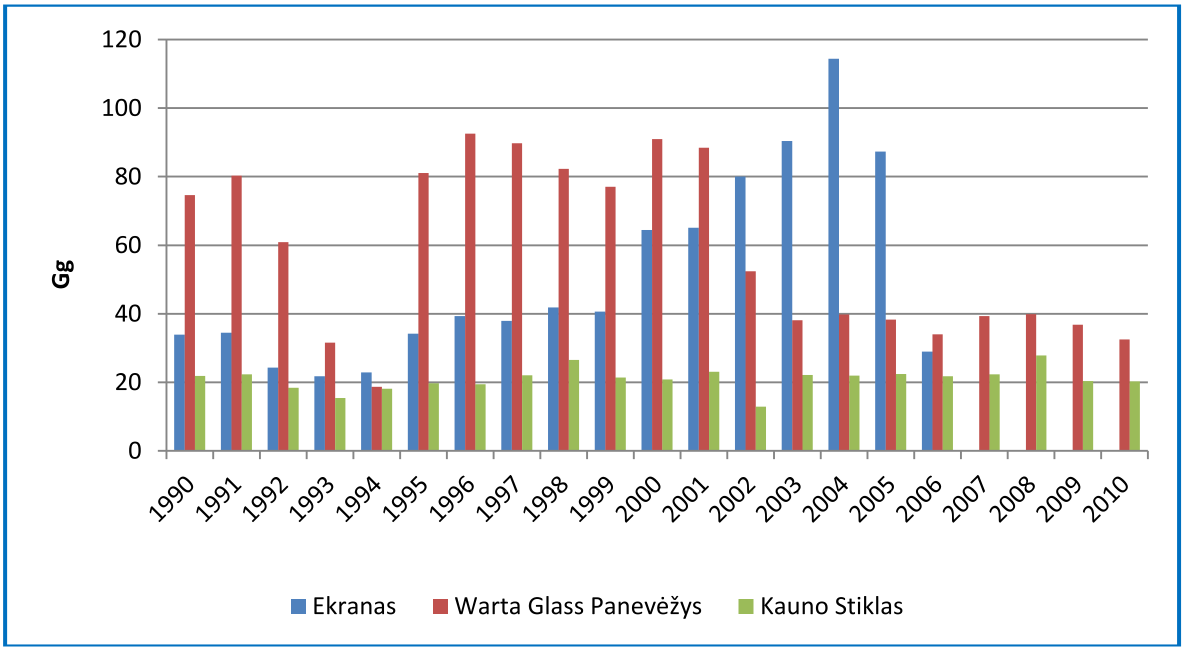


Figure 4-10. Glass production in 1990-2010, Gg

4.2.6.1.2 Methodological issues

UAB Kauno Stiklas provided data on dolomite, soda ash, chalk composition and cullet use for 2004-2010. AB Warta Glass Panevėžys provided data on dolomite, soda ash, chalk consumption and cullet use starting from 1999, however, the data on composition of these batch components were available only from 2005. Average composition of the components was used for calculation of CO_2 emissions in 1999-2004.

CO_2 emissions were calculated using the following equation:

$$Emission = \sum(CC_i \times \sum(C_{i,j} \times (M_{CO2}/M_j))).$$

where:

CC_i - consumption of component *i*, Gg;

$C_{i,j}$ - the fractions of accordingly $CaCO_3$, $MgCO_3$, Na_2CO_3 and K_2CO_3 in component *i*;

M_{CO2} - molecular weights of CO_2;

M_l - the molecular weights of $CaCO_3$, $MgCO_3$, Na_2CO_3 and K_2CO_3 accordingly.

CO_2 emissions for the periods for which data on batch composition were not available were established using emission factors calculated by dividing the total annual CO_2 emission by the total glass production. Calculated emission factors (tonne CO_2/tonne glass produced) were 0.102 for AB Warta Glass Panevėžys and 0.114 for UAB Kauno Stiklas.

Estimated CO_2 emissions from glass production are provided in Table 4-10. CH_4 and N_2O emissions from glass production were not estimated due to lack of IPCC methodology.

Table 4-10. Estimated CO_2 emissions (Gg/year) from glass production

Year	Emission
1990	13,2
1991	13,9
1992	10,6
1993	7,0
1994	6,1
1995	13,7
1996	15,3
1997	15,2
1998	15,3
1999	15,2
2000	18,5
2001	18,3
2002	13,4
2003	14,9
2004	16,7
2005	14,6
2006	8,3
2007	6,7
2008	6,9
2009	5,0
2010	4,2

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. UAB Kauno Stiklas provided data on dolomite, soda ash, chalk composition and cullet use for 2004-2010. AB Warta Glass Panevėžys provided data on dolomite, soda ash, chalk consumption and cullet use starting from 1999, however, the data on composition of these batch components were available only from 2005. Average composition of the components was used for calculation of CO_2 emissions in 1999-2004. CO_2 emissions by company AB Ekranas cover period 1990-2006 due to bankrupt of the company.

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 2007-2010 have been verified with EU ETS data for two glass production plants (the third plant got bankrupt in 2006). The the difference between the GHG inventory and the EU ETS data is less than 2%.

4.2.6.1.5 Source-specific recalculations

No source-specific recalculations were done.

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 1998-2010 were provided by the UAB Paroc company. Production data for the 1998-2010 were reviewed and corrected in 2011 submission.

Mineral wool production during 1990- 2010 is shown in Figure 4-11.

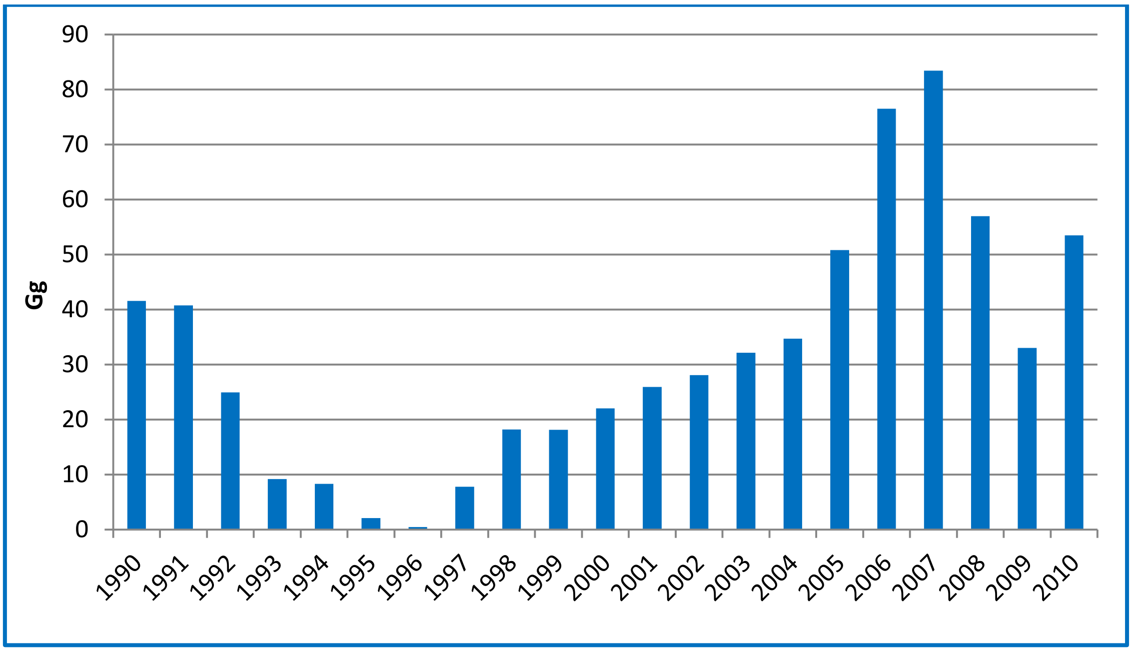


Figure 4-11. Mineral wool production in 1990-2010, Gg

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 (1997-2010).

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.

Specific batch composition for mineral wool production is considered confidential by the Paroc and was not disclosed. However, the company provided data on dolomite consumption for the years 1997 to 2010 and CO_2 emission factors:

0,44 t CO_2/t dolomite in 2008 and 2010;
0,42 t CO_2/t dolomite in 2009.

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 4-11.

Table 4-11. 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

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 may contain errors. 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 1998-2010 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 2008-2010 have been verified with ETS data and the correspondence between these data is 100%.

4.2.6.2.5 Source-specific recalculations

Source-specific recalculations were done for the whole time series based on more precise activity data and plant specific CO_2 emission factor provided by the producer UAB Paroc:

- total production of mineral wool (1998-2010);
- data on dolomite consumption (1997-2010);
- plant specific CO_2 emission factor for dolomite (2008-2010).

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[18]. 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[19]. 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 1990-2010 is provided in Figure 4-12.

[18] http://db1.stat.gov.lt/statbank/default.asp?w=1440
[19] http://www.palemonokeramika.lt/

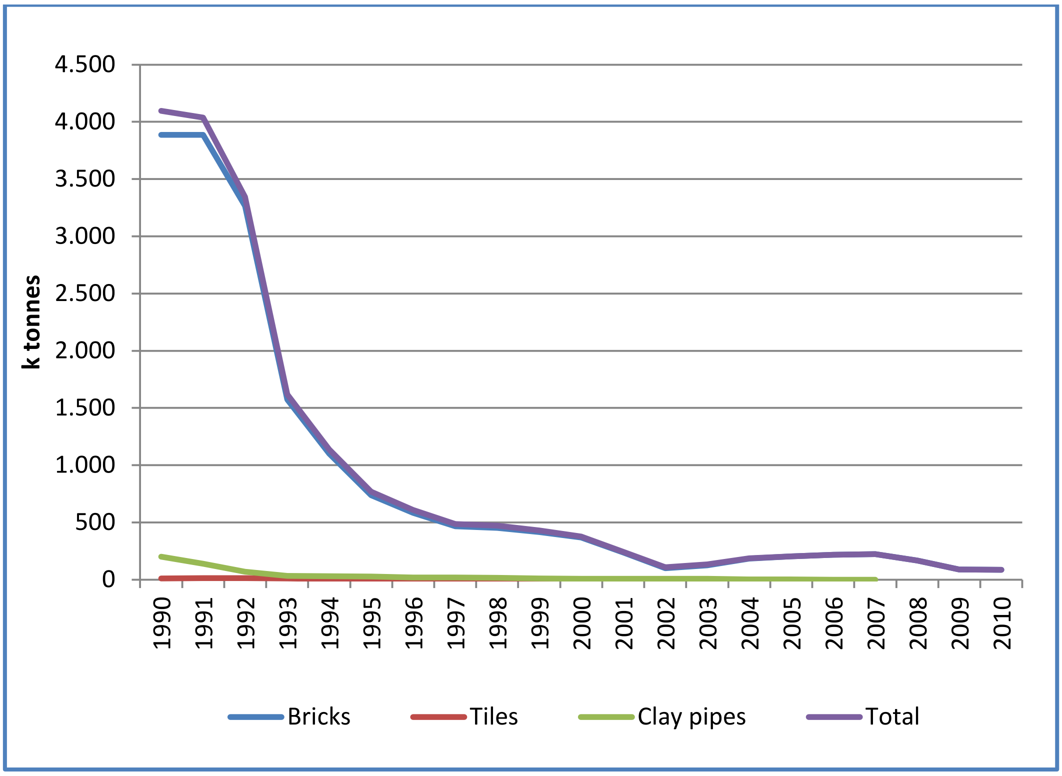


Figure 4-12. Production of ceramic products in 1990-2010, k tonnes

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 4-12.

Table 4-12. 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

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[20]. 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.

[20] http://db1.stat.gov.lt/statbank/default.asp?w=1440

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 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 4-13).

Table 4-13. 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 2010 were 1728,34 Gg CO_2 eq., and it was 77% of industry sector emissions.

Nitric acid and ammonia is nowadays produced in Lithuania in a single company. Emissions of CO_2 from ammonia production were 1190,53 Gg in 2010. Emissions of N_2O from nitric acid production were 1,86 Gg in 2010. Significant decline in N_2O emissions in 2009 and 2010 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 gasses from chemical industry (did not exceed 0,2% during the whole time series 1990-2008). No methanol was produced in 1999, 2009 and 2010.

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. According to information, provided by AB Achema, 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.

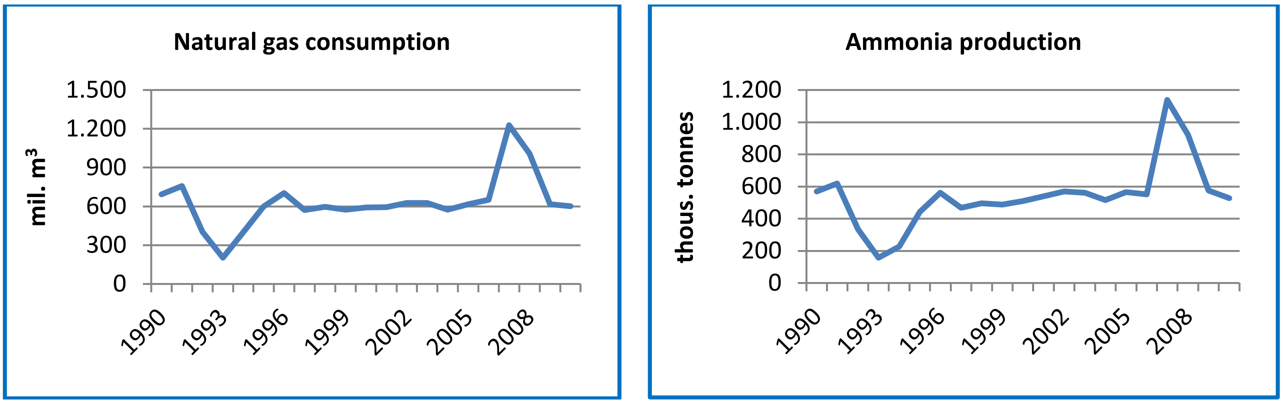


Figure 4-13. Natural gas consumption and ammonia production

4.3.1.2 Methodological issues

CO_2 emissions were calculated from natural gas consumption using carbon content in natural gas data (Tier 1a, IPCC 1996):

Emission = Consumption of natural gas × carbon content x 44/12

Natural gas consumption and carbon content in natural gas data was provided by the production company. Implied emission factor's for ammonia production variations are directly related to carbon content variations. The reason of carbon content fluctuations is that natural gas is imported from Russia and variations of carbon content in natural gas mostly depends on supply source. Calorific value of supplied natural gas is measured twice per month at Lithuania's natural gas supplier (AB "Lietuvos dujos") laboratory. Average annual carbon content values of the natural gas used as feedstock and CO_2 emissions are provided in Table 4-14.

Table 4-14. Estimated CO_2 emissions (Gg/year) from ammonia production and carbon content of natural gas

Year	Carbon content of natural gas, kg/m^3	Emission, Gg/year
1990	0,469	1190,53
1991	0,467	1296,58
1992	0,474	699,37
1993	0,444	330,48
1994	0,396	579,64
1995	0,421	925,12
1996	0,455	1173,17
1997	0,467	977,91
1998	0,474	1037,24
1999	0,484	1020,08
2000	0,492	1066,34
2001	0,519	1130,57
2002	0,519	1190,14

2003	0,405	929,02
2004	0,510	1073,75
2005	0,510	1153,98
2006	0,518	1234,19
2007	0,517	2328,45
2008	0,519	1915,94
2009	0,519	1173,01
2010	0,521	1150,30

4.3.1.3 **ncertainties 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 10%;
- Combined uncertainty is 10,2%.

The data is consistent over the time-series. Natural gas consumption and carbon content in natural gas data was provided by the production company.

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

No source-specific recalculations were done.

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 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 1990-2010 period in AB Achema is provided in Table 4-15.

Table 4-15. Nitric acid production units in AB Achema in 1990-2010

Nitric acid production unit	1990-2002	2003	2004	2005-2008	2009-2010
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.

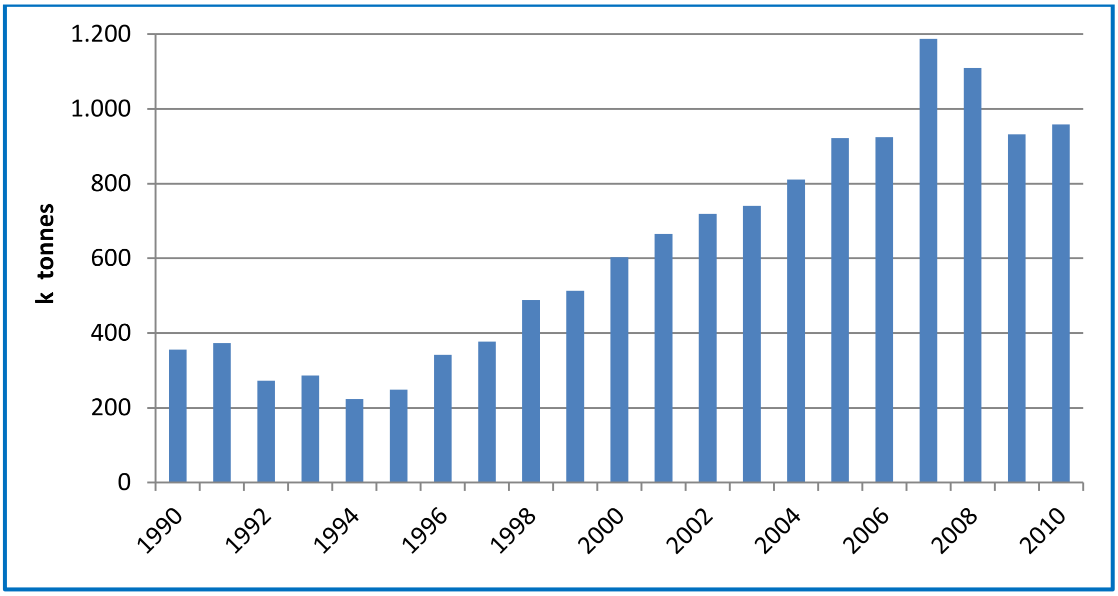


Figure 4-14. Nitric acid production, thous tonnes (100% acid)

4.3.2.2 Methodological issues

Following the recommendation of expert review team (ERT) in 2011 to report annual emissions using the mean value of EFs of the actually operating units for years 1990-2008 and to use unit-specific AD and EFs for estimation of emission for years 2009-2010, plant and production unit specific N_2O emission factors were obtained from the producer (Table 4-16). The emisison factors were measured and registered in automated monitoring system (AMS) by AB Achema.

Table 4-16. Production unit specific N_2O emission factors calculated using measured and registered data in automated monitoring system

Line No	2007-2008*	2009	2010
UKL-1	9,63	1,72	1,86
UKL-2	9,51	1,43	1,42
UKL-3	5,45	2,22	2,92
UKL-4	7,73	1,88	2,4
UKL-5	6,61	2,07	1,87
UKL-6	10,34	3,73	3,51
UKL-7	9,09	2,7	1,54
UKL-8	6,96	2,35	1,58
UKL-9		4,81	4,84
GP	8,83	1,17	0,96

* Data source: Report of the AB Achema for the calculation of EU allowances for the third EU ETS period 2013-2020

For 1990-2008 emission calculation, the unit specific average emission factors for years 2007-2008 (measured in automated monitoring system prior to installation of catalyst) were used (Table 4-16). Production for each operational unit was extrapolated from the data on total production of nitric acid in particular year based on 2009-2011 unit specific production data.

Emission for 2009-2010 was estimated using unit specific emission factors (Table 4-15) and unit specific prodution data provided by the producer. As already mentioned, in 2008 JI project for N2O 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 4-16).

Estimated emissions of N_2O from nitric acid production are provided in Table 4-17.

Table 4-17. 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

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.

Source category-specific quality control procedures have been carried out in 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

Recalulation was made for the entire time series (1990-2010) using plant and production unit specific emission factors and unit specific activity data.

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.

Capacities: Project capacity of methanol unit is 74000 t/year.

Methanol production data (Figure 4-15) 1990-2008 were obtained from Statistics Lithuania publications[21]. According to AB Achema data methanol was not produced in 1999, 2009 and 2010.

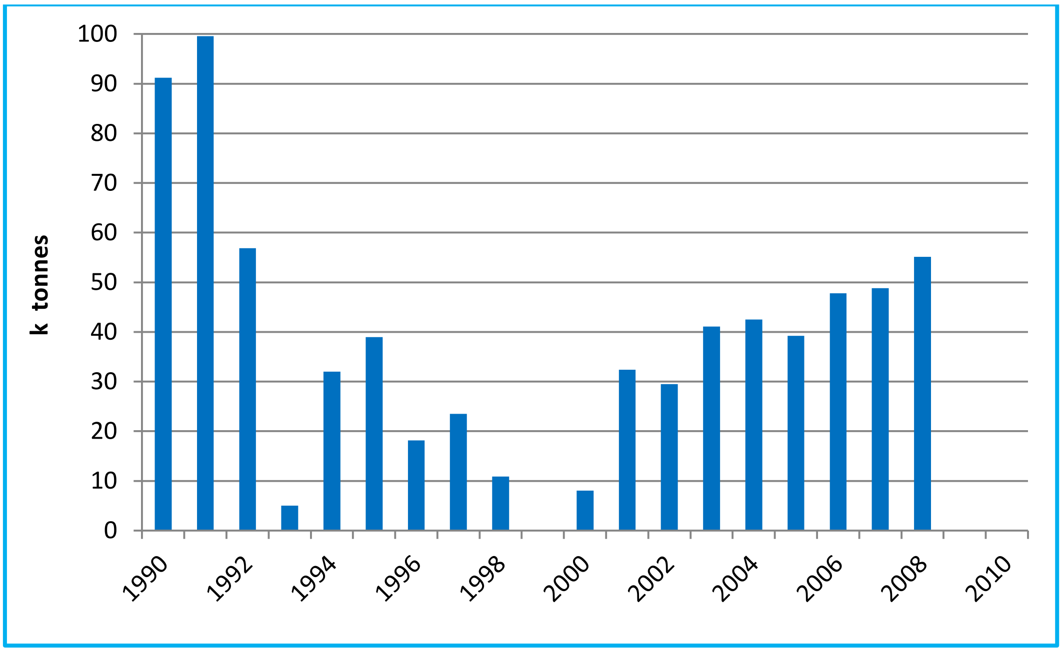


Figure 4-15. Methanol production, k tonnes

[21] http://db1.stat.gov.lt/statbank/default.asp?w=1440

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 4-18.

Table 4-18. Estimated emissions of CH_4 (Gg/year) from methanol production

Year	Emission
1990	0,182
1991	0,199
1992	0,114
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

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 and 2010.

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 inventory this category includes non-fuel emissions of CO_2 from pig iron production (Table 4-19). 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 4-19. 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 2010 were 4,1 Gg CO_2 eq., and it was only 0,3% 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[22]. 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.

[22] http://db1.stat.gov.lt/statbank/default.asp?w=1440

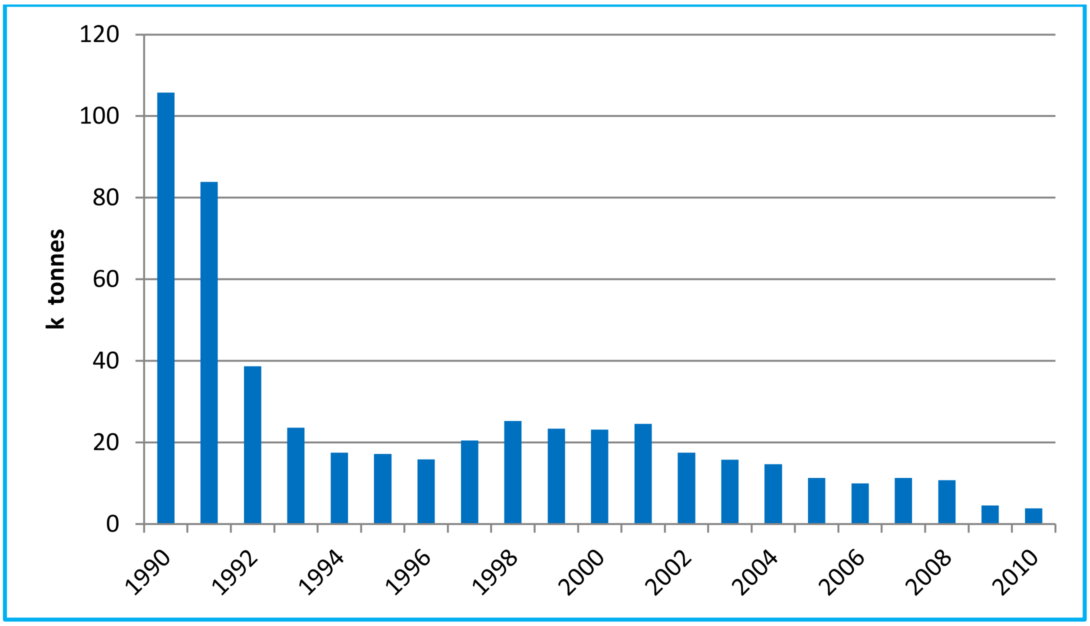


Figure 4-16. Cast iron production, k tonnes

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 4-20.

Table 4-20. 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	5,6
1996	5,5
1997	6,0
1998	6,6
1999	7,0
2000	7,5
2001	7,8
2002	7,2
2003	7,3
2004	7,0

2005	7,2
2006	6,9
2007	6,5
2008	5,0
2009	4,0
2010	4,1

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

No source-specific recalculations were done.

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 4-21). 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 4-21. 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 2010 and it was 0,6% 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 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. Data on the pulp production was provided by AB Klaipėdos kartonas. Variations of pulp production are shown in Figure 4-17.

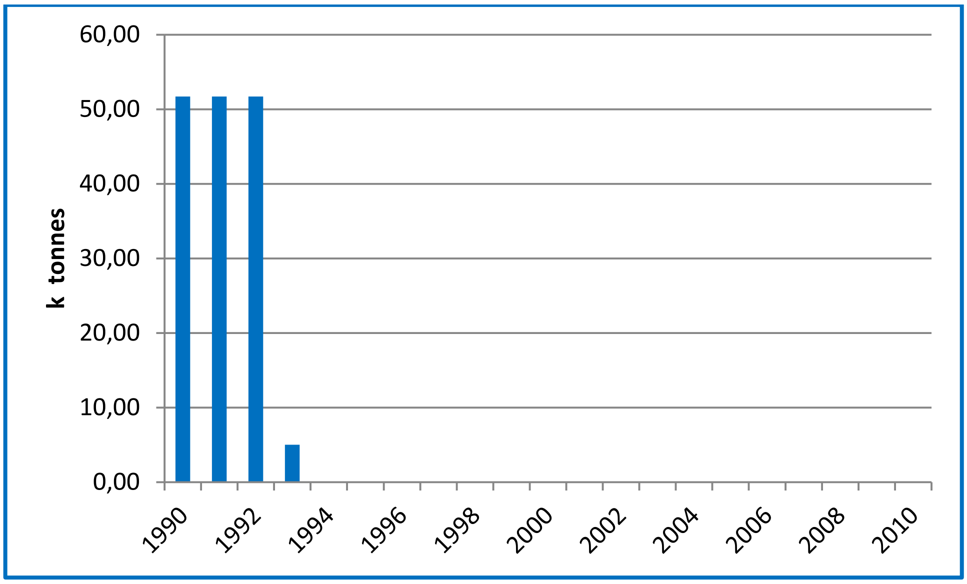


Figure 4-17. Pulp production, k tonnes

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 4-22.

Table 4-22 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
1994-2010	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[23]. Data is available for 2000-2010. 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 4-23).

Table 4-23. Total annual production of beverages, thousand decaliters in 2000-2010

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

[23] http://db1.stat.gov.lt/statbank/default.asp?w=1440

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

Note: Spirits and liqueurs are expressed as 100% alcohol

Average for the period 2000-2010 was used to estimate production of beverages for the period 1990-1999.

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 4-24).

Table 4-24. Total annual production of food products, k tonnes in 2000-2010

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

Average for the period 2000-2010 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 4-25.

Table 4-25. 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 4-26.

Table 4-26. Estimated NMVOC and CO_2 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

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

Data on NMVOC emissions from food and drink production were recalculated for the whole reporting period using statistical data on total annual production. Activity data in previous submission was based on PRODCOM classification and provided double counting for some of the products. CO_2 emissions from food and drink production are reported for the first time in Lithuanian inventory.

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)

According to Article 3.8 of the Kyoto Protocol Lithuania has chosen 1995 as its base year for F-gases.

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 use of equipment and form the destruction of such equipment after use.

General knowledge on use of HFCs and SF_6 in the country is rather low. In 2012 it is planned to carry out a Norway Grants capacity building project between Lithuania and Norway "Cooperation on GHG inventory". The partner of this programme will be Norwegian Climate and Pollution Agency, which is national entity responsible for GHG inventory preparation in Norway. Within the project it is planned to carry out a comprehensive study on use of F-gases in Lithuania. It is expected that this study will cover all remaining reporting gaps in this area, but results of this study will be available of 2013 submission, at the earliest.

Share of GHG emissions from Consumption of Halocarbons and SF_6 is steadily increasing. In 2010 estimated emissions were 183,0 Gg CO_2 eq., 7,7% of the total emissions from the Industrial processes.

Based on the current knowledge major source of GHG emissions in the sub-sector Consumption of Halocarbons and SF6 is mobile air-conditioning (CRF 2.IIA.F.1.6), accounting for approximately 56% of emissions (as CO_2 equivalent). Commercial Refrigeration (CRF 2.IIA.F.1.2) and Transport Refrigeration (CRF 2.IIA.F.1.3) account for 18% and 17% of emissions respectively (as CO_2 equivalent).

Estimated emissions from Consumption of Halocarbons and SF_6 in 1995-2010 are shown in Figure 4-18.

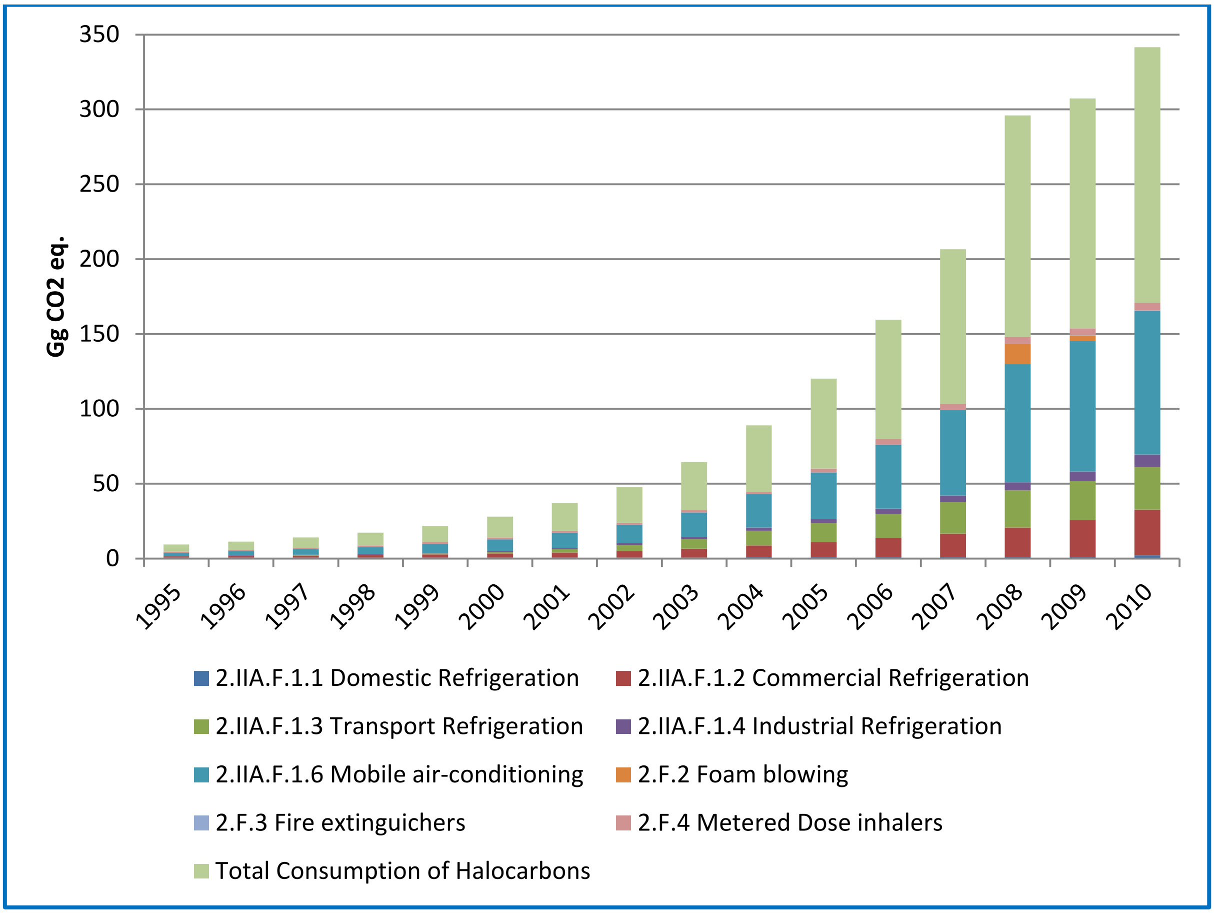


Figure 4-18. Estimated emissions from Consumption of Halocarbons and SF_6, Gg CO_2 eq. in 1995-2010

4.7.1 Refrigeration and air conditioning equipment (CRF 2.F.1)

This section covers emissions of halocarbons from domestic refrigeration, commercial and industrial refrigeration, transport refrigeration and mobile air-conditioning.

4.7.1.1 Source Category Description and Methodological issues

4.7.1.1.1 Domestic Refrigeration

There is one company manufacturing domestic refrigerators in Lithuania (AB Snaigė). The company is producing domestic refrigerators charged with R600a gas and is not using HFCs as a refrigerants for their production. Therefore losses during the erection/ assembly of domestic refrigerators are not relevant for Lithuanian inventory.

Emissions from the stock of HFC-134a in existing domestic refrigerators were estimated using Revised IPCC Guidelines 1996. The following data was used:
number of inhabitants in Lithuania – obtained from Statistics Lithuania;
average size of households in Lithuania – obtained from Statistics Lithuania;
percentage of households using domestic refrigerators – obtained from Statistics Lithuania.

Estimated number of refrigerators charged with F-gases is shown in Figure 4-19.

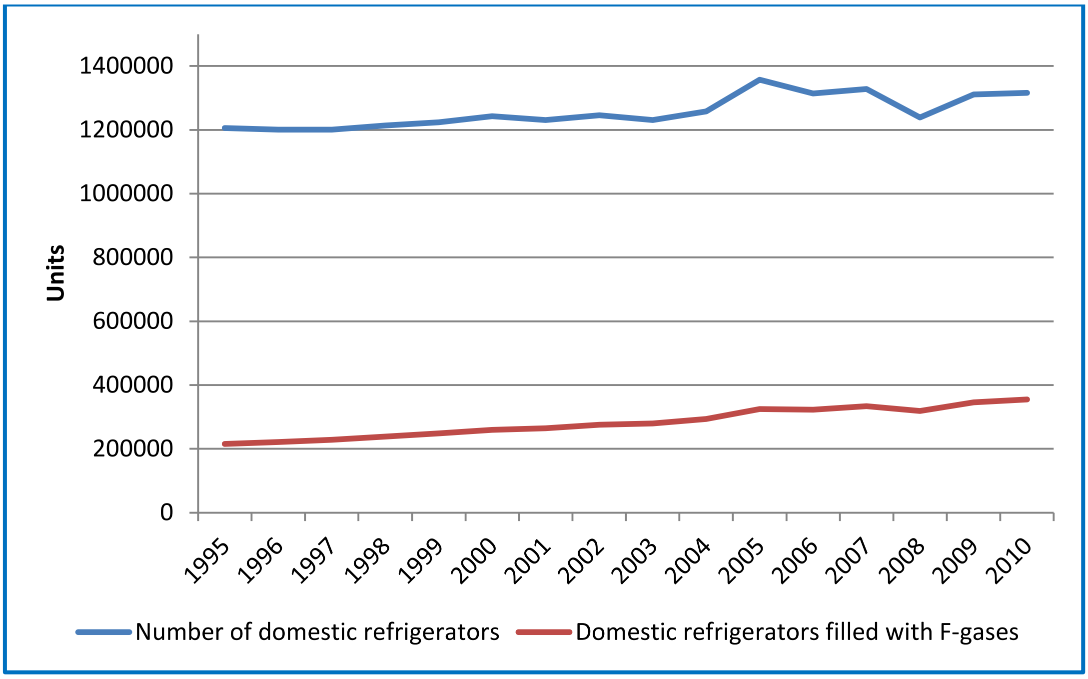


Figure 4-19. Estimated number of domestic refrigerators

Due to absence of sufficient data for calculating the amount of HFC-134a charged in domestic refrigerators and the percentage of domestic refrigerators containing HFC-134a, the following assumptions based on the expert judgment were made:

- the amount of HFC-134a charged in domestic refrigerators is 100 g;
- life time of domestic refrigerator is 20 years (based on the data from company EMP Recycling);
- 18% of domestic refrigerators were filled with HFC-134a in 1995 (based on lab analysis gasses collected from discarded domestic refrigerators, data source EMP Recycling);
- 30% of refrigerators sold in 1995-2010 are filled with HFC-134a;
- Average refrigerant loss per year is 2% of the quantity banked in stock[24].

Annual leakage from the stock in the domestic refrigerators was calculated using following equation (Revised IPCC Guidelines 1996, p. 2.53):

$$E_{operation.\ t} = E_{stock.\ t} \times x$$

where:

$E_{operation.\ t}$ - amount of HFC emitted during system operation in year t;
$E_{stock.\ t}$ - amount of HFC stocked in existing systems in year t;
x - annual leakage rate in per cent of total HFC charge in the stock, per cent

Emissions at system disposal were calculated using the following formula (Revised IPCC Guidelines 1996, p. 2.54):

[24] Default refrigerant loss per year is 1% of the quantity banked in stock according to Revised IPCC Guidelines 1996. The amount was doubled to compensate for refilling of the lost charge.

$$E_{disposal.\ t} = Ei_{charge\ (t-n)} \times (y/100) \times (100-z)/100$$

where:

$E_{disposal.\ t}$ - amount of HFC emitted at system disposal in year t;
$Ei_{charge\ (t-n)}$ - amount of HFC initially charged into new systems installed in year (t-n);
n - average equipment life time, years;
y - amount of HFC in systems at time of disposal in per cent of initial charge, per cent;
z - amount of HFC recovered in per cent of actual charge ("recovery efficiency"), per cent;

Emissions from disposal of domestic refrigerators were calculated starting from 2010. The following factors were used for calculation of emissions at system disposal:

- Average equipment life time is 20 years;
- Amount of HFC in systems at time of disposal is 90% of initial charge;
- Amount of HFC recovered is 20% of actual charge (based on percentage of domestic refrigerators recycled in Lithuania, data source EMP Recycling).

Evaluated emissions of fluorinated gases from domestic refrigeration are provided in Table 4-27.

Table 4-27. Evaluated emissions of fluorinated gases from domestic refrigeration

Year	HFC-134a, tonnes	Total, Gg CO_2 eq.
1995	0,43	0,56
1996	0,44	0,58
1997	0,46	0,59
1998	0,48	0,62
1999	0,50	0,64
2000	0,52	0,67
2001	0,53	0,69
2002	0,55	0,72
2003	0,56	0,73
2004	0,59	0,76
2005	0,65	0,84
2006	0,64	0,84
2007	0,67	0,87
2008	0,64	0,83
2009	0,69	0,90
2010	1,55	2,01

4.7.1.1.2 Commercial and Industrial Refrigeration

A survey of fluorinated gases in Lithuania was conducted in 2008 and the results of the survey were used as a basis for calculation of emissions. The data on use of F-gases were collected by interviewing representatives of most important trade and industry sectors. The representatives were asked also to evaluate the market situation and market share of the company. Evaluated use of fluorinated gases is shown in Table 4-28.

Table 4-28. Evaluated 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 most widely used refrigerant in meat, milk and other food product production and storage systems in eighties. However, these huge systems were not able to survive in early nineties after introduction of market economy and were closed or split to smaller production units. The old refrigeration systems were substituted by the new smaller systems mainly using chlorinated refrigerants such as R-12 and R-22 which also were 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 accession to the EU, it reached 45% annually.

Refrigerant R-410A for air conditioning systems is used in Lithuania from only approximately from 2001. It was evaluated that its amount was increasing by 70%-85% annually.

Estimated use of F-gases is shown in Figure 4-20 and Figure 4-21.

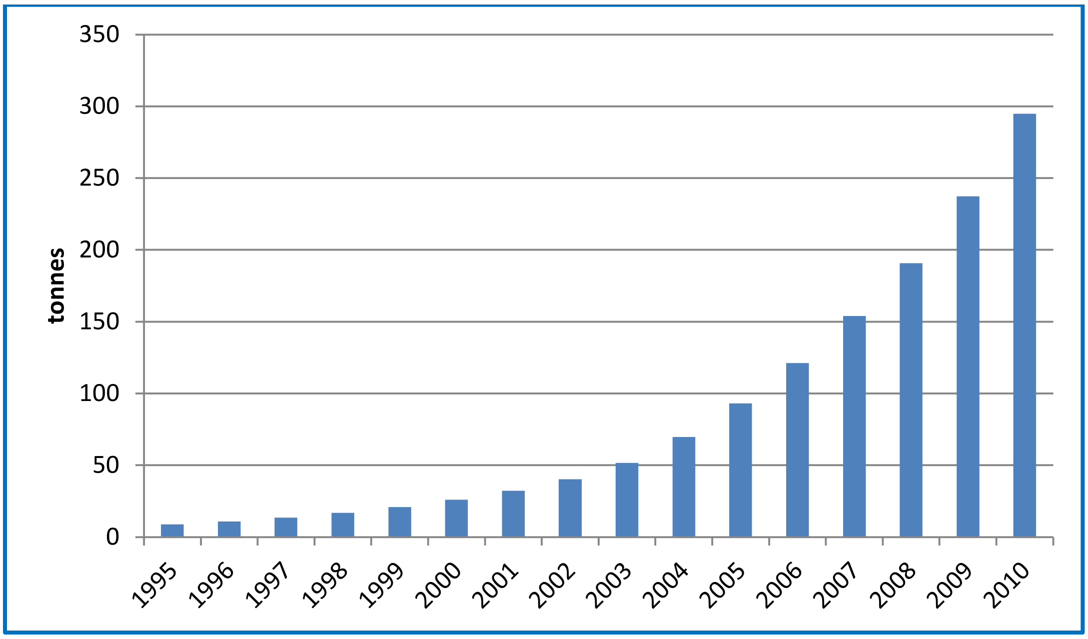


Figure 4-20. Estimated use of R-404a, tonnes in 1995-2010

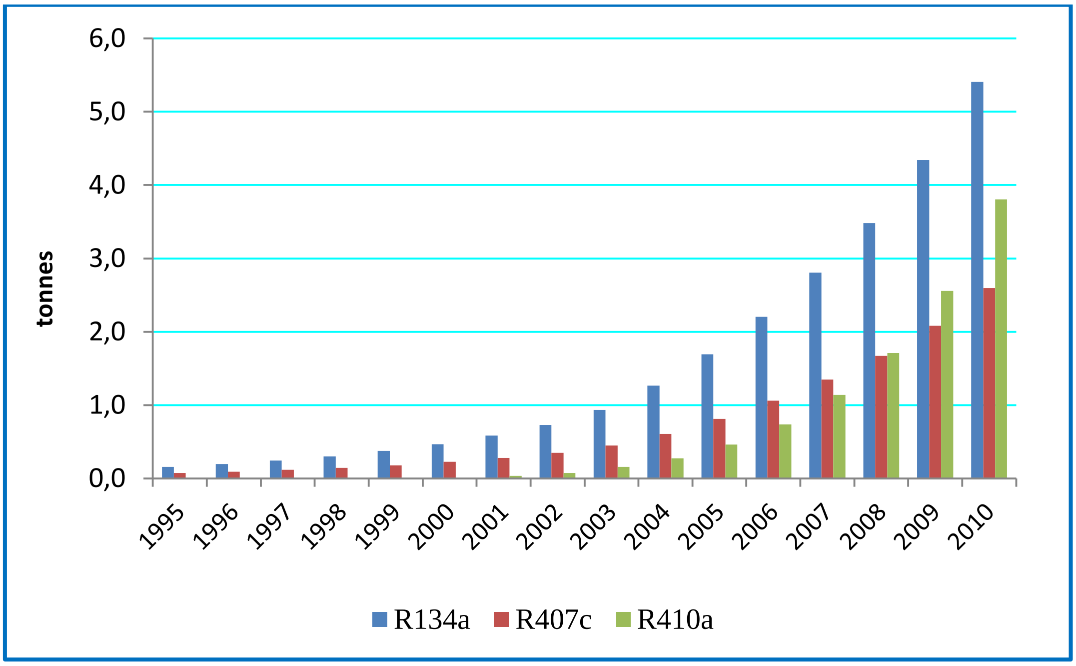


Figure 4-21. Estimated use of F-gases R134a, R407c and R410a, tonnes in 1995-2010

F-gases used separately in commercial and industrial sectors were evaluated by separating reviewed uses into two corresponding groups.

Commercial uses:

- Skating rinks
- Supermarkets
- Other retail enterprises
- Storage facilities

Industrial users:

- 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

Representatives of eight companies involved in installation and operation of equipment containing F-gases were interviewed concerning leakages of F-gases during installation and operation. Leaking during operation was evaluated at approximately 3% of the amount of F-gases in circulation, and leaking during installation and refilling was evaluated at approximately 4%.

Evaluated emissions of fluorinated gases from commercial and industrial refrigeration are provided in Table 4-29.

Table 4-29. Evaluated emissions of fluorinated gases from commercial and industrial refrigeration

	Commercial					Industrial				
Year	**HFC-32, t**	**HFC-125, t**	**HFC-134a, t**	**HFC-143a, t**	**Total, Gg CO_2 eq.**	**HFC-32, t**	**HFC-125, t**	**HFC-134a, t**	**HFC-143a, t**	**Total, Gg CO_2 eq.**
1995	NO	0,121	0,016	0,143	**0,90**	0,001	0,033	0,005	0,038	**0,24**
1996	NO	0,151	0,020	0,178	**1,12**	0,001	0,041	0,007	0,047	**0,30**
1997	NO	0,187	0,025	0,221	**1,40**	0,001	0,051	0,008	0,059	**0,38**
1998	NO	0,233	0,031	0,275	**1,74**	0,001	0,063	0,010	0,073	**0,47**
1999	NO	0,289	0,039	0,342	**2,16**	0,002	0,079	0,013	0,091	**0,58**
2000	NO	0,359	0,049	0,425	**2,68**	0,002	0,098	0,016	0,113	**0,73**
2001	0,001	0,448	0,060	0,528	**3,34**	0,003	0,122	0,020	0,140	**0,90**
2002	0,003	0,581	0,078	0,683	**4,33**	0,003	0,157	0,026	0,182	**1,17**
2003	0,005	0,796	0,107	0,935	**5,92**	0,005	0,215	0,036	0,249	**1,60**
2004	0,008	1,061	0,142	1,244	**7,89**	0,006	0,286	0,047	0,331	**2,12**
2005	0,012	1,374	0,184	1,610	**10,21**	0,008	0,371	0,061	0,428	**2,75**
2006	0,019	1,740	0,233	2,033	**12,91**	0,010	0,468	0,078	0,541	**3,47**
2007	0,028	2,145	0,287	2,501	**15,9**	0,012	0,576	0,096	0,665	**4,27**
2008	0,043	2,679	0,358	3,115	**19,83**	0,015	0,717	0,119	0,828	**5,32**
2009	0,063	3,339	0,445	3,871	**24,68**	0,019	0,891	0,148	1,029	**6,61**
2010	0,094	4,166	0,553	4,813	**30,73**	0,024	1,108	0,184	1,279	**8,22**

As F-gases from used fire extinguishing equipment currently are not collected or destructed, it was assumed that potential emissions of fluorinated gases are equal to the annual increases of F-gases in fire extinguishing equipment.

4.7.1.1.3 Transport Refrigeration

HFC emissions from transport refrigeration were estimated using Revised IPCC Guidelines 1996 methodology. The assessment is based on a number of transport refrigeration units registered in Lithuania. Data on number of transport refrigeration units registered in Lithuania by year of manufacture was obtained from the State Enterprise REGITRA. The vehicle registration covers period 2002-2010.

Number of transport refrigeration units in 1995-2001 was estimated on the basis of the trend in 2002-2010. Estimated number of transport refrigeration units including vehicles produced in 1993 and newer during 1995-2010 is presented in Figure 4-22.

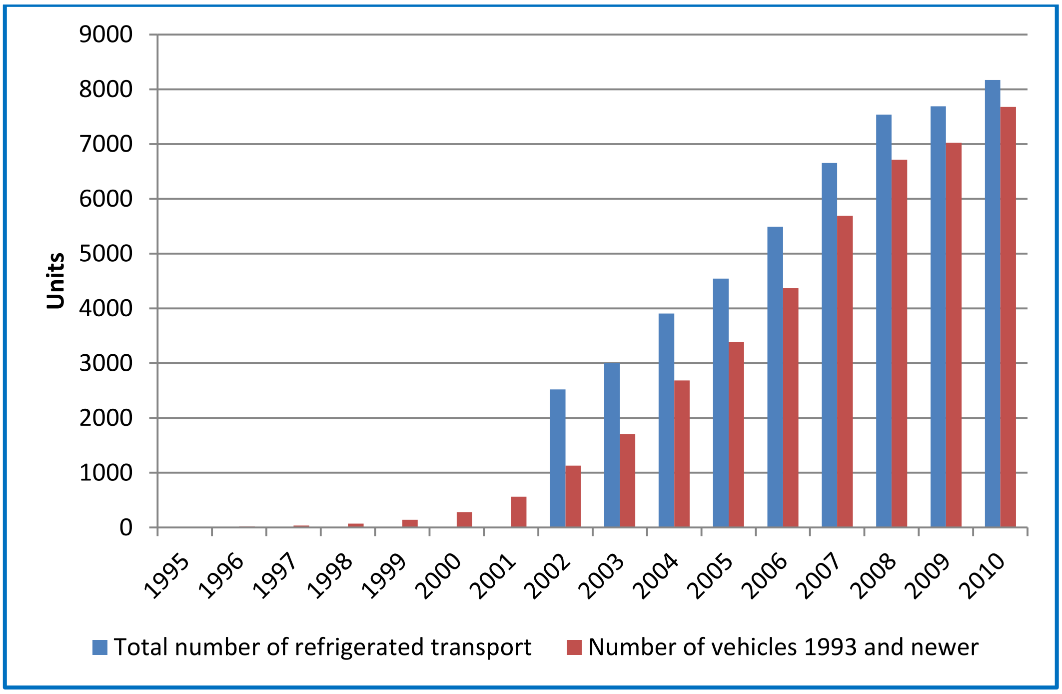


Figure 4-22. Estimated number of transport refrigeration units in 1995-2010

The typical refrigerant charges in transport refrigeration unit is 8 kg and operation lifetime of the of the unit is 15 years. Average percentage of losses during operation lifetime is 17% of the total quantity banked in the stock. Amount of HFC emitted at system disposal is 90%.

Average composition of gases (by weight) in the transport refrigeration units was obtained from the maintenance companies: HFC-125 – 32%, HFC-134a – 30% and HFC-143a – 38%.
Evaluated emissions of fluorinated gases from transport refrigeration are provided in Table 4-30.

Table 4-30. Evaluated emissions of fluorinated gases from transport refrigeration

Year	HFC-125, t	HFC-134a, t	HFC-143a, t
1995	0,004	0,004	0,005
1996	0,008	0,007	0,009
1997	0,016	0,015	0,019
1998	0,031	0,029	0,037
1999	0,061	0,058	0,073
2000	0,123	0,115	0,146
2001	0,245	0,230	0,291
2002	0,490	0,460	0,582
2003	0,744	0,697	0,883
2004	1,168	1,095	1,387
2005	1,474	1,381	1,750
2006	1,901	1,783	2,258
2007	2,476	2,321	2,940
2008	2,920	2,738	3,468
2009	3,055	2,864	3,627
2010	3,360	3,150	3,991

4.7.1.1.4 Mobile Air-Conditioning

HFC-134a emissions from mobile air conditioning were estimated using Revised IPCC Guidelines 1996 methodology. The assessment is based on a number of vehicles registered in Lithuania. Data on number of vehicles registered in Lithuania by year of manufacture and vehicle type was obtained from the State Enterprise REGITRA. The vehicle registration covers period 2002-2010.

Total number and age distribution of vehicles in 1990-2001 was estimated on the basis of 2002 registration data and trend in 2002-2006:

Personal cars (M1)	annual increase by 2.0%
Busses <5t (M2)	annual decrease by 2.9%
Busses >5t (M3)	annual increase by 1.3%
Trucks <3.5t (N1)	annual increase by 0.9%
Trucks 3.5t - <12t (N2)	annual decrease by 3.6%
Trucks >12t (N3)	annual increase by 7.6%

Age distribution of the fleet was based on 2002-2006 average (separately for each vehicle type listed above). Percentage of cars equipped with air-conditioning by vehicle type and year of manufacture was estimated based on interview of car distributors (Table 4-31).

Table 4-31. Estimated percentage of cars equipped with air-conditioning by the year of manufacture

Year of manufacture	Personal cars	Busses <5t	Busses >5t	Trucks <3.5t	Trucks 3.5t	Trucks >12t
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%

Estimated number of vehicles equipped with air conditioning units is presented in Figure 4-23.

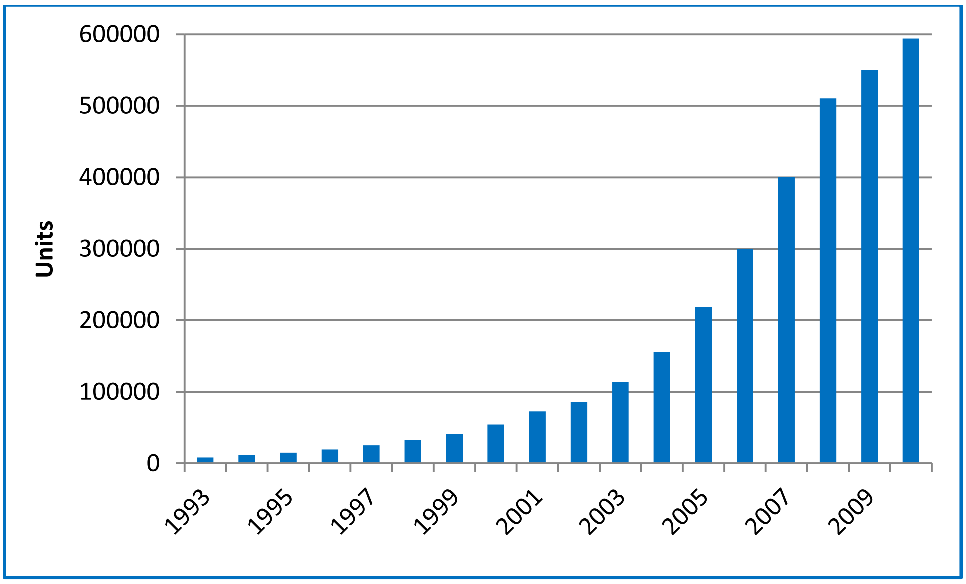


Figure 4-23. Estimated number of vehicles equipped with air conditioning units in 1993-2010

The typical refrigerant charges in mobile air conditioners were obtained from refrigerant refill companies (corresponding to IPCC 2006 Guidelines page 7.57):
0,7 kg/unit for personal cars, Busses <5 t and Trucks <3,5 t and
1,2 kg/unit for Busses >5 t, Trucks > 3,5 t

Operation lifetime of the mobile air conditioning unit is 15 years. Average percentage of losses during operation lifetime is 15% of the total quantity banked in the stock (Revised IPCC 1996

Guidelines, p. 2.57). Mobile air conditioning units are primarily filled with HFC-134a. Amount of HFC emitted at system disposal is 90%.

Annual leakage from the stock is calculated using the following equation (Revised IPCC 1996 Guidelines, p. 2.53):

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

where:

$E_{operation}$ - amount of emissions during equipment operation, t;
E_{stocks} - amount of f-gases held in stocks in year, t;
x - losses during operation period, %.

Evaluated emissions of fluorinated gases from mobile air-conditioning are provided in Table 4-32.

Table 4-32. Evaluated emissions of fluorinated gases from mobile air-conditioning

Year	HFC-134a, t	Total, Gg CO_2 eq.
1995	1,66	2,16
1996	2,15	2,80
1997	2,77	3,60
1998	3,56	4,63
1999	4,58	5,95
2000	5,97	7,77
2001	7,95	10,34
2002	9,36	12,17
2003	12,46	16,19
2004	17,11	22,24
2005	23,95	31,14
2006	32,84	42,69
2007	43,84	57,00
2008	60,74	78,96
2009	66,82	86,87
2010	73,84	95,99

4.7.1.2 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 10%;
- Emission factor uncertainty is assumed to be 50%;
- Combined uncertainty is 51,0%.

The data is consistent over the time-series.

4.7.1.3 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.

4.7.1.4 Source-specific recalculations

Emissions from the mobile air conditioning were recalculated using updated calculation method to account for the age of air conditioning units. The whole time series is covered in the current submission.

Emissions from the domestic refrigeration were recalculated using updated calculation method to account for the age of refrigeration units and refilling of the lost charge. Emissions were recalculated for the whole time series.

Gap in reporting on potential emissions was filled. In this submission potential emissions cover Domestic Refrigeration, Commercial Refrigeration, Transport refrigeration, Industrial Refrigeration and Mobile Air-Conditioning.

4.7.1.5 Source-specific planned improvements

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 is needed in order to complement GHG inventory and collect more detailed information on F-gases use in Lithuania during 1990-2010. To improve F-gases estimates in GHG inventory, a study to determine the quantity of fluorinated gases (HFCs, PFCs and SF6) use in Lithuania during 1990-2011 was initiated in 2012. It is expected that this study will cover all remaining reporting gaps in this area (F-gases emissions for the years 1990–1994), improved methods for emissions calculations and recommendations how to enhance F-gases data collection system will be developed. Procurement procedure for this study was started in April 2012. Study results are to be ready in August 2012.

According to the Order of the Minister of Environment (MoE) issued in 2008, users of F-gases provided initial data on imports and use of F-gases in 2009. However, collected data was not complete, data providers from industrial companies have misunderstood certain requirements included in the Order of the MoE. Existing reporting requirements were analysed, reviewed and amendment of the Order of the MoE was approved (17-01-2012 MoE Order No D1-42) with a number of changes introduced aiming to improve the quality of the reports, making them more suitable to use for the F-gases emission estimates. In addition, a workshop for industries importing and using F-gases took place in November 2011. EPA will install electronic data base for the compilation of F-gases data forms by data providers via internet in 2012.

4.7.2 Foam Blowing (CRF 2.F.2)

4.7.2.1 Source Category Description and Methodological issues

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 total amount of material used and composition of the F-gases (HFC-365 mfc, HFC-134a, HFC-245fa, HFC-227ea). According to the data providers, use of foams containing HFCs in Lithuania started approximately in 2005. Actual amounts of F-gases used for the foam blowing were not disclosed by the producers, therefore it was assumed that fluorinated gases constitute 5% of the foam material by weight.
Emission of F-gases from the closed-cell foam is calculated using the following equation (IPCC 2000 Guidelines, p. 3.93):

$$E_{closed\text{-}cell\ foam} = E_{HFC} \times EF_{1st\ yr} + [Ei_{charge\ (t-n)} \times EF] - E_{destroyed}$$

where:
$E_{closed\text{-}cell\ foam}$- Emissions from Closed-cell Foam;
E_{HFC} - amount of total HFCs used in manufacturing new closed cell foam in year t;
$Ei_{charge\ (t-n)}$ – amount of original HFC charge blown into closed-cell foam manufacturing between year t and year (t-n);
$EF_{1st\ yr}$ - first-year loss Emission Factor;
EF - annual loss Emission Factor;
$E_{destroyed}$ – amount of destroyed HFC;
n – product life time of closed-cell foam, years

The following default emission factors were used (IPCC 2000 Guidelines, p. 2.96, table 3.17):
Product Lifetime n = 20 years
First Year Losses 10% of the original HFC or PFC charge/year.
Annual Losses 4.5% of the original HFC or PFC charge/year
HFC destroyed was assumed to be zero.

Evaluated emissions of fluorinated gases from foam blowing are provided in Table 4-33.

Table 4-33. Evaluated emissions of fluorinated gases from imported foam products

Year	HFC-365mfc, t	HFC-134a, t	HFC 245fa, t	HFC227ea, t	Total, Gg CO_2 eq,
2005	0,07	0,00	0,07	0,09	0,43
2006	0,03	0,01	0,33	0,04	0,50
2007	0,12	0,01	0,25	0,16	0,91
2008	0,18	0,01	0,21	0,21	1,10
2009	0,16	0,02	0,24	0,19	1,08
2010	0,19	0,04	0,27	0,22	1,25

4.7.2.2 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 50%;
- Emission factor uncertainty is assumed to be 50%;
- Combined uncertainty is 70,7%.

4.7.2.3 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.

4.7.2.4 Source-specific recalculations

Emission of HFC-365mfc, HFC-134a, HFC 245fa and HFC227ea was estimated for the period 2005-2010 based on newly collected activity data. In previous submission emission of F-gases from foam blowing was estimated based on emission rate from a cluster of countries.

4.7.2.5 Source-specific planned improvements

To improve F-gases estimates, a study to determine the quantity of fluorinated gases (HFCs, PFCs and SF_6) use in Lithuania during 1990-2011 was initiated in 2012. It is expected that this study will cover all remaining reporting gaps, improved methods for emissions calculations and recommendations how to enhance F-gases data collection system will be developed. Procurement procedure for this study was started in April 2012. Study results are to be ready in August 2012.

4.7.3 Fire Extinguishers (CRF 2.F.3)

4.7.3.1 Source Category Description and Methodological issues

The first data on use of HFCs were collected by Lithuanian Environmental Protection Agency in 2010 covering 2009. According to the data, total amount of fluid in fire extinguishing equipment was 2270 kg of HFC-134a, 544 kg of HFC125 and 537 kg of HFC227ea in 2010. According to the data providers, use of HFCs in fire extinguishing equipment in Lithuania started approximately in 2000.

Based on this data it was assumed that the amount of HFCs in fire extinguishing equipment since 2000 was increasing annually by 90% (i.e. 45% of the total amount of HFCs at the end of a current year were added during that year).

Same as in case of refrigeration, leaking from equipment was evaluated at approximately 3% of the amount of F-gases, and leaking during installation and refilling was evaluated at approximately 4%.

Evaluated emissions of fluorinated gases from fire extinguishing equipment are provided in Table 4-34.

Table 4-34. Evaluated emissions of fluorinated gases from fire extinguishing equipment

Year	HFC-125, t	HFC-134a, t	HFC227ea, t	Total, Gg CO2 eq,
2000	0,0001	0,0003	0,0000	0,0007
2001	0,0001	0,0005	0,0000	0,0010
2002	0,0002	0,0009	0,0001	0,0019
2003	0,0004	0,0017	0,0001	0,0036
2004	0,0007	0,0032	0,0003	0,0069
2005	0,0013	0,0060	0,0007	0,0134
2006	0,0025	0,0115	0,0014	0,0258

2007	0,0047	0,0218	0,0030	0,0499
2008	0,0089	0,0413	0,0062	0,0966
2009	0,0124	0,1098	0,0130	0, 2154
2010	0,0243	0,0947	0,0274	0,2706

4.7.3.2 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 20%;
- Emission factor uncertainty is assumed to be 50%;
- Combined uncertainty is 53,9%.

4.7.3.3 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.

4.7.3.4 Source-specific recalculations

HFC227ea emissions were estimated for the period 2000-2010. Estimates are based on 2009-2010 activity data collected by Environmental Protection Agency.

4.7.3.5 Source-specific planned improvements

To improve F-gases estimates, a study to determine the quantity of fluorinated gases (HFCs, PFCs and SF_6) use in Lithuania during 1990-2011 was initiated in 2012. It is expected that this study will cover all remaining reporting gaps, improved methods for emissions calculations and recommendations how to enhance F-gases data collection system will be developed. Procurement procedure for this study was started in April 2012. Study results are to be ready in August 2012.

4.7.4 Aerosols/Metered Dose Inhalers (CRF 2.F.4)

4.7.4.1 Source Category Description and Methodological issues

Emissions from metered dose inhalers were estimated using IPCC Guidelines 1996 methodology. Data on total annual sales of metered dose inhalers containing HFCs and specific HFC-134a quantity initially charged in product was obtained from State Medicines Control Agency under the Ministry of Health of Republic of Lithuania.

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 assumption that emission in 1995 constituted 50% of emission in 2004.

Total amount of HFC-134a used in metered dose inhalers was calculated as follows:

$$HFC_{sold} = \sum MDI_{sold} \times HFC_{filled} / 1000000$$

where:

HFC_{sold} – total amount of HFC sold in country, tonnes
MDI_{sold} – number of metered dose inhalers of particular type, sold in particular year
HFC_{filled} – amount of F-gases filled in particular type of the dose inhaler, g

Emissions of HFC in a particular year were calculated using the following equation (Revised IPCC 1996 Guidelines, p 2.61):

$$E_{HFC's\ t} = 50\%\ HFC_{sold\ t} + 50\%\ HFC_{sold\ t-1}$$

where:
$E_{HFC's\ t}$ – total emissions of HFC-134a from metered dose inhalers in a year t, tonnes
$HFC_{sold\ t}$ – quantity of HFC contained in aerosols sold in a year t
$HFC_{sold\ t-1}$ – quantity of HFC contained in aerosols sold in a year t-1

Evaluated emissions of fluorinated gases from metered dose inhalers are provided in Table 4-35.

Table 4-35. Evaluated emissions of fluorinated gases from aerosols/metered dose inhalers

Year	HFC-134a, t	Total, Gg CO_2 eq,
1995	0,59	0,77
1996	0,64	0,83
1997	0,69	0,90
1998	0,75	0,97
1999	0,81	1,05
2000	0,87	1,13
2001	0,94	1,22
2002	1,02	1,32
2003	1,10	1,43
2004	1,19	1,54
2005	1,98	2,58
2006	2,75	3,58
2007	3,15	4,09
2008	3,54	4,60
2009	3,40	4,42
2010	3,95	5,13

Potential emissions from the use of metered dose inhalers were estimated assuming that 100% of HFC-134a filled in inhalers sold in country in particular year is emitted to the air.

4.7.4.2 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 5%;
- Emission factor uncertainty is assumed to be 50%;
- Combined uncertainty is 50,2%.

Data is consistent over the time-series.

4.7.4.3 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.

4.7.4.4 Source-specific recalculations

No source-specific recalculations were done.

4.7.4.5 Source-specific planned improvements

No source-specific improvements have been planned.

4.7.5 Solvents and Other Applications Using ODS Substitutes (CRF 2.F.5 & 2.F.6)

During survey of fluorinated gases in 2008 no possible sources from "Solvents" were identified in Lithuania, therefore notation keys „NA" (1990-1994) and „NO" (1995-2010) are used.

SF_6 is used from 2008 in one plant in Lithuania as gaseous insulator for testing semiconductor equipment. All used SF_6 is emitted to the environment. This emission was reported under the „2.F.6 Other" subcategory.

4.7.6 Semiconductor Manufacture (CRF 2.F.7)

There is one company in Lithuania producing semiconductors. F-gases are not being directly used in semiconductors manufacture processes, therefore emission reported as „NA" (1990-1994) and „NO" (1995-2010) are used.

4.7.7 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.

4.7.7.1 Source Category Description and Methodological issues

Data on use and emissions of SF_6 was collected directly from electricity transmission and distribution network operators. AB Lietuvos energija operates high voltage lines in entire territory of Lithuania and AB LESTO is a distribution network operator and distributes and transmits electrical power throughout the entire territory of Lithuania (low and medium voltage lines and equipment). AB LESTO was created in 2011 by merge of two regional distribution network operators AB Rytų skirstomieji tinklai and AB Vakarų skirtomieji tinklai. According to the Order of the Minister of Environment all operators have obligation to report consumption of SF_6 if amount of SF_6 in installations exceed 3kg.

Estimated SF_6 emissions in Lithuania are provided in Figure 4-24.

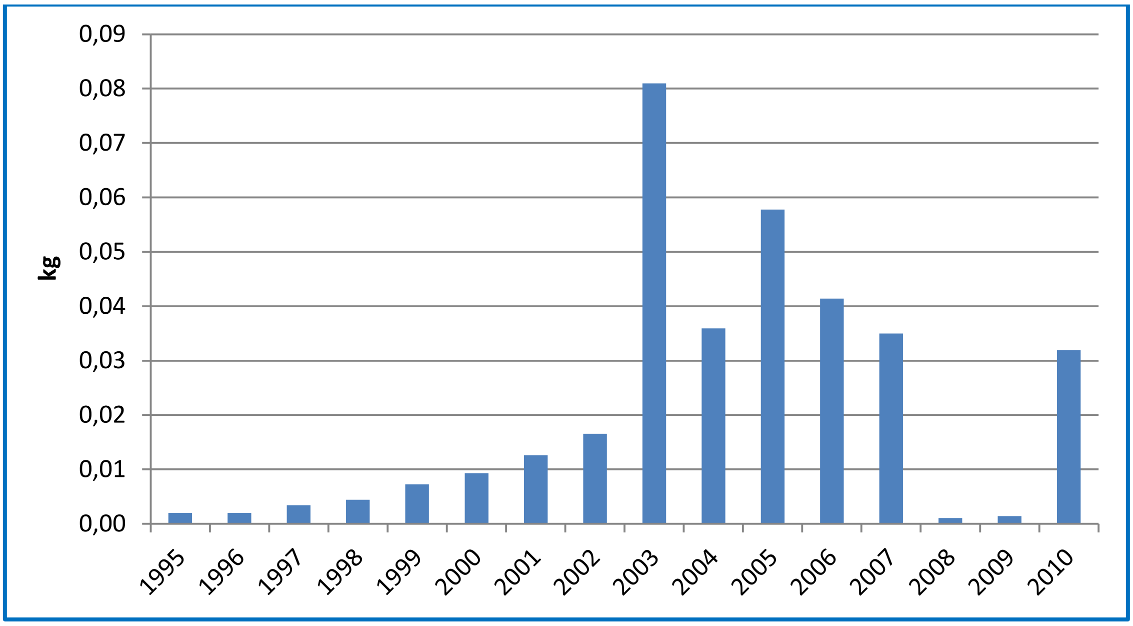


Figure 4-24. Estimated emissions of SF_6 from electrical equipment, kg in 1995-2010

4.7.7.2 Uncertainties and time-series consistency

The data is consistent over the time-series.

4.7.7.3 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.

4.7.7.4 Source-specific recalculations

No source-specific recalculations were done.

4.7.7.5 Source-specific planned improvements

To improve F-gases estimates, a study to determine the quantity of fluorinated gases (HFCs, PFCs and SF_6) use in Lithuania during 1990-2011 was initiated in 2012. It is expected that this study will cover all remaining reporting gaps, improved methods for emissions calculations and recommendations how to enhance F-gases data collection system will be developed. Procurement procedure for this study was started in April 2012. Study results are to be ready in August 2012.

5 SOLVENT AND OTHER PRODUCTS USE (CRF 3)

Solvent and other products use contribute a small amount to GHG emissions in Lithuania. Share of total emissions was only 0,4% in 2010 (excluding 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 the Lithuanian Environmental Protection Agency. The NMVOC inventory is carried out to meet the obligations of the UNECE Convention on Long-range Transboundary Air Pollution.

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 5-1).

Table 5-1. NMVOC emission factors

Subsectors	**NMVOC emission factors, kg/cap/year**
Paint application	4,5
Industrial degreasing	0,85
Dry cleaning	0,313
Graphic arts	0,65
Glues and adhesives	0,6
Domestic solvent use	1,8

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.

$$Emission_{CO2} = Emission_{NMVOC} \times 0,85 \times 44/12$$

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 5-2.

Table 5-2. CO_2, N_2O and NMVOC emissions (Gg) from solvents and other products use for the period 1990-2010

Year	CO_2 emission	NMVOC emission	N_2O emission
1990	100,50	32,22	0,31
1991	100,59	32,27	0,31
1992	100,48	32,24	0,30
1993	100,0	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	94,54	30,33	0,25
2002	94,21	30,23	0,24
2003	93,80	30,10	0,24
2004	93,30	29,93	0,23
2005	92,72	29,75	0,22
2006	92,17	29,57	0,13
2007	91,67	29,41	0,10
2008	91,19	29,26	0,01
2009	90,68	29,09	0,03
2010	89,25	28,64	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

No source-specific recalculations were done.

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 and cultivation of organic soils. 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 the 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 categories in agriculture sector shown by level (L) and trend (T), (excl. LULUCF) in 2010

IPCC source category	Gas	Identification criteria
4.A. Enteric Fermentation, cattle	CH_4	L, T
4.B. Manure Management swine	CH_4	L
4.B. Manure Management, cattle	CH_4	L
4.B. Manure Management	N_2O	L, T
4.D.1. Direct Soil Emissions Crop residues	N_2O	L
4.D.1. Direct Soil Emissions manure fertilizers	N_2O	L
4.D.1. Direct Soil Emissions synthetic N fertilizer	N_2O	L, T
4.D.2. Pasture, Range and Paddock Manure	N_2O	L
4.D.3. Indirect Emissions	N_2O	L

Emissions were evaluated using methods proposed in the Revised 1996 IPCC Guidelines, IPCC Good Practice Guidance 2000 and IPCC Guidelines for National Greenhouse Gas Inventories 2006. About 4458,3 Gg CO_2 eq. of GHG emissions in Lithuania originated from agriculture sector in 2010. The major part of GHG emissions is related to the agricultural soils (Figure 6-1).

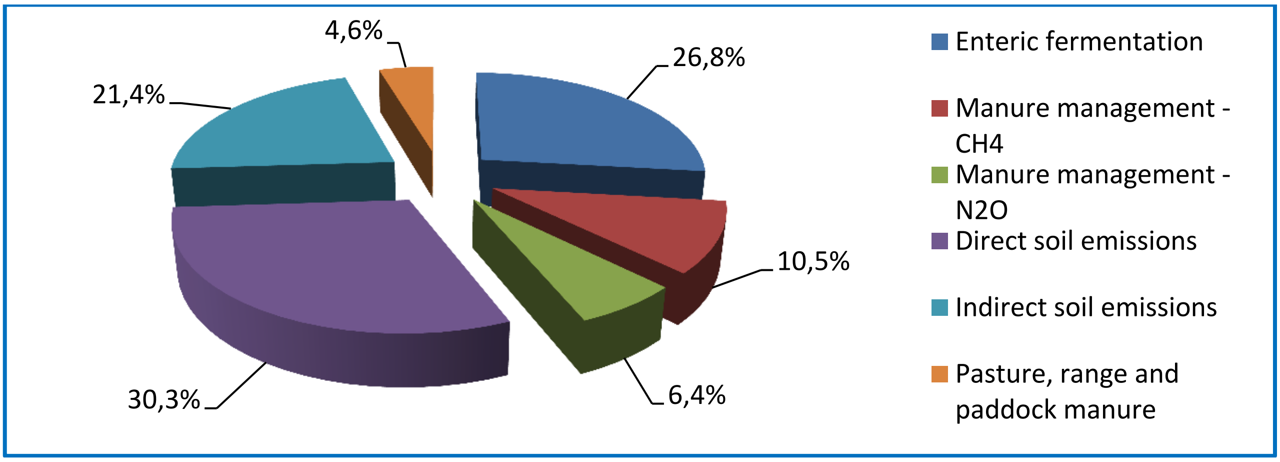


Figure 6-1. The share of aggregated emissions (%) by categories from key sources within the sector in 2010

[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

N_2O emissions contributed 65,7% 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 2010 emissions from agriculture have decreased by 55,3% (Figure 6-2, Table 6-2).

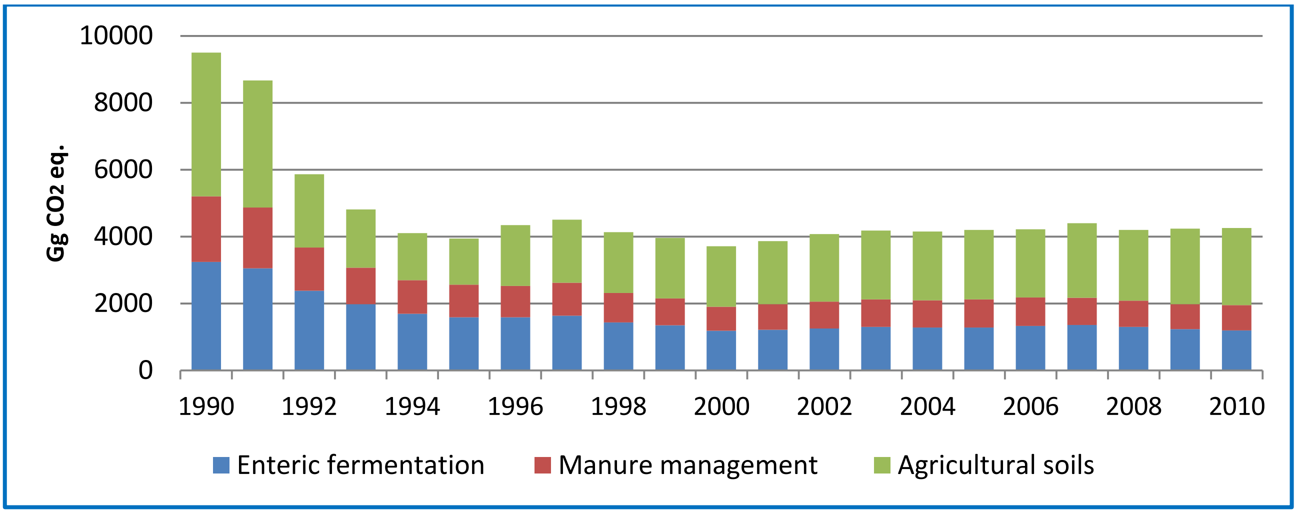


Figure 6-2. The trend in aggregated emissions by categories within the sector in 1990-2010 (Gg CO_2 eq.)

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 in agriculture by sources in 1990-2010 (Gg CO_2 eq.)

Year	Enteric fermentation	Manure management		Agricultural soils	
				Direct	Indirect
	CH_4	CH_4	N_2O	N_2O	N_2O
1990	3238,9	1095,0	873,5	2415,0	1878,5
1991	3051,7	1013,1	808,5	2140,8	1651,4
1992	2377,6	702,5	597,9	1205,7	980,3
1993	1977,0	611,1	486,7	1003,5	733,6
1994	1693,7	592,8	414,4	796,4	607,3
1995	1591,8	584,9	385,8	804,3	578,4
1996	1591,3	552,0	380,0	1086,9	732,2

1997	1639,4	588,0	390,5	1132,4	755,0
1998	1438,4	540,8	340,2	1099,5	717,6
1999	1353,2	479,8	317,5	1075,0	734,1
2000	1191,1	430,6	277,7	1101,5	713,8
2001	1218,0	479,5	286,9	1138,7	746,7
2002	1255,9	506,3	297,2	1204,9	813,5
2003	1298,2	514,0	309,3	1223,8	832,2
2004	1280,1	512,8	306,9	1217,8	836,8
2005	1284,8	521,5	313,2	1224,2	852,9
2006	1327,0	528,1	323,0	1161,9	875,3
2007	1355,5	493,4	323,1	1305,4	924,6
2008	1301,5	481,0	307,1	1244,1	865,4
2009	1234,2	458,1	291,2	1348,2	902,3
2010	1195,0	466,8	287,9	1352,6	952,2

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% 1999 comparing to 1998 and could have an impact on milk productivity indicators. Overall, during 1990-2010 period dairy cattle productivity increased by 30%.

Table 6-3. Milk yield average per cow, kg

Year	Milk yield
1990	3 734
1991	3 481
1992	3 080
1993	2 910
1994	2 925
1995	3 010
1996	3 093
1997	3 205
1998	3 384
1999	3 228
2000	3 673
2001	3 903
2002	4 003
2003	4 015
2004	4 176
2005	4 312

2006	4 484
2007	4 708
2008	4 778
2009	4 811
2010	4 901

Climatic conditions
Lithuanian climate belongs to Atlantic forest area in the continental southwest region. Except the Baltic coastal region 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 given 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 snow thickness increased by 0,8-2 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 IPCC Guidelines[27], the relevant quantities are considered as negligible and are not calculated, however population of poultry is presented in Table 6-4 as it will be used in section "Manure management" Activity data have been taken from Statistics Lithuania (agriculture section)[28] and from the register of Agricultural Information and Rural Business Centre[29]. Animal population figures used in the inventory are shown in Table 6-4. The number of dairy cattle in 2010 decreased by 57,9% comparing with 1990. In the same time non-dairy cattle population decreased by 76,1%, population of horses decreased by 44,1%, swine population – by 61,8%. The number of sheep population decreased by 1,2%, goats population increased by 207,7%.

[26] Lithuania's Fifth National Communication under the United Nations Framework Convention on Climate Change. Vilnius, January 2010
[27] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories
[28] Statistics Lithuania: http://www.stat.gov.lt/en/
[29] State enterprise Agricultural Information and Rural Business Centre: http://www.vic.lt/

Table 6-4. Animal population data 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

CH_4 emissions are primarily related to cattle, which, in 2010, contributed 95,6% of the total emission from enteric fermentation. In 2010 dairy cattle produced 64.0% and non-dairy cattle – 31,6% of CH_4 emissions from enteric fermentation. The share of other livestock was small. Emission from swine made 1,7 %, horses – 1,4%, sheep and goats – 1,1% of the total emission from enteric fermentation.

CH_4 emission from enteric fermentation comprised 71,9% of the total CH_4 emission from livestock and 26,8% of the total agriculture emissions. In 2010, comparing with 2009, CH_4 emission from enteric fermentation decreased by 3,2%. During the period 1990-2010 CH_4 emission from enteric fermentation decreased by 63,1% (Table 6-5).

Table 6-5. CH_4 emissions from enteric fermentation by livestock categories in 1990-2010 (Gg)

Year	Cattle		Sheep	Goats	Horses	Swine	Rabbits, nutria and fur-bearing animals
	Dairy	Non-dairy					
1990	76,35	73,15	0,59	0,03	1,44	2,62	0,07

1991	73,32	67,47	0,60	0,03	1,49	2,35	0,07
1992	62,06	47,62	0,53	0,04	1,43	1,46	0,07
1993	55,88	34,92	0,48	0,05	1,46	1,29	0,07
1994	50,76	26,57	0,43	0,06	1,41	1,36	0,06
1995	48,88	23,69	0,34	0,07	1,40	1,37	006
1996	49,69	22,95	0,30	0,08	1,47	1,21	0,07
1997	52,52	22,38	0,27	0,09	1,41	1,31	0,08
1998	47,19	18,38	0,17	0,12	1,34	1,23	0,07
1999	42,37	19,37	0,14	0,12	1,35	1,03	0,06
2000	39,55	14,73	0,12	0,12	1,23	0,92	0,05
2001	40,77	14,70	0,13	0,12	1,16	1,08	0,05
2002	41,30	15,96	0,14	0,11	1,09	1,15	0,05
2003	41,92	17,25	0,17	0,14	1,14	1,13	0,07
2004	41,36	16,87	0,23	0,13	1,14	1,14	0,07
2005	40,21	18,19	0,30	0,11	1,13	1,17	0,08
2006	39,23	21,17	0,37	0,10	1,10	1,15	0,08
2007	40,12	21,76	0,52	0,10	1,01	0,97	0,08
2008	40,18	19,16	0,54	0,08	0,98	0,96	0,08
2009	38,02	18,24	0,55	0,07	0,88	0,93	0,08
2010	36,40	17,98	0,57	0,08	0,80	0,98	0,08

The overall reduction of CH_4 emission was caused by decrease in total number of livestock (excluding 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 population of livestock. Cattle are a key source due to the contribution to total greenhouse gas emission. Therefore the Tier 2 method was used for estimating 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	IPCC
Nutria				Tier 1	IPCC
Fur-bearing animals				Tier 1	IPCC, Modified

* 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 data of the Register of Agricultural Information and Rural Business Centre and the data from Statistics Lithuania. During the period 1990-2006 the number of cattle provided in Statistics Lithuania (as of 1st of January) was used. During the period 2007-2010 the average annual number of cattle was collected from the Register of Agricultural Information and Rural Business Centre.

The data given in the 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 Agricultural Information and Rural Business Centre 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. Therefore we suppose that data on animal population in Register is more accurate than data provided in Statistics Lithuania publications.

In the Lithuanian inventory, the animal category "cattle" (CRF 4.A) consists of "dairy cattle" and "non-dairy cattle". The data of CH_4 emission calculations of "dairy cattle" group are taken in general, not dividing in to sub-categories.

"Non-dairy cattle" subcategory includes purebred and hybrid cattle used for meat production. Furthermore for the period 1990-2006 sub-category "Non-dairy" cattle consists of:

- 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 the only available data is 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 2007-2010 sub-category "Non-dairy cattle" consists of:

- bulls to 8 months,
- heifers to 8 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 number of cattle is given in Table 6-4, the number of non-dairy cattle in Tables 6-7 and 6-8.

Table 6-7. The number of non-dairy cattle by sub-categories in Lithuania in 1990-2006 (thous. heads)

Year	Cattle sub-categories										
	Beef cattle (mature 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 in 2007-2010 (thous. heads)

Year	Cattle sub-categories								
	Beef cattle (mature 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

The number of swine by sub-categories used in 1990-2010 report is given in Tables 6-4 and 6-9

Table 6-9. The number of swine by sub-categories in Lithuania in 1990-2010 (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

The number of sheep used in 1990-2010 report is given in Tables 6-4 and 6-10. In the period from 1990 to 2006 number of sheep was provided by Statistics Lithuania (as of 1st of January). In the period 2007-2010 the average annual number of sheep provided in the register of Agricultural Information and Rural Business Center was used.

The collection of data from different sources for the periods 1990-2006 and 2007-2010 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.

Table 6-10. The number of sheep by sub-categories in Lithuania in 1990-2010 (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

Calculation of CH_4 emission factors for cattle, swine and sheep
The CH_4 emissions from enteric fermentation were calculated using the following equation[30]:

$$CH_4\ emission = EF \times Population / (10^6\ kg/Gg)$$

where:
EF – emission factor for each animal category, kg/head/yr;
Population – the number of head in the defined livestock population.

[30] IPCC 2000. Agriculture. Eq. 4.12. P. 4.25

National emission factors for dairy and non-dairy cattle were calculated in accordance with the Tier 2 methodology provided in IPCC GPG 2000[31]:

$$EF = (GE \times Ym \times 365\ days/yr) / 55,65\ MJ/kg\ CH_4$$

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%)).

To estimate the EF from dairy cattle in the period 1990-2006 gross energy was calculated using equation[32]:

$$GE = (NE_m + NE_a + NE_l + NE_p) / (NE_{ma}/DE) / (DE/100)$$

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.

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, milk production and fat content of milk were obtained from statistical databases. Average milk yield per cow are given in table 6-11.

Table 6-11. Average milk yield (kg/head/day) and fat content of milk (%) in 1990-2010

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

[31] IPCC 2000. Agriculture. Eq. 4.14. P. 4.26
[32] IPCC 2000. Agriculture. Eq. 4.11. P. 4.20

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

To estimate the EF from dairy cattle in the period 2007-2010 and non-dairy cattle in the period 1990-2010 gross energy was calculated using equation[33]:

$$Gross\ energy\ (MJ/kg\ feed) = 0{,}0239 \times CP + 0{,}0398 \times C_{Fat} + 0{,}0201 \times C_{Fibre} + 0{,}0175 \times NFE$$

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.

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:

$$GE_{(MJ/head/day)} = GE_{(MJ/kg\ feed)} \times (F_{quantity} \times dry\ matter/kg\ feed) / 365$$

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).

In this time–period 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 animal production[34]. The average daily feed intake for dairy cattle and for each subcategory of non-dairy cattle was calculated from national zoo-technical activity data, mainly milk production including the percentage milk fat for dairy cows, weight and weight gain.

Most frequently used feedstuffs were included in calculation, namely, hay from cultivated meadows and pastures of different nutritive value, also clover and cereal grass hay, straw from different crops, maize, cultivated meadow grass and silage from perennial wilted grass, root-crops and their leaves, grass from cultivated meadows and pastures of different nutritive values, also leguminous green feeds, concentrates with respect to the composition of every different type of

[33] Kulpys H., Šeškevičienė J., Jeroch H. *Žemės ūkio gyvulių ir paukščių mitybos fiziologinės reikmės*. Kaunas, 2004, p. 30
[34] Gyvulininkystės žinynas. Baisogala, Institute of Animal Science of LVA, 2007, p. 616

feed, milk and milk replacers. Average gross energy intake for non-dairy cattle subcategories are given in Tables 6-12 and 6-13.

Table 6-12. Calculated average gross energy intake for non-dairy cattle subcategories in 1990-2006 (MJ/head/day)

Cattle sub-categories		GE (MJ/head/day)
Beef cattle (mature cows)		221,4
Cattle less than 1 year old	For slaughter	90,8
	Bulls for breeding	100,4
	Heifers for breeding	78,6
Cattle from1 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 6-13. Calculated average gross energy intake for non-dairy cattle subcategories in 2007-2010 (MJ/head/day)

Cattle sub-categories								
Beef cattle (mature 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
221,4	84,2	70,4	134,9	106,2	181,5	137,3	177,3	171,2
	76,1		117,4		150,6		172,3	

The average weight of dairy and suckling cows was estimated based on the experts judgment. Pasture-cowshed time calculations are based on the data of the national zoo-technical activity data[35,36].

Emission factors in the particular subgroups of cattle, estimated by calculations, are given in the Tables 6-14 and 6-15.

Table 6-14. Calculated emission factors used for calculation of CH_4 emission from enteric fermentation of non-dairy cattle in 1990-2006 (kg CH_4/head/year)

Cattle sub-categories		EF (kg CH_4/head/year)
Beef cattle (mature cows)		87,1
Cattle less than 1 year old	For slaughter	35,73
	Bulls for breeding	39,51
	Heifers for breeding	30,93
Cattle from1 to 2 years old	Bulls	71,43
	Heifers for slaughter	51,71

[35] Gyvulininkystės žinynas. Mokslas, Vilnius, 1976, p. 98-99
[36] Tarvydas V. ir kt. Šėrimo normos, pašarų struktūra ir sukaupimas galvijams, Vilnius, 1995, p. 4.

	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 6-15. Calculated emission factors used for calculation of CH4 emission from enteric fermentation of non-dairy cattle in 2007-2010 (kg CH_4 /head/year)

Cattle sub-categories		EF (kg CH_4/head/year) (average (heifers-bulls))
Beef cattle (mature cows)		87,1
Cattle	To 8 month	29,96 (27,7-33,1)
	From 8 to12 month	46,19 (41,8-53,1)
	From 1 to 2 years old	59,33 (54,0-71,4)
	2 years old and older	67,82 (67,4-69,8)

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 methods as for cattle. Calculated average gross energy intakes for swine are given in Table 6-16. Calculated emission factors in particular sub-groups of swine are given in Table 6-17.

Table 6-16. Calculated average gross energy intake for swine in 2010 (MJ/head/day)

Sows	Piglets <2 month (<20 kg)	Growing pigs (20-110 kg)	Pigs > 110 kg (8 month and>)	Gilts for breeding	Boars
43,9	3,5	29,2	47,3	48,9	39,4

Table 6-17. Calculated average gross energy intake for swine (MJ/head/day) and emission factors of CH4 emission from enteric fermentation of swine (kg CH_4/head year) in 1990-2010

Year	GE	EF
1990	27,34	1,08
1991	27,34	1,08
1992	27,34	1,08
1993	27,34	1,08
1994	27,34	1,08
1995	27,34	1,08
1996	27,34	1,08
1997	27,63	1,09
1998	26,83	1,06
1999	27,85	1,10
2000	26,96	1,06
2001	27,19	1,07

2002	27,55	1,08
2003	27,16	1,07
2004	27,06	1,06
2005	26,63	1,05
2006	25,93	1,02
2007	26,67	1,05
2008	27,08	1,07
2009	25,34	1,00
2010	26,93	1,06

Table 6-18. Calculated emission factors used for calculation of CH_4 emission from enteric fermentation of swine in 2010 (kg CH4/head/year)

Swine sub-category	EF (kg CH_4/head/year)
Sows	1,73
Piglets <2 month (<20 kg)	0,14
Growing pigs (20-110 kg)	1,15
Pigs > 110 kg (8 month and>)	1,86
Gilts for breeding	1,93
Boars	1,55

Determining CH_4 emission from sheep, gross energy was calculated same methods as for cattle, based on the feed accumulation standards.

Gross energy for sheep was calculated as well as for cattle. Calculated average gross energy intakes for sheep are given in Table 6-19. Calculated emission factors in particular subgroups of sheep are given in Table 6-20 and 6-21.

Table 6-19. Calculated average gross energy intake for sheep in 1990-2006 (MJ/head/day)

Mature sheep and ewe over 1 year	Lambs to 1 year
32,79	14,87

Table 6-20. Calculated average gross energy intake for sheep in 2007-2010 (MJ/head/day)

Mature sheep	Ewe lambs for breeding	Baa-lambs to 8 months	Rams
34,7	21,8	10,3	36,4
Average: 26,02			

Table 6-21. Calculated emission factors used for CH_4 emission calculation from enteric fermentation of sheep (kg CH_4 /head/year)

Sheep sub-categories	EF (kg CH_4/head/year)
Mature sheep	13,64
Ewe lambs for breeding	8,59
Baa-lambs to 8 month	4,69
Rams	14,34

Calculated emission factors for dairy cattle, non-dairy cattle and sheep vary across the years due to the changes of allocation of subcategories, number of animals and feed consumption (Table 6-21).

Table 6-22. Calculated emission factors used for calculation of CH_4 emission from enteric fermentation of cattle and sheep (kg CH_4/head/year)

Animal category	Dairy cattle	Non-dairy cattle	Sheep
1990	90,68	49,44	10,37
1991	88,14	49,44	10,33
1992	84,11	49,44	10,31
1993	82,40	49,44	10,66
1994	85,55	49,44	10,68
1995	83,41	49,44	10,55
1996	84,24	49,44	10,75
1997	85,36	49,44	11,08
1998	87,23	47,54	10,58
1999	85,72	48,01	10,30
2000	90,21	47,53	10,45
2001	92,27	47,42	10,27
2002	93,17	47,53	10,21
2003	93,55	47,39	10,15
2004	95,33	47,10	10,45
2005	96,53	47,40	10,32
2006	98,32	48,13	10,01
2007	100,82	49,89	9,97
2008	102,07	50,51	10,07
2009	102,24	50,79	10,20
2010	102,63	50,94	10,24

Calculation of CH_4 emission factors from other animals

Comparing with cattle contribution of other farm 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 approach. Considering the rather small numbers of these animals the default values (emission factors) pursuant to IPCC were used[37]. As no IPCC and national default emission factors for fur-bearing animals, rabbits and nutria are available, the Norwegian[38] emission factor for fur-bearing animals and Russian[39] emission factors for rabbits and nutria were used in calculations.

Table 6-23. Default emission factors for each animal category used for calculation of CH_4 emission from enteric fermentation[40] (kg CH_4/head/year)

Animal category	EF (kg CH_4 / head /year)
Goat	5,0
Horse	18,0

[37] IPCC, Guidelines 2006. Agriculture, Forestry and Other Land Use. Table 10.10, p. 10.28
[38] Greenhouse gas emission in Norway 1990-2009, National inventory report, 2011, p. 214, table 6.2
[39]Greenhouse gas emission in Russian Federation 1990-2009, National inventory report, 2011, p. 175, table 6.5
[40] IPCC 1996. Agriculture. Table 4-2. P. 4.3

Rabbits	0,59
Nutria	0,35
Fur-bearing animals	0,1

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 1990-2010 activity data, excluding data on number of cattle and sheep (this data since 2007 is being collected from the register of Agricultural information and rural business center), 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., or if the population of cattle is smaller than 500 thous., 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 (2007-2010) the data on number of cattle and sheep are based on the data of the register of Agricultural Information and Rural Business Center. The precision of calculated emissions is influenced by the fact that it is impossible to divide the dairy cattle into sub-groups. 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.

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 for swine and non-dairy cattle categories the constant values of 1997-1998 herd structure data were used for the 1990-1996 period estimates.

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%[41],[42]. Emission factors estimated using the Tier 2 method are likely to be in the order of ±20%[43].

[41] IPCC GPG 2000. P. 4.27.
[42] IPCC 2006. Emissions from livestock and manure management. P. 10.33
[43] IPCC GPG 2000. P. 4.28.

6.2.4 Source-specific QA/QC and verification

General QC procedures outlined in the QA/QC plan were applied for estimates from enteric fermentation. Furthermore, emission factors were compared with IPCC defaults and with emission factors of neighbouring states. (Tables 6-24, 6-25 and 6-26).

Comparing results obtained in 2009 it can be seen that CH_4 emission factor from enteric fermentation of dairy cattle category is approximately comparable to Poland's EFs (Table 6-24). Estonia and Latvia showed higher emission factors, however they also showed higher productivity of cattle.

Table 6-24. CH_4 emission from enteric fermentation from dairy cattle in the neighboring countries – a comparison of Emission Factors

Country	EF (kg CH_4/head/year)	Milk yield (kg/head/day)	Weight (kg/animal)	Average gross energy intake (MJ/head/day)
Belarus	109,70	12,85	550,00	278,76
Estonia	136,07	18,73	587,44	345,97
Latvia	116,48	13,40	550,00	295,98
Lithuania	102,24	13,18	575,00	259,80
Poland	97,03	12,58	500,00	246,57

In non-dairy category the level of Lithuanian emission factor is similar to the corresponding EF results for Belarus, Latvia and Poland (Table 6-25). Besides, those countries indicated similar gross energy intake as well.

Table 6-25. CH_4 emissions from enteric fermentation in non-dairy cattle, in the neighboring countries – a comparison of Emission Factors

Country	EF (kg CH_4/head/year)	Weight (kg/animal)	Average gross energy intake (MJ/head/day)
Belarus	51,42	NE	130,65
Estonia	60,14/33,37	438,39/230,00	148,78 /84,79
Latvia	52,16	500,00	132,54
Lithuania	50,79	323,94	129,06
Poland	48,90	317,47	124,27

The level of Lithuanian emission factor for swine is higher than corresponding results of Estonia (Table 6-26), Estonia also indicated lower gross energy intake and lower average weight of swine

Table 6-26. CH_4 emissions from enteric fermentation in swine, in the neighboring countries – a comparison of Emission Factors

Country	EF (kg CH_4/head/year)	Weight (kg/animal)	Average gross energy intake (MJ/head/day)
Belarus	1,50	NE	NE
Estonia	0,80	44,25	20,37
Latvia	1,50	NE	NE
Lithuania	1,00	66,96	25,34
Poland	1,50	82,00	NA

6.2.5 Source-specific recalculations

In this submission, the number of animals was updated and corrected for the following animal categories and years:

- Dairy cattle (1997-1998, 2007-2009);
- Non-dairy cattle (1997-1998, 2007-2009);
- Sheep (2004-2009);
- Swine (1997-1998);
- Poultry (2009).

Following the recommendation of ERT in 2011, in order to increase consistency of used methodologies for calculation of emission from enteric fermentation, the following recalculations have been made:

- disaggregated into sub-categories non-dairy cattle population data was collected and gross energy (GE) intake was recalculated for entire time-series for each subcategory of the non-dairy cattle (Table 6-27), therefore emission was calculated by Tier 2 method for all time series.
- Emission from dairy cattle for years 1990-1998 was recalculated due to updated milk fat data.
- Emission from swine was recalculated disaggregating swine population by sub-categories, therefore emission was calculated by Tier 2 method for all time series in this submission. The calculation of GE intake for every sub-category of swine led to reduction of emission factors.
- In addition, emission for all time-series from sheep was recalculated using Tier 2 method: sheep population was divided into subcategories and GE intake was estimated for each sheep subcategory. The calculation of GE intake for every subcategory of sheep resulted in increase of emission factors.

The changes of CH_4 emission factors and emissions from enteric fermentation are presented in Table 6-27 and 6-28.

Table 6-27. Comparison of calculated CH_4 emission factors from enteric fermentation for non-dairy cattle in previous and in this submission (kg CH_4/head/year)

Year	Previous submission	This submission	Relative difference, %
1990	45,49	49,44	8,68
1991	45,68	49,44	8,23
1992	42,34	49,44	16,77
1993	42,25	49,44	17,02
1994	41,64	49,44	18,73
1995	42,31	49,44	16,85
1996	43,69	49,44	13,16
1997	44,15	49,44	11,98
1998	45,83	47,54	3,73
1999	47,09	48,01	1,95
2000	48,22	47,53	-1,43
2001	49,02	47,42	-3,26

2002	49,57	47,53	-4,12
2003	50,91	47,39	-6,91
2004	50,46	47,10	-6,66
2005	51,01	47,40	-7,08
2006	52,02	48,13	-7,48
2007	56,18	49,89	-11,20
2008	56,67	50,51	-10,87
2009	56,73	50,79	-10,47

Table 6-28. Reported in previous submission and recalculated CH_4 emissions from enteric fermentation in 1990-2010 (Gg)

Year	Previous submission	This submission	Absolute difference	Relative difference, %
1990	149,28	154,23	4,95	3,32
1991	140,97	145,32	4,35	3,09
1992	106,84	113,22	6,38	5,97
1993	89,45	94,14	4,69	5,24
1994	76,89	80,65	3,76	4,89
1995	72,84	75,80	2,96	4,06
1996	73,51	75,78	2,27	3,09
1997	72,47	78,07	5,60	7,73
1998	67,90	68,49	0,59	0,87
1999	64,35	64,44	0,09	0,14
2000	57,22	56,72	-0,50	-0,87
2001	58,95	58,00	-0,95	-1,61
2002	60,99	59,81	-1,18	-1,93
2003	63,50	61,82	-1,68	-2,65
2004	62,48	60,96	-1,52	-2,43
2005	62,98	61,18	-1,80	-2,86
2006	65,35	63,19	-2,16	-3,31
2007	64,28	64,55	0,27	0,42
2008	64,90	61,98	-2,92	-4,50
2009	61,11	58,77	-2,34	-3,83

6.2.6 Source-specific planned improvements

No improvements 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 types 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 domestic animal 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 consisted approximately 10,5% of total agricultural emissions or 28,1% of total CH_4 emissions in 2010. In 2010, comparing with 2009, CH_4 emissions from manure management increased by 1,9% (Table 6-29). In 2010 the highest CH_4 emission from manure management systems among different categories of domestic animals was determined in swine breeding category. 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 6-29. CH_4 emissions (Gg) from manure management by animal category in 1990–2010

Year	Animal categories							
	Dairy cattle	Non-dairy cattle	Sheep	Goats	Horses	Swine	Poultry	Fur-bearing animals, rabbits and nutria
1990	11,05	9,17	0,011	0,001	0,11	30,36	1,31	0,13
1991	10,85	8,64	0,011	0,001	0,11	27,17	1,33	0,12
1992	9,39	6,23	0,010	0,001	0,11	16,95	0,64	0,12
1993	8,64	4,66	0,009	0,001	0,11	14,91	0,68	0,08
1994	8,02	3,62	0,008	0,001	0,11	15,70	0,69	0,08
1995	7,88	3,29	0,006	0,002	0,11	15,83	0,66	0,07
1996	8,17	3,25	0,005	0,002	0,11	14,06	0,61	0,08
1997	8,81	3,23	0,005	0,002	0,11	15,18	0,58	0,07
1998	8,07	2,72	0,003	0,003	0,10	14,28	0,53	0,04
1999	7,39	2,93	0,003	0,003	0,10	11,89	0,50	0,04
2000	7,03	2,24	0,002	0,003	0,10	10,67	0,43	0,04
2001	7,38	2,27	0,002	0,003	0,09	12,53	0,51	0,04
2002	7,61	2,50	0,003	0,003	0,08	13,33	0,53	0,05

2003	7,86	2,72	0,003	0,003	0,09	13,10	0,63	0,07
2004	7,90	2,69	0,004	0,003	0,09	12,98	0,66	0,10
2005	7,81	2,97	0,006	0,003	0,09	13,10	0,73	0,13
2006	7,75	3,51	0,007	0,002	0,08	12,93	0,74	0,13
2007	8,06	3,74	0,010	0,002	0,08	10,72	0,77	0,12
2008	8,20	3,31	0,010	0,002	0,08	10,48	0,71	0,13
2009	7,76	3,15	0,010	0,002	0,07	10,01	0,73	0,09
2010	7,43	3,11	0,011	0,002	0,06	10,75	0,74	0,13

Comparing to 1990 CH_4 emissions from manure management decreased by 57,4% in 2010 (Figure 6-3).

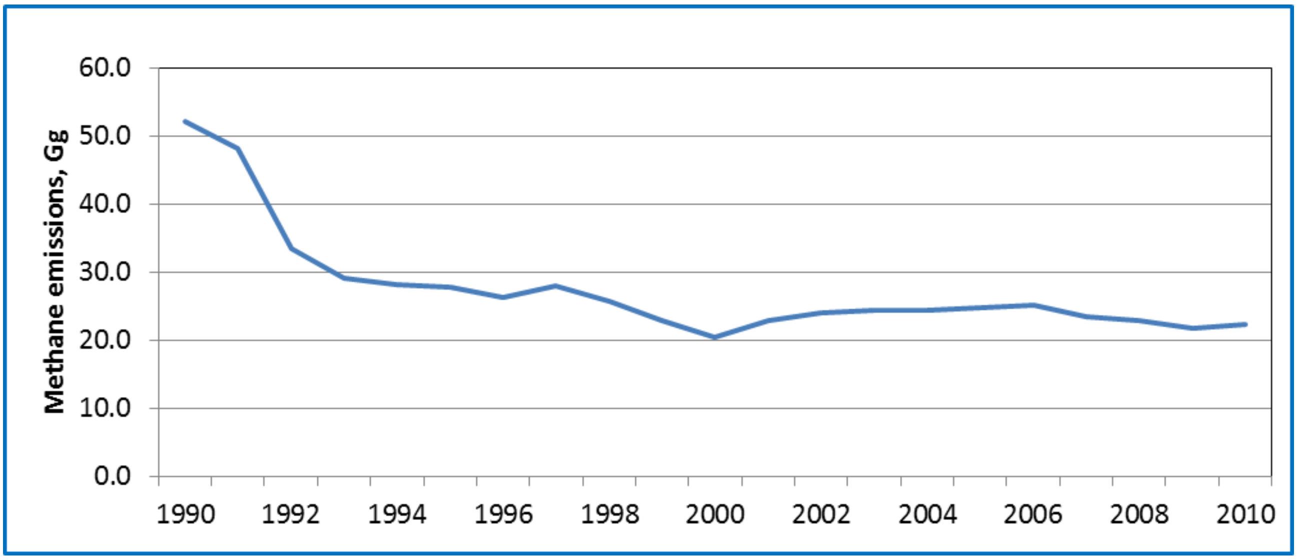


Figure 6-3. CH_4 emission from manure management in 1990–2010 (Gg)

The overall reduction of CH_4 emissions from manure is caused by a decrease in total number of animals (excluding goats), but in the case of dairy and non-dairy cattle the attrition of animals is partly counterbalanced by increase in emissions per animal (because of the increase in volatile solid excretion and related gross energy intake).

6.3.1.2 Methodological issues

Choice of methods

CH_4 emissions from manure management systems of cattle and swine were calculated using Tier 2 method, as emission from the following livestock sub-categories represent a significant share of emissions. The Tier 2 method for estimating CH_4 emission from manure management systems requires detailed information on animal characteristics and the manner in which manure is managed. Emission from sheep, goats, horses, rabbits, nutrias, fur-bearing animals and poultry have a minor importance, therefore the Tier 1 methodology has been applied to estimate the CH_4 emissions of these livestock categories.

The summary of methods of calculation used in this report is given in Table 6-30.

Table 6-30. 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 1	IPCC 1996
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. In the 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.

About 30% of cattle breeders use liquid manure reservoirs, others use slurry storing systems. Therefore solid manure constitutes about 70% of the total manure generated through the stall period. As stall period takes about 60% of the year, the total fraction of manure managed by solid storage method is 42%. Fraction of manure stored in liquid/slurry systems is 18%.

Bulls, partly calves and cows for slaughter, normally are kept in stalls all the time while 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. As the number of animals for slaughter in 2010 was approximately 32%, average fraction of manure remaining on pastures and not managed was approximately 27%. Remaining manure is divided between solid storage and liquid/slurry systems in the same proportions as for dairy cattle. This means that, approximately 52% of manure was managed in solid storage systems and 21% in liquid/slurry systems.

Majority of swine farms use liquid manure storing systems. Such farms breed up to 68% of swine in Lithuania. In other farms swine are breeding on concrete flooring using litter, 12% of swine manure is managed in pits below confinements as deep bedding or is used for biogas generation. However, pits below animal confinements are not included in the CRF reporter. Therefore, this type of swine manure management 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 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 Revised 1996 IPCC Guidelines (Table 6-31). 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.

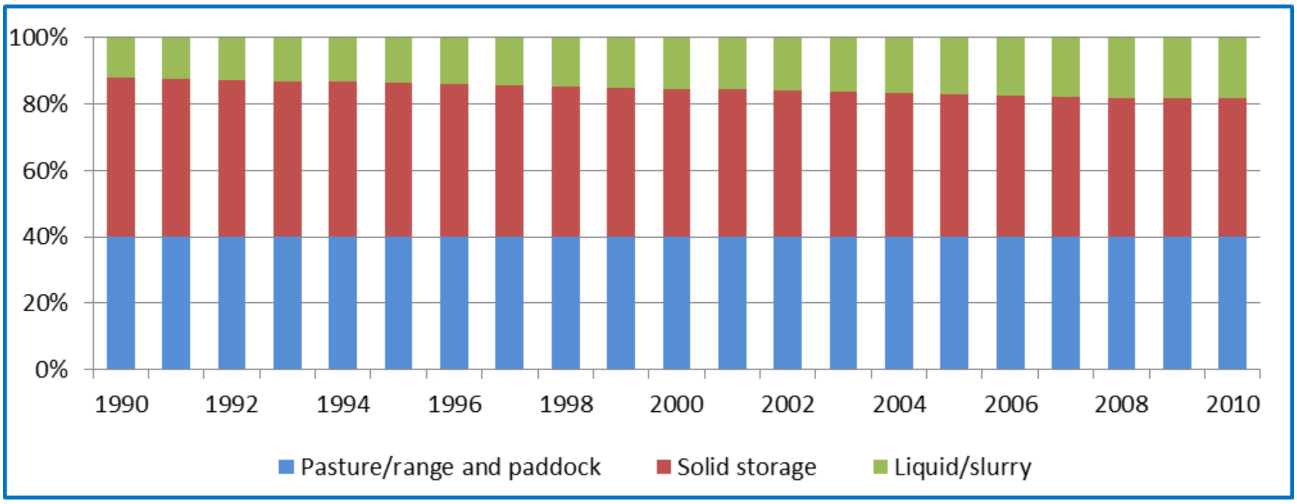


Figure 6-4. Data on manure management systems for dairy cattle (%)

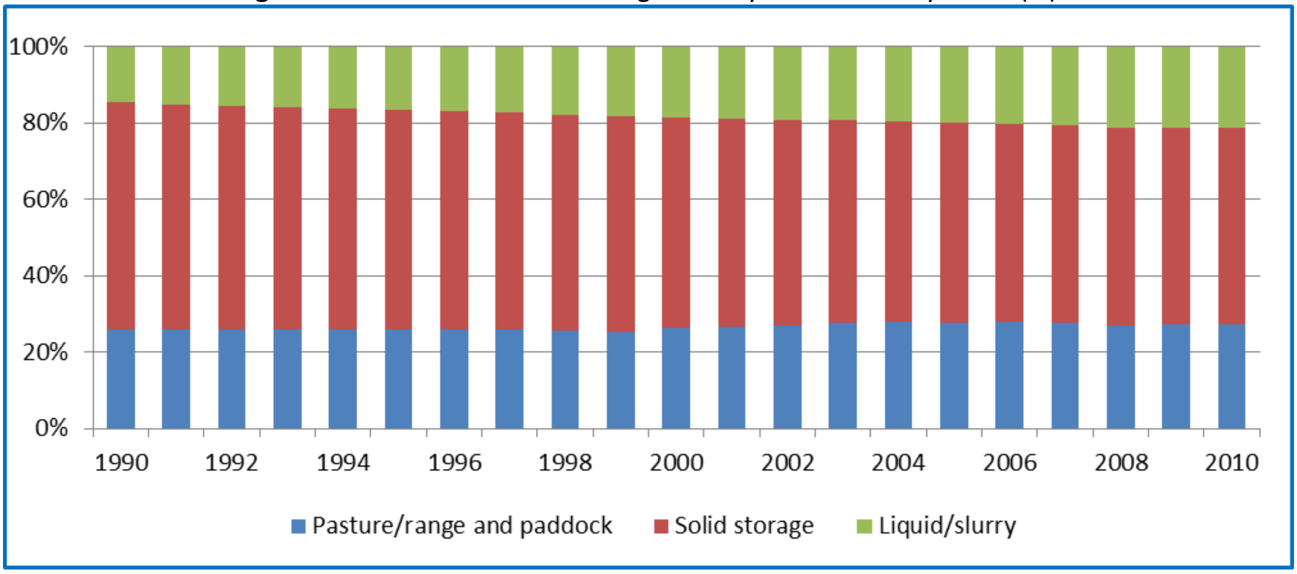


Figure 6-5. Data on manure management systems for non-dairy cattle (%)

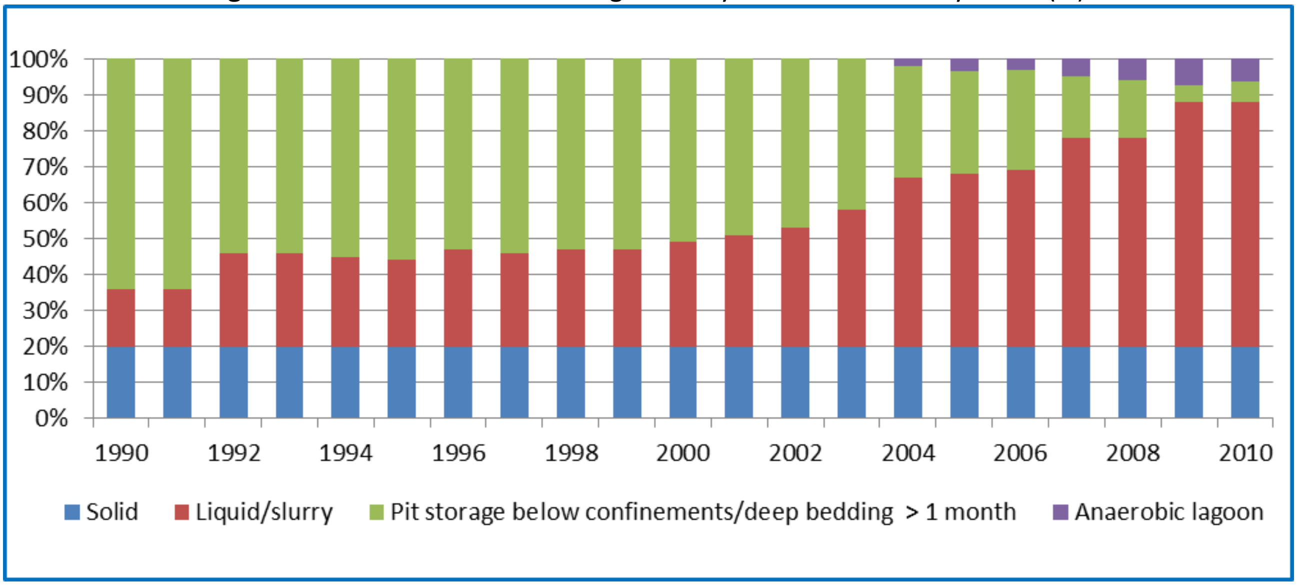


Figure 6-6. Data on manure management systems for swine (%)

Calculation of CH_4 emissions

CH_4 emissions from manure management were calculated using the following equation:[44]

$$CH_{4\ EMISSIONS} = EF \times Population / (10^6\ kg/Gg)$$

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, sheep, poultry, rabbits, nutria and fur-bearing animals were calculated according to the Tier 1 method. Default IPCC emission values for each relevant livestock category are used to calculate emissions from manure (Table 6-31).

Table 6-31. Emission factors used for calculation of CH_4 emission from manure management[45][46]

Animal category	EF (kg CH_4/head/year)
Sheep	0,19
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 and swine were determined using the fallowing equation:[47]

$$EF = VS \times 365\ days/year \times B_0 \times 0{,}67\ kg/m^3 \times \Sigma MCF \times MS$$

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.

VS excretion rates were estimated from feed intake levels:

$$VS = GE \times (1\ kg\text{-}dm/18{,}45\ MJ) \times (1 - DE/100) \times (1 - ASH/100)$$

where:
GE – estimated daily average feed intake, MJ/day;
DE – digestible energy of the feed, %;
ASH – ash content of manure, %.

[44] IPCC 2000. Agriculture. Eq. 4.15. P. 4.30
[45] IPCC 1996. Agriculture Table 4-4. P. 4.6
[46] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Table10.16. P. 10.41
[47] IPCC 2000. Agriculture. Eq. 4.17. P. 4.34

Gross energy consumption values for dairy cattle, non-dairy cattle and swine were used 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 and 75% for swine) ash content of manure (8% for cattle and 2% for swine) provided in the IPCC Good Practice Guidance[48]. Methane producing capacities B_0 (0,24 m^3 CH_4/kg VS for dairy cows and 0,17 m^3 CH_4/kg VS for non-dairy cattle, 0,45 for swine) were also taken from the IPCC Good Practice Guidance.

Table 6-32. Methane conversion factors (MCF) for manure management systems (%)[49]

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 (Table 6-33).

Table 6-33. Amount of biogas produced and burned in biogas device, k Nm^3 (amount of CH_4 – 72%)

Year	**Biogas**
2004	513,0
2005	848,8
2006	768,7
2007	984,4
2008	1172,3
2009	1394,3
2010	1296,8

The emission factor for dairy cattle has increased as a result of the increasing milk yield and also the changes in housing types of animals when solid manure management was replaced by slurry-based system (Table 6-34). Methane conversion factor for slurry manure is higher than solid manure MCF.

Table 6-34. Calculated emission factors used for calculation of CH_4 emission from manure management for dairy cattle (kg CH_4/head/year)

Year	**EF (kg CH_4/head/year)**
1990	13,12
1991	13,05
1992	12,73
1993	12,74
1994	13,04
1995	13,45
1996	13,86

[48] IPCC 2000. Agriculture. P. 4.31-4.32.
[49] IPCC Good Practice Guidance and Uncertainty management in National Greenhouse Gas Inventories. Table 4.10. P. 4.36.

1997	14,32
1998	14,92
1999	14,95
2000	16,03
2001	16,7
2002	17,17
2003	17,55
2004	18,2
2005	18,74
2006	19,42
2007	20,24
2008	20,83
2009	20,86
2010	20,94

Tables 6-35, 6-36 and 6-37 shows the changes in emission factors for non-dairy cattle and swine.

Table 6-35. Calculated emission factors used for calculation of CH_4 emission (kg CH_4/head/year) from manure management for non-dairy cattle sub-categories in 1990-2006

Year	EF by cattle sub-categories (kg CH_4/head/year)											
	Non-dairy cattle	Beef cattle (mature 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	6,33	-	4,78	6,39	3,24	11,55	5,42	5,67	11,28	7,06	7,06	11,23
1992	6,47	-	4,89	6,51	3,32	11,77	5,54	5,79	11,49	7,22	7,22	11,48
1993	6,60	-	5,00	6,63	3,39	11,99	5,66	5,92	11,71	7,38	7,38	11,74
1994	6,74	-	5,11	6,76	3,46	12,21	5,78	6,04	11,93	7,54	7,54	11,99
1995	6,87	-	5,22	6,88	3,53	12,44	5,90	6,17	12,15	7,69	7,69	12,25
1996	7,01	-	5,33	7,00	3,60	12,66	6,03	6,30	12,36	7,85	7,85	12,51
1997	7,14	-	5,44	7,13	3,68	12,88	6,15	6,42	12,58	8,01	8,01	12,76
1998	7,02	-	5,55	7,25	3,75	13,10	6,27	6,55	12,80	8,17	8,17	13,02
1999	7,26	-	5,67	7,37	3,82	13,33	6,39	6,67	13,01	8,32	8,32	13,28
2000	7,22	0,005	5,78	7,50	3,89	13,55	6,51	6,80	13,23	8,48	8,48	13,53
2001	7,33	0,01	5,89	7,62	3,97	13,77	6,63	6,93	13,45	8,64	8,64	13,79
2002	7,43	0,01	6,00	7,74	4,04	13,99	6,75	7,05	13,67	8,79	8,79	14,05
2003	7,48	0,03	6,11	7,86	4,11	14,22	6,87	7,18	13,88	8,95	8,95	14,30
2004	7,53	0,04	6,22	7,99	4,18	14,44	6,99	7,31	14,10	9,11	9,11	14,56
2005	7,74	0,08	6,33	8,11	4,25	14,66	7,11	7,43	14,32	9,27	9,27	14,82
2006	7,99	0,16	6,44	8,23	4,33	14,88	7,23	7,56	14,54	9,42	9,42	15,07

Table 6-36. Calculated emission factors used for calculation of CH_4 emission (kg CH_4/head/year) from manure management for non-dairy cattle subcategories in 2007-2010

Year	EF by cattle sub-categories (kg CH_4/head/year)									
	Non-dairy cattle	Cattle								
		Beef cattle (mature 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	8,59	17,49	7,01	3,94	11,23	5,94	15,11	7,68	14,75	9,58
2008	8,71	17,78	7,11	4,00	11,39	6,04	15,33	7,81	14,97	9,74
2009	8,77	17,78	7,11	4,00	11,39	6,04	15,33	7,81	14,97	9,74
2010	8,82	17,78	7,11	4,00	11,39	6,04	15,33	7,81	14,97	9,74

Table 6-37. Calculated emission factors used for calculation of CH_4 emission (kg CH_4/head/year) from manure management for swine in 1990-2010

Year	EF (kg CH_4/head/year)
1990	12,47
1991	12,47
1992	12,47
1993	12,47
1994	12,47
1995	12,47
1996	12,47
1997	12,60
1998	12,23
1999	12,70
2000	12,29
2001	12,40
2002	12,56
2003	12,39
2004	12,09
2005	11,75
2006	11,47
2007	11,61
2008	11,68
2009	10,78
2010	11,56

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.

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, 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 for National Greenhouse Gas Inventories refers 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%[50].

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 to the other countries' emission factors.

Data in the table 6-38 shows that Lithuania uses significantly higher emission factors for calculation of emission from manure management than neighbouring countries. While these countries most often use MCF 10% for the calculation of emission from liquid/slurry, Lithuania uses MCF 39%. Also, the other countries use relatively more solid manure management than the liquid/slurry systems.

Table 6-38. CH_4 emissions from manure management of dairy cattle, in the neighboring countries – a comparison of Emission Factors

Countries	**Dairy cattle**		**Non-dairy cattle**		**Swine**	
	EF (kg CH_4/head/yr)	**GE intake (MJ/head/day)**	**EF (kg CH_4/head/yr)**	**GE intake (MJ/head/day)**	**EF (kg CH_4/head/yr)**	**GE intake (MJ/head/ day)**
Belarus	5,14	278,76	2,39	130,65	4,43	NE
Estonia	10,57	345,97	4,34/2,17	148,78/84,79	3,15	20,37
Latvia	10,34	295,98	4,00	132,54	4,00	NA
Lithuania	20,86	259,80	8,77	359,17	10,78	25,34
Poland	10,53	246,57	4,93	124,27	6,54	NA

6.3.1.5 Source-specific recalculations

In this submission, the number of animals was updated and corrected for the following animal categories and years:

- Dairy cattle (1997-1998, 2007-2009);
- Non-dairy cattle (1997-1998, 2007-2009);
- Sheep (2004-2009);
- Swine (1997-1998);
- Poultry (2009).

[50] IPCC 2006. Emissions from Livestock and Manure management. P. 10.48

Following the recommendation of ERT in 2011, in order to ensure consistency of methodologies used to estimate CH_4 emission from manure management, the following recalculations have been made:

- Non-dairy cattle population data was disaggregated into sub-categories and gross energy (GE) intake was recalculated for entire time-series for each subcategory of the non-dairy cattle. Due to the use of the disaggregated population data of non-dairy cattle sub-categories, the percentage of AWMS (Animal waste management system) for non-dairy cattle was also recalculated.
- CH_4 emission from dairy cattle recalculations for 1997-2009 period are related to milk fat data updates used for GE intake estimates.
- Swine population data was disaggregated into sub-categories for the period 1990-2009. The calculation of gross energy (GE) intake for each sub-category of swine led to a reduction of emission factors. In addition, biogas recovery data for years 2004-2010 was updated. Treated liquid manure in biogas reduces emission of CH_4.
- CH4 emission from sheep was recalculated due to animal number data corrections and updates.

Table 6-39. Comparison of recalculated CH_4 emission factors from manure management for non-dairy cattle in previous and this submission (kg CH_4/head/year)

Year	Previous submission	This submission
1990	5,94	6,20
1991	6,1	6,33
1992	5,79	6,47
1993	5,91	6,60
1994	5,95	6,74
1995	6,18	6,87
1996	6,52	7,01
1997	6,73	7,14
1998	7,12	7,02
1999	7,47	7,26
2000	7,8	7,22
2001	8,08	7,33
2002	8,32	7,43
2003	8,71	7,48
2004	8,79	7,53
2005	9,04	7,74
2006	9,38	7,99
2007	10,31	8,59
2008	10,57	8,71
2009	10,59	8,77

Table 6-40. 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	63,48	52,14	-11,34	-17,86
1991	58,27	48,24	-10,03	-17,21
1992	39,15	33,45	-5,70	-14,56

1993	34,11	29,10	-5,01	-14,69
1994	33,51	28,23	-5,28	-15,76
1995	33,18	27,85	-5,33	-16,06
1996	31,00	26,29	-4,71	-15,19
1997	32,17	28,00	-4,17	-12,96
1998	30,80	25,75	-5,05	-16,40
1999	26,61	22,85	-3,76	-14,13
2000	24,38	20,50	-3,88	-15,91
2001	27,21	22,83	-4,38	-16,10
2002	28,52	24,11	-4,41	-15,46
2003	29,11	24,48	-4,63	-15,91
2004	29,35	24,42	-4,93	-16,80
2005	30,29	24,83	-5,46	-18,03
2006	31,01	25,15	-5,86	-18,90
2007	27,75	23,50	-4,25	-15,32
2008	27,55	22,91	-4,64	-16,84
2009	26,62	21,82	-4,80	-18,03

6.3.1.6 Source-specific planned improvements

In 2012 a Study on ecperimental research and evaluation of country specific methane producing capacity (B_0) in Lithuania manure management system was initiated. Additionally, collection of more accurate data on manure storage systems used in the Lithuanian agriculture will be done in the scope of this study. The study results will allow to improve methane emission estimates from manure management. Procurement tender for this study was announced in March 2012. Study results are to be ready in August 2012.

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: the 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 287,9 Gg CO_2 eq. or 6,5% of the total emissions in 2010. In 2010, comparing with 1990, N_2O emissions from manure management decreased by 67,0% (Fig. 6-7). Calculated N_2O emissions from different manure management systems are presented in Table 6-41.

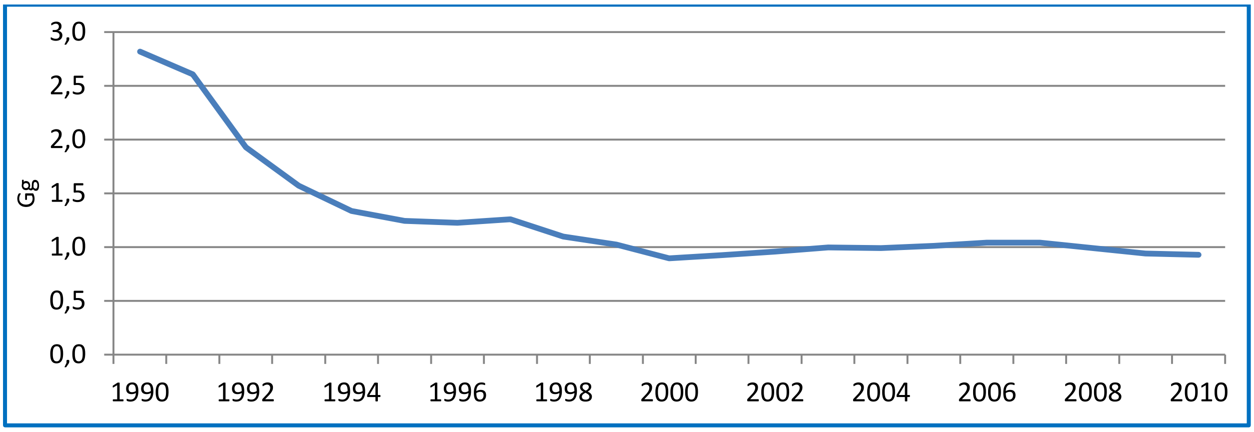


Figure 6-7. Nitrous oxide emission from manure management in 1990 – 2010 (Gg)

Table 6-41. Calculated N_2O emissions (Gg) for different manure management systems

Year	AWMS		
	Liquid system	Solid storage and dry lot	Other systems
1990	0,04	2,69	0,09
1991	0,04	2,48	0,08
1992	0,03	1,85	0,04
1993	0,03	1,50	0,04
1994	0,02	1,27	0,04
1995	0,02	1,18	0,04
1996	0,02	1,16	0,04
1997	0,02	1,20	0,04
1998	0,02	1,04	0,04
1999	0,02	0,97	0,03
2000	0,02	0,85	0,03
2001	0,02	0,87	0,03
2002	0,02	0,90	0,03
2003	0,02	0,94	0,04
2004	0,03	0,93	0,04
2005	0,03	0,94	0,04
2006	0,03	0,97	0,04
2007	0,03	0,97	0,04
2008	0,03	0,93	0,04
2009	0,03	0,87	0,03
2010	0,03	0,86	0,04

6.3.2.2 Methodological issues

To estimate N_2O emissions from manure management the Tier 1 method was used. This method for estimating 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 (2007-2010) 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 (CRF 4.B(a)) – CH_4 emission" and in the Table 6-42.

Table 6-42. Percentage of manure production per animal waste management systems (%)

Year	Solid storage and dry lot	Liquid system	Pasture, range and paddock	Other systems
Sheep				
1990-2010			73	27
Goats				
1990-2010			92	8
Poultry				
1990-2010		28	1	71
Rabbits				
1990-2010	100			
Fur-bearing animals				
1990-2006	100			
2007	93	7		
2008	85	15		
2009-2010	78	22		
Nutria				
1990-2010	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[51]:

$$(N_2O\text{-}N)(mm) = \Sigma_{(S)} ((\Sigma_{(T)} (N_{(T)} \times Nex_{(T)} \times MS_{(T,S)})) \times EF_{3(S)})$$

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.

[51] IPCC.2000. Agriculture. Eq. 4.18. P. 4.42.

Conversion of (N_2O-N)(mm) emission to N_2O(mm) emission for reporting purposes is performed by using the following equation:

$$N_2O(mm) = (N_2O\text{-}N)\ (mm) \times 44/28$$

For calculation of total nitrogen excretion IPCC default annual average nitrogen excretion rates for each animal category were used (Table 6-43).

Table 6-43. Default N excretion values for livestock categories[52,53]

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	19,09

The annual amount of N excretion per head for cattle and swine was calculated on the total annual N intake and total annual N retention of the animal[54]. Annual average N intake per head for cattle and swine were calculated in accordance with the tables[55] of forage sustenance and ration. The difference between intake and retention is N excretion (Table 6-44). The emission factors for each manure management system were taken from IPCC Guidelines (Table 6-45).

Table 6-44. N excretion factors used in the estimates of N_2O emissions from dairy cattle and swine (kg N/head/yr)

Animal category	Dairy cattle	Non-dairy cattle	Swine
1990	80,07	52,56	11,05
1991	76,39	52,56	11,05
1992	70,84	52,56	11,05
1993	69,25	52,56	11,05
1994	69,34	52,56	11,05
1995	69,87	52,56	11,05
1996	71,01	52,56	11,05
1997	72,55	52,56	11,21
1998	75,13	50,58	10,77
1999	73,03	51,05	11,29
2000	73,39	50,42	11,05
2001	82,43	50,27	10,95
2002	83,77	50,29	11,05
2003	74,36	50,06	10,90
2004	87,11	49,70	10,83
2005	88,99	49,85	10,66
2006	91,86	50,27	10,14

52 IPCC 1996. Agriculture. Table 4-6. P. 4.10.
53 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Table 10.19. P. 10.59.
54 IPCC.2000. Agriculture. Eq. 4.19. P. 4.45.
55 Gyvulininkystės žinynas. Baisogala, Institute of Animal Science of LVA. 2007. – P. 584-601.

2007	95,96	49,92	10,80
2008	97,13	50,42	10,80
2009	97,81	50,36	10,22
2010	99,35	50,49	10,72

Table 6-45. Default emission factors for N_2O estimation from manure management[56]

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 For sheep, goats, horses and poultry	 0,001 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. 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%[57]. The uncertainty of nitrogen excretion for categories of livestock is ±50%. The uncertainties associated with the N excretion rates related with the N intake and N retention of animals may be as low as ±25%[58].

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.

6.3.2.5 Source-specific recalculations

Following ERT recommendation in 2011, N-excretion for dairy, non-dairy cattle and swine was recalculated for entire time series using Tier 2 method and updated data on animal herd structure and protein consumption (Table 6-46). N excretion for beef cattle were calculated as a function of milk production – output, for other non-dairy cattle – as a function of weight gain – output. N excretions for swine were calculated in detail as a function of weight gain – output.

[56] IPCC 1996. Agriculture. Table 4-8. P. 4.14.
[57] IPCC. 2000. Agriculture. Table 4.13. P. 4.43.
[58] IPCC. 2000. Agriculture. P. 4.46.

Table 6-46. Comparison of recalculated N_2O emission from manure management in previous and this submission (Gg)

Submission	Previous submission	This submission	Absolute difference	Relative difference, %
1990	2,64	2,82	0,18	6,82
1991	2,49	2,61	0,12	4,82
1992	1,79	1,93	0,14	7,82
1993	1,48	1,57	0,09	6,08
1994	1,26	1,34	0,08	6,35
1995	1,19	1,24	0,05	4,20
1996	1,18	1,23	0,05	4,24
1997	1,15	1,26	0,11	9,57
1998	1,06	1,10	0,04	3,77
1999	1,02	1,02	0,00	0,00
2000	0,91	0,90	-0,01	-1,10
2001	0,96	0,93	-0,03	-3,13
2002	1,01	0,96	-0,05	-4,95
2003	1,07	1,00	-0,07	-6,54
2004	1,07	0,99	-0,08	-7,48
2005	1,10	1,01	-0,09	-8,18
2006	1,16	1,04	-0,12	-10,34
2007	1,10	1,04	-0,06	-5,45
2008	1,09	0,99	-0,10	-9,17
2009	1,03	0,94	-0,09	-8,74

6.3.2.6 Source-specific planned improvements

Collection of more accurate data on manure storage systems used in the Lithuanian agriculture is planned in the scope of study on experimental research and evaluation of country specific methane producing capacity (B_0) in Lithuania's manure management systems during 2012. 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".

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 6-47). Agricultural soils represent a large source of nitrous oxide. N_2O emission from agricultural soils contributed 56,3% of the total GHG emission from agricultural sector.

Table 6-47. Nitrous oxide emissions from agricultural soils (Gg)

Year	Direct soil emissions	Pasture manure	Indirect emissions
1990	7,79	1,57	6,06
1991	6,91	1,47	5,33
1992	3,89	1,15	3,16
1993	3,24	0,98	2,37
1994	2,57	0,85	1,96
1995	2,59	0,80	1,87
1996	3,51	0,80	2,36
1997	3,65	0,83	2,44
1998	3,55	0,74	2,31
1999	3,47	0,69	2,37
2000	3,55	0,63	2,30
2001	3,67	0,65	2,41
2002	3,89	0,67	2,62
2003	3,95	0,70	2,68
2004	3,93	0,70	2,70
2005	3,95	0,70	2,75
2006	3,75	0,72	2,82
2007	4,21	0,74	2,98
2008	4,01	0,71	2,79
2009	4,35	0,68	2,91
2010	4,36	0,66	3,07

6.5.1 Direct emissions from agricultural soils (CRF 4.D1)

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 waste as fertilizer can lead to substantial emissions of N_2O from agricultural soils.

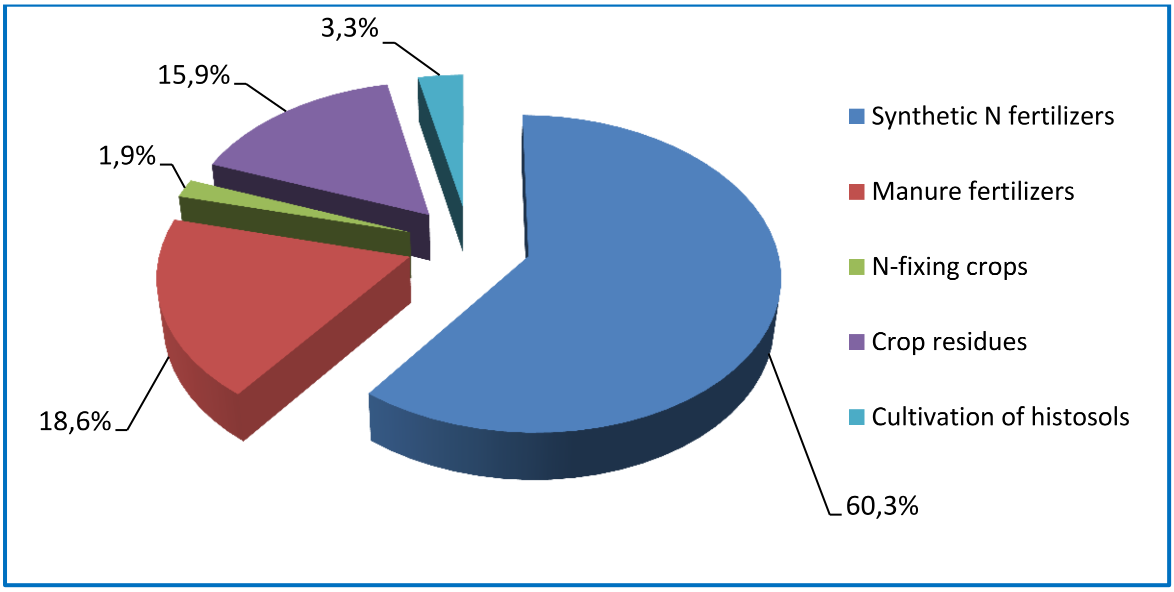


Figure 6-8. Direct N_2O emissions from agricultural soils in 2010 (%)

Calculated emissions

The major part of N_2O direct emissions from agricultural soils in 2010 were caused by synthetic fertilizers (60,3%), crop residues (15,8%) and manure fertilizers (18,6%). For the variation of N_2O emission from agricultural soils in 1990-2010 the biggest influence had usage of nitric fertilizers.

Table 6-48. Direct N_2O emissions from agricultural soils in 1990–2010 by source category (Gg)

Index	Synthetic N fertilizers	Manure fertilizers	N-fixing crops	Crop residues,	Cultivation of histosols
1990	4,33	2,15	0,24	0,92	0,16
1991	3,61	2,00	0,23	0,92	0,15
1992	1,67	1,43	0,03	0,62	0,15
1993	1,02	1,19	0,04	0,84	0,14
1994	0,73	1,06	0,05	0,59	0,14
1995	0,71	1,00	0,06	0,68	0,15
1996	1,40	0,97	0,10	0,89	0,15
1997	1,43	1,01	0,13	0,94	0,15
1998	1,47	0,89	0,12	0,91	0,15
1999	1,66	0,83	0,08	0,76	0,15
2000	1,73	0,73	0,09	0,86	0,15
2001	1,80	0,78	0,06	0,89	0,15
2002	2,03	0,81	0,07	0,82	0,15
2003	2,05	0,84	0,06	0,85	0,15
2004	2,07	0,85	0,07	0,80	0,15
2005	2,10	0,87	0,07	0,76	0,15
2006	2,16	0,89	0,04	0,51	0,15
2007	2,37	0,89	0,07	0,74	0,15
2008	2,18	0,85	0,07	0,76	0,15
2009	2,40	0,81	0,10	0,88	0,15
2010	2,63	0,81	0,08	0,69	0,15

6.5.1.2 Methodological issues

Choice of methods

Nitrogen inputs to soils from main sources were calculated using IPCC Tier 1a method.

Calculation of N_2O emissions

Direct N_2O emissions from agricultural soils have been calculated using equation[59]:

$$N_2O_{DIRECT} – N = ((F_{SN} + F_{AM} + F_{BN} + F_{CR}) \times EF_1) + F_{OS} \times EF_2$$

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_{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:

$$N_2O = N_2O\text{-}N \times 44/28$$

Synthetic N fertilizers (F_{SN}) (CRF 4.D.1.1)

Data about consumption of synthetic fertilizers were collected from different sources:
Statistics Lithuania data for years 1990-1994;
International Fertilizer Industry Association (IFA)[60] data for years 1995-2006;
UAB Agrochema data for years 2007-2010. UAB Agrochema is a single source of information on N fertilizer consumption in Lithuania. UAB Agrochema is retail and wholesale trade company of fertilizers, chemical products for plant protection, seeds, peat products, forages and their supplements, farming goods and building materials, which also produces liquid fertilizers and their compounds. Agrochema is the main distributor of AB Achema production in the Baltic States.

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 ($Frac_{GASF}$)[61]:

[59] IPCC 2000. Agriculture. Eq. 4.20. P. 4.54.
[60] International Fertilizer Industry Association (IFA): http://www.fertilizer.org/
[61] IPCC 2000. Agriculture. Eq. 4.22. P. 4.56.

$$FSN = N_{FERT} \times (1 - FRAC_{GASF})$$

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 IPCC default factors were used (Table 6-49).

Table 6-49. IPCC default factors used for estimation of synthetic fertiliser nitrogen[62]

Factor	Unit
EF1	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 39,3% in 2010 comparing with the base year (Figure 6-9).

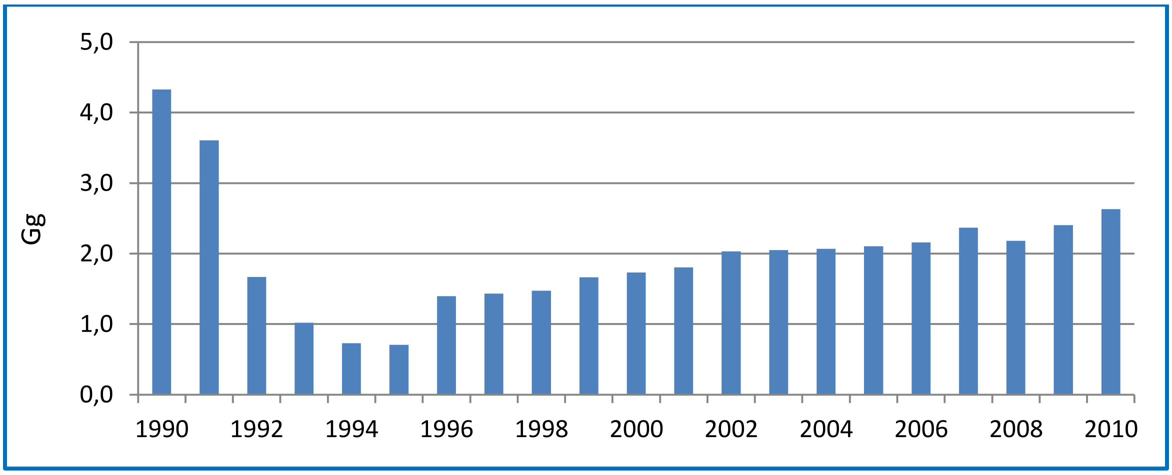


Figure 6-9. Nitrous oxide emission from Synthetic N fertilizers in 1990 – 2010 (Gg)

Animal manure applied to soils (CRF 4.D.1.2)

Data about the number of animals were taken from Statistics Lithuanian and the Register of Agricultural Information and Rural Business Center. The 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.

Animal manure nitrogen (FAM) emits from agricultural soil through manure application to fields as organic fertilizer and animal pastures by grazing of animals were estimated by determining the total amount of animal manure nitrogen produced annually and then

[62] IPCC 1996. Agriculture. P. 4.89, 4.94.

adjusting this amount to account for the animal manure that is volatilized as NH_3 and NO_x ($Frac_{GASM}$)[63]:

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

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.

$$N_2O_{DIRECT} = F_{AM} \times EF_1 \times 44/28$$

To calculate annual amount of Animal Manure nitrogen (F_{AM}) applied to soils IPCC default factors were used (Table 6-50, 6-51).

Table 6-50. IPCC default factors used in the estimation of N_2O emission from animal waste applied to soils[64]

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[65]

The background data used for calculation of fraction of animal manure that is deposited onto soils by grazing livestock ($Frac_{GRAZ}$) is provided in the figures 6-4, 6-5, 6-6 (percentage of manure production per animal waste management systems), tables 6-42 and 6-43 (N excretion values) and tabale 6-44 (default emission factors for N_2O estimation from manure management).

Table 6-51. Fraction of livestock nitrogen excreted and deposited on soil during grazing (%)

Year	Fraction excreted on pasture
1990	26,67
1991	26,68
1992	28,77
1993	29,02
1994	28,53
1995	28,41
1996	29,23
1997	29,19
1998	29,28
1999	29,41
2000	30,21

[63] IPCC 2000. Agriculture. Eq. 4.23. P. 4.56.
[64] IPCC 1996 Agriculture. P. 4.94, 4.97
[65] IPCC 1996. Agriculture. Workbook. Table 4-17. P. 4.35.

2001	29,55
2002	29,25
2003	29,29
2004	29,34
2005	28,79
2006	28,97
2007	29,57
2008	29,73
2009	29,60
2010	29,06

N_2O emission from Manure fertilizer application to soil has decreased by 62,3% in 2010 comparing with 1990 (Figure 6-10). This decrease is associated with reduction of livestock population.

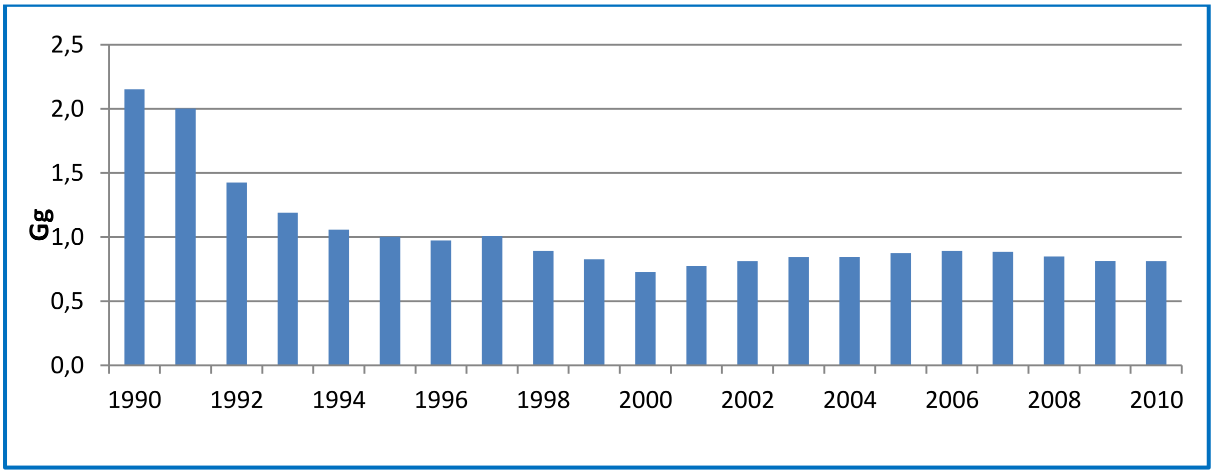


Figure 6-10. Nitrous oxide emission from Manure fertilizers in 1990 – 2010 (Gg)

N-fixing crops (CRF 4.D.1.3)

Data on the area of cultivated land and crop and on crop yield was taken from the Statistics Lithuania „Agriculture in Lithuania 2010".

N_2O emission (F_{BN}) of nitrogen stored crop was estimated in accordance with common leguminous plant yield (Table 6-52).

Table 6-52. Yield of legumes in Lithuania in 1990-2010 (k tonnes)

Year	Yield
1990	200,2
1991	194,2
1992	27,5
1993	35,3
1994	39,6
1995	47,5
1996	87,4
1997	106,4

1998	104,1
1999	63,8
2000	73,0
2001	52,2
2002	62,9
2003	48,5
2004	57,5
2005	58,9
2006	34,9
2007	56,4
2008	62,3
2009	85,7
2010	70,1

The IPCC Guidelines also assumes that the mass ratio of residue to product is 1 (i,e, the total aboveground plant biomass is 2 times the crop product), Therefore, the amount of fixed N is estimated by multiplying the seed yield of pulses ($Crop_{BF}$) by a default value of 2 and then by the fraction of crop biomass that is nitrogen ($Frac_{NCRBF}$)[66]:

$$F_{BN} = 2 \times Crop_{BF} \times Frac_{NCRBF}$$

where:
$Crop_{BF}$ – production of pulses, kg dry biomass/yr;
$Frac_{NCRBF}$ – fraction of nitrogen in N-fixing crop, kg N/kg of dry biomass;
$N_2O_{DIRECT} = F_{BN} \times EF_1 \times 44/28$.

To calculate the annual amount of nitrogen from N-fixing crops applied to soils IPCC default factors were used (Table 6-53).

Table 6-53. IPCC default factors used in the estimation of N_2O emission from N-fixing crops applied to soils[67]

Factor	Unit
$Frac_{NCRBF}$	0,03 kg N/kg of dry biomass
N_2O EF	0,0125 kg N_2O-N/kg N

Crop residue (CRF 4.D.1.4)

The amount of nitrogen returning to soils annually through incorporation of crop residues (FCR) were estimated by determining the total amount of crop residue N produced (from both non-nitrogen-fixing crops and N-fixing crops). The annual production of residue N is estimated by multiplying annual crop production of N-fixing (Table 6-52) crops ($Crop_{BF}$) and other crops ($Crop_O$) (Table 6-54) by their respective N contents ($Frac_{NCRBF}$ and $Frac_{NCRO}$) summing these two nitrogen values, multiplying by a default value of 2 (to yield total aboveground crop biomass). and then adjusting for the amount of total aboveground crop biomass that is removed from the field as product ($Frac_R$)[68].

[66] IPCC 2000. Agriculture. Eq. 4.25. P. 4.57.
[67] IPCC 1996. Agriculture. P. 4.89, 4.94.
[68] IPCC 2000. Agriculture. Eq. 4.28. P. 4.58.

Table 6-54. Crop yield in Lithuania in 1990-2010 (k tonnes)

Year	Plants								
	Winter cereals	Spring cereals	Flax seed	Linseed	Winter rape	Summer rape	Sugar beet	Potatoes	Vegetables
1990	1651,5	1413,4	10,2	0	23,9	4,1	718,1	1573,1	295,0
1991	1192,2	1961,1	10,2	0	12,3	0,2	811,2	1508,3	398,4
1992	1174,0	1023,6	3,1	0	7,5	0,1	621,5	1079,2	259,8
1993	1370,1	1302,4	1,2	0	1,6	1,5	855,3	1772,6	376,0
1994	907,4	1190,8	3,5	0	1,1	12,1	461,5	1096,4	282,6
1995	902,0	1004,5	6,5	0	4,9	14,0	692,4	1593,5	368,7
1996	1222,3	1392,8	3,2	0	1,7	20,9	795,5	2044,3	432,6
1997	1429,0	1516,3	2,9	0	0,8	36,4	1001,9	1829,8	415,0
1998	1307,5	1409,3	2,7	0	2,3	69,6	949,2	1849,2	436,9
1999	982,7	1065,9	3,7	0	4,8	110,3	869,9	1708,1	436,9
2000	1410,1	1247,6	2,7	0	11,9	69,1	881,6	1791,6	329,4
2001	1242,0	1103,3	0,9	0	22,4	42,4	880,4	1054,4	322,0
2002	1329,8	1209,3	2,5	0,2	43,9	61,7	1052,4	1531,3	290,0
2003	1386,4	1245,4	2,2	0,5	13,9	105,6	977,4	1445,2	549,3
2004	1663,0	1196,4	1,6	0,2	65,6	139,1	904,9	1021,4	379,4
2005	1458,1	1353,0	1,3	0,7	72,6	128,6	798,5	894,7	369,2
2006	822,0	1035,8	0,1	0,6	45,8	123,8	717,1	457,1	225,5
2007	1553,3	1463,7	0,1	0,2	141,8	170,1	799,9	576,1	281,9
2008	1921,3	1500,6	0,0	0,2	178,7	151,5	339,1	716,4	310,4
2009	2440,5	1366,1	0,0	0,2	269,6	146,2	682,0	662,5	321,7
2010	1592,5	1204,6	0,0	0,2	177,6	239,1	722,5	476,9	188,6

$$F_{CR} = 2 \times (Crop_O \times Frac_{NCRO} + Crop_{BF} \times Frac_{NCRBF}) \times (1 - Frac_R) \times (1 - Frac_{FOD})$$

where:
2 – conversion factor of crop production to total crop biomass;
$Crop_0$ – production of non-N-fixing crops, kg dry biomass/yr;
$Frac_{NCRO}$ – fraction of nitrogen in non-N-fixing crops, kg N/kg of dry biomass;
$Crop_{BF}$ – production of pulses in country, kg dry biomass/yr;
$Frac_R$ – the fraction of residue removed from the field as a product, N/kg crop-N;
$Frac_{FOD}$ – the fraction of residue used as fodder, N/kg crop-N.

IPCC default emission factors and other parameters used for emission estimates are presented in Table 6-55. The value of $Frac_{FOD}$ was estimated by expert judgement – 0,55 kg N/kg crop-N.

Table 6-55. IPCC default factor used in the estimation of N_2O emission from crop residue returned to soils[69]

Factor	Unit
N_2O EF	0,0125 kg N_2O-N/kg dry biomass
$Frac_{NCRO}$	0,015 kg N/kg of dry biomass
$Frac_{NCRBF}$	0,03 kg N/kg of dry biomass
$Frac_R$	0,45 kg N/kg crop-N

[69] IPCC 1996. Agriculture. P. 4.89, 4.94.

Cultivation of histosols (CRF 4.D.1.5)

For assessment of organic soils (histosols)[70] data from the study on economic evaluation of Lithuanian wetlands was used.
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:

$$N_2Odirect = Area \times EF_2 \times 44/28$$

where:
EF_2 – 8 kg N_2O-N/ha/year[71].

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.
In addition, source category-specific quality control procedures have been carried out in this submission. The national data on synthetic fertilizers use for years 1990-1994 and 2007-2009 was compared to International Fertilizers Industry Association (IFA) data. For 1990-1994 years, the difference between those data is on average 14%, but for years 2007-2009 correspondence between the data is much higher, about 3,5% on average (national data on fertilizers consumption used in GHG inventory is higher than IFA's data).

6.5.1.5 Source-specific recalculations

Recalculation of N-excretion for dairy cattle, non-dairy cattle and swine caused certain changes in evaluated N_2O emissions from manure application on agricultural soils (Table 6-56).

Recalculation of emission from synthetic fertilizers use is related to update and correction of activity data for the years 2003-2004, 2006 and 2008.

[70] Lietuvos pelkių ekonominis vertinimas. Ataskaita, Aplinkos apsaugos politikos centras, 2010
[71] IPCC 2000. Agriculture. P. 4.60.

Table 6-56. Reported in previous submission and recalculated N_2O emission from animal manure applied to soils (Gg)

Year	Previous submission	This submission	Absolute difference	Relative, %
1990	2,08	2,15	0,07	3,37
1991	1,96	2,00	0,04	2,04
1992	1,36	1,43	0,07	5,15
1993	1,16	1,19	0,03	2,59
1994	1,03	1,06	0,03	2,91
1995	0,99	1,00	0,01	1,01
1996	0,96	0,97	0,01	1,04
1997	0,96	1,01	0,05	5,21
1998	0,89	0,89	0,00	0,00
1999	0,83	0,83	0,00	0,00
2000	0,75	0,73	-0,02	-2,67
2001	0,82	0,78	-0,04	-4,88
2002	0,86	0,81	-0,05	-5,81
2003	0,91	0,84	-0,07	-7,69
2004	0,92	0,85	-0,07	-7,61
2005	0,96	0,87	-0,09	-9,38
2006	1,00	0,89	-0,11	-11,00
2007	0,94	0,89	-0,05	-5,32
2008	0,94	0,85	-0,09	-9,57
2009	0,90	0,81	-0,09	-10,00

6.5.1.6 Source-specific planned improvements

The investigation on possibilities to use a higher-tier method and country-specific EFs for the estimation of emissions from this category is planned.

6.5.2 Pasture, range and paddock manure (CRF 4.D.2)

6.5.2.1 Source category description

N_2O emission from pasture, range and paddock manure in the time-period decreased by 58% due to decrease in number of livestock population (Figure 6-11).

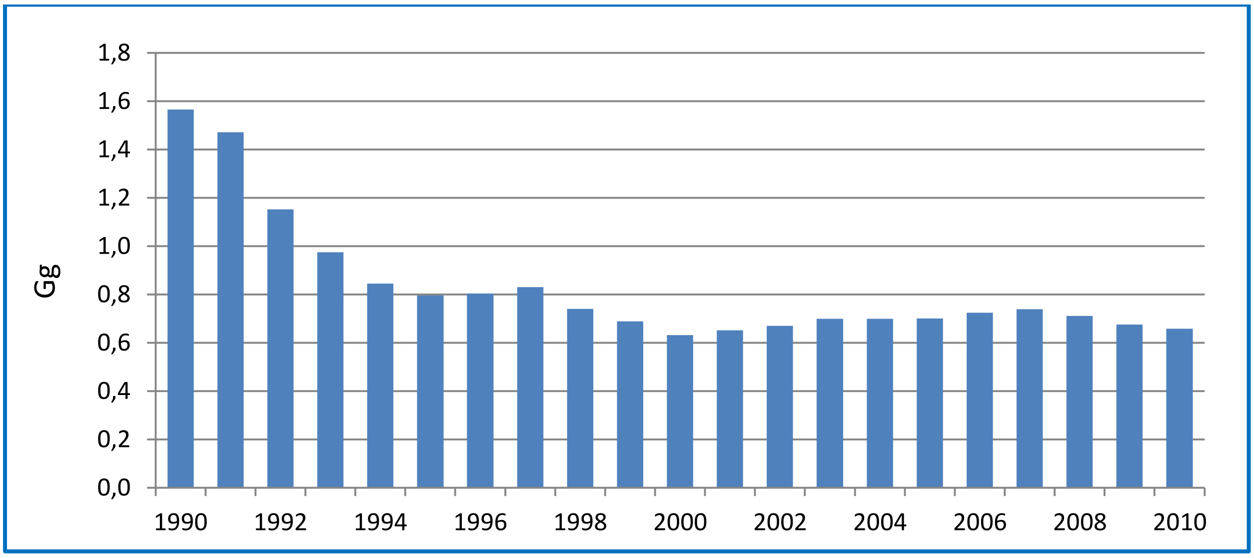


Figure 6-11. Nitrous oxide emission from Pasture, range and paddock manure in 1990 – 2010 (Gg)

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 (CRF 4.B (b)) – N_2O emissions).

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-excretion for cattle was recalculated using new data on animal herd structure and protein consumption (table 6-57).

Table 6-57. Reported in previous submission and recalculated N-excretion from pasture, range and paddock manure (Gg N/yr)

Year	Previous submission	This submission	Absolute difference	Relative, %
1990	39,91	49,84	9,93	24,88
1991	38,75	46,82	8,07	20,83

1992	31,24	36,67	5,43	17,38
1993	27,41	31,02	3,61	13,17
1994	24,05	26,89	2,84	11,81
1995	22,79	25,34	2,55	11,19
1996	23,04	25,59	2,55	11,07
1997	22,55	26,44	3,89	17,25
1998	20,94	23,55	2,61	12,46
1999	20,05	21,92	1,87	9,33
2000	18,71	20,11	1,40	7,48
2001	19,71	20,71	1,00	5,07
2002	20,35	21,33	0,98	4,82
2003	21,15	22,27	1,12	5,3
2004	21,31	22,27	0,96	4,5
2005	21,54	22,29	0,75	3,48
2006	22,17	23,06	0,89	3,86
2007	22,22	23,51	1,29	5,49
2008	22,24	22,62	0,38	1,68
2009	20,90	21,49	0,59	2,75

6.5.2.6 Source-specific planned improvements

No improvements are planned.

6.6 Agricultural soils (CRF 4.D.3) – indirect emissions

6.6.1 Source category description

As indirect emissions of N_2O, emissions from leaching and runoff of the applied or deposited on soils Nitrogen and atmospheric deposition on soils of NO_X and ammonium were estimated.

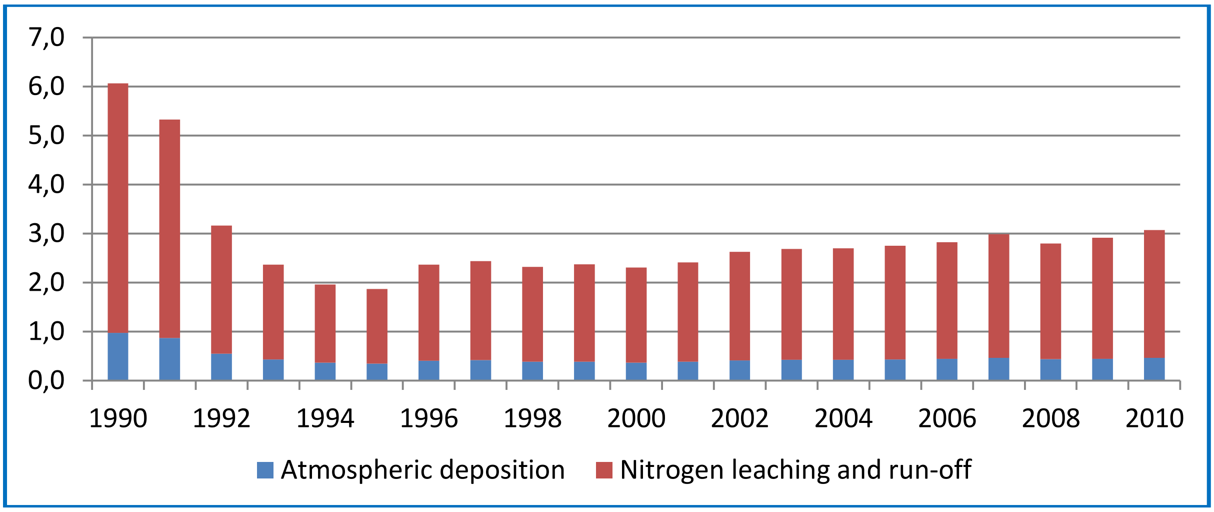


Figure 6-12. Indirect N_2O emissions from agricultural soils in 1990–2010 (Gg)

N_2O emission from atmospheric deposition and nitrogen leaching and run-off in 2010 decreased by 52,6% and 48,7% respectively comparing to 1990 due to decrease of consumption of synthetic fertilizers and number of livestock population (Figure 6-12).

6.6.2 Methodological issues

Choice of methods

The default Tier 1a method was used to estimate emissions from atmospheric deposition.

Activity data

Activity data used to the estimation of N_2O emission from agricultural soils were amount of nitrogen applied to soils from synthetic fertilizers and manure N excreted.

Emission factors

Atmospheric deposition

Atmospheric deposition in our calculations includes the emission from livestock manure and use of synthetic fertilizers applied to agricultural soils. According to the IPCC Guidelines (1996), the amount of applied agricultural N that volatilizes and subsequently deposits on nearby soils is equal to the total amount of synthetic fertilizer nitrogen applied to soils (N_{FERT}) plus the total amount of animal manure nitrogen excreted in the country multiplied by appropriate volatilization factors. The volatilized N is then multiplied by an emission factor for atmospheric deposition (Table 6-57) to estimate N_2O emissions[72]:

$$N_2O_{(atmospheric\ deposition)} = (N_{FERT}\ x\ Frac_{GASF} + N_{EX}\ x\ Frac_{GASM})\ x\ EF_{deposited}$$

where :
N_{FERT} – total amount of synthetic nitrogen fertilizer applied to soils, kg N/yr;
$Frac_{GASF}$ – fraction of synthetic fertilizer nitrogen applied to soils that volatilizes as NH_3 and NO_x (kg NH_3 – N and NO_x–N/kg of N input);
N_{EX} – total amount of animal manure nitrogen excreted in a country, kg N/yr;
$Frac_{GASM}$ – fraction of livestock nitrogen excretion that 260ertilizer260 volatilises as NH_3 and NO_x (kg NH_3-N and NO_x–N/kg of N excreted);
$EF_{deposited}$ – emission factor for atmospheric deposition (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:

$$N_2O = N_2O\text{-}N\ x\ 44/28.$$

Table 6-58. IPCC default factors used in the estimation of indirect nitrous oxide emissions from atmospheric deposition[73]

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

Leaching and runoff (4 D.3.2)

To estimate the amount of applied N that leaches or runs off (N_{LEACH}) in country using the method in the IPCC Guidelines, the total amount of synthetic fertilizer nitrogen (N_{FERT}) applied to the soils and the total amount of animal N excretion in the country are summed and then multiplied by the fraction of N input that is lost through leaching and run-off ($Frac_{LEACH}$) (Table 6-58):

$$N_{LEACH} = (N_{FERT} + Nex)\ x\ Frac_{LEACH}$$

where:
N_{FERT} – total amount of synthetic nitrogen fertilizer applied to soils, kg N/yr;
N_{EX} – total amount of animal manure nitrogen excreted in a country, kg N/yr;
$Frac_{LEACH}$ – fraction of nitrogen input to soils that is lost through leaching and runoff
(kg N/kg of nitrogen applied).

N_{LEACH} is then multiplied by the emission factor for leaching/runoff (EF) to obtain emissions of N_2O in units of N, N_2O:

$$N_2O(_{LEACH}) = N_{LEACH}\ x\ EF_{leaxed}$$

[72] IPCC 1996. Agriculture. P. 4.40.
[73] IPCC 1996. Agriculture. P. 4.94, 4.105

where:
N_{LEACH} – N leaching in country (kg N/yr);
EF_{leaxed} – 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:

$$N_2O = N_2O–N \times 44/28.$$

Table 6-59. IPCC default factors used in the estimation of indirect nitrous oxide emissions from nitrogen leaching and run- off[74]

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

6.6.3 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%.

6.6.4 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.

6.6.5 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 (Table 6-60).

Table 6-60. Reported in previous submission and recalculated indirect nitrous oxide emission from agricultural soils (Gg)

Submission	Previous submission	This submission	Absolute difference	Relative, %
1990	5,84	6,06	0,22	3,63
1991	5,17	5,33	0,16	3,00
1992	3,02	3,16	0,14	4,43
1993	2,28	2,37	0,09	3,80
1994	1,89	1,96	0,07	3,57
1995	1,81	1,87	0,06	3,21
1996	2,31	2,36	0,05	2,12
1997	2,33	2,44	0,11	4,51

[74] IPCC 1996. Agriculture. P. 4.105-4.106.

1998	2,27	2,31	0,04	1,73
1999	2,35	2,37	0,02	0,84
2000	2,30	2,30	0,00	0,00
2001	2,43	2,41	-0,02	-0,83
2002	2,66	2,62	-0,04	-1,53
2003	2,81	2,68	-0,13	-4,85
2004	2,83	2,70	-0,13	-4,81
2005	2,82	2,75	-0,07	-2,55
2006	3,55	2,82	-0,73	-25,89
2007	3,02	2,98	-0,04	-1,34
2008	2,87	2,79	-0,08	-2,87
2009	2,98	2,91	-0,07	-2,41

6.6.6 Source-specific planned improvements

No improvements are planned.

6.7 Prescribed burning of savannas (CRF 4.E)

Savannas do not exist in Lithuania.

6.8 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)[75], therefore emission from field burning of agricultural residues is reported as "NO".

[75] 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 organisations and activities are responsible for provision of the official data about various land use categories and their use in Lithuania. These organisations and activities are presented below:

- National Land Service (NLS) under the Ministry of Agriculture (www.nzt.lt) provides data on the Lithuanian Land Fund and its data distributed between 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 (http://www.amvmt.lt).

- 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, cuttings, deadwood etc.). Data for this dataset is collected by sampling method from 1998.

Official statistics about land use categories and their use in Lithuania:

- Statistics Lithuania publishes statistical information in their annual publications "Statistical Yearbook of Lithuania" and statistics databases on the web (www.stat.gov.lt/en/).

- Statistical data about Lithuanian forests and forestry are published in annual reports "Forest assessment", annual publications "Lithuanian Statistical Yearbook of Forestry" and periodic publications of NFI (http://www.amvmt.lt), FAO country reports (http://www.fao.org/forestry/fra/en/).

- National Land Service publishes annual statistical information about all land that covers Lithuanian territory in publication "Land Fund of the Republic of Lithuania". The latest edition is available on the web (www.zis.lt/download.php/fileid/73).

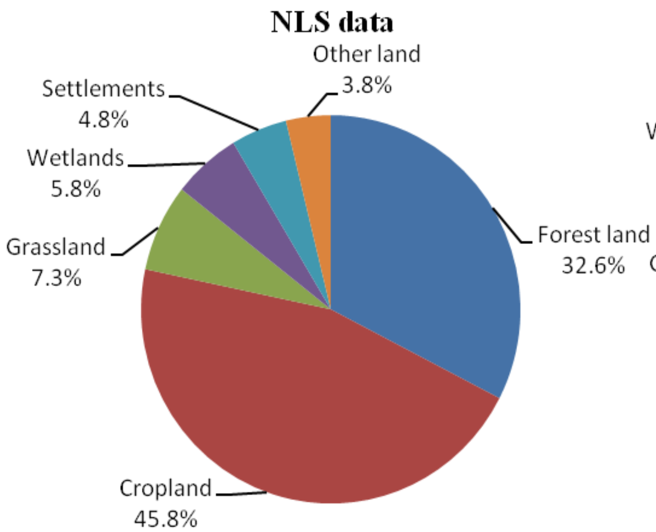
Following the requirements of *Good Practice Guidance for Land Use, Land-Use Change and Forestry*, IPCC 2003 (*IPCC GPG LULUCF*) provision of official statistics was improved, land-use area and their changes assessment has been done or is still in progress by State Forest Service using permanent sample plots net of NFI:

1) For the period 1990-2011 using data of the special studies,
2) From 2012 by direct annual field measurements.

Above mentioned data sources that have been used for determination of total land area, not always were precise. Mostly they were fragmented and did not cover the whole 1990-2010 period. Due to different inventory methodologies and land use categories definitions used for each inventory, the results did not complied each other. Furthermore, land use categories definitions used by the statistics on which basis land area was estimated do not complied with the *IPCC GPG LULUCF* (Table 7-5). For instance, meadows and natural pastures were assigned to croplands in national definition, though it comes under grassland category by *IPCC GPG LULUCF* definition. Therefore, implementing United Nations Framework Convention on Climate Change (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. Study "Changes of areas of Croplands, Grasslands, Wetlands, Settlements and Other lands in Lithuania during 1990-2011" (*Study-2*) – addressed to track the changes of croplands, grasslands, wetlands, settlements and other lands. The main difference of these studies comparing with the previous practice was recalculation of all area changes (and construction of area change matrix) using single data collection instrument – uniform network of NFI permanent sample plots and secondly – basing all the computations and assumptions on data directly collected from the individual plots. Therefore, one of the fundamental results of these studies was creation of a single and comprehensive database of land use in Lithuania. Furthermore, during the *Study-1*, analyzing historical datasets of Lithuanian State Forest Cadastre, aerial photography archives of SLF and other available material with the help of GIS techniques wall to wall areas specific to Afforestation, Reforestation and Deforestation were mapped, identified and accordingly classified.

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 01.01.2011.

According to completed *Study-1* and *Study-2* data, total land area is 6.530 thousand hectares. Forest land occupy 33,2%, croplands – 32,1%, grasslands – 24,2%, wetlands – 5,3%, settlements – 5,1% and other land – 0,2% of the total land area in Lithuania (Figure 7-1) .



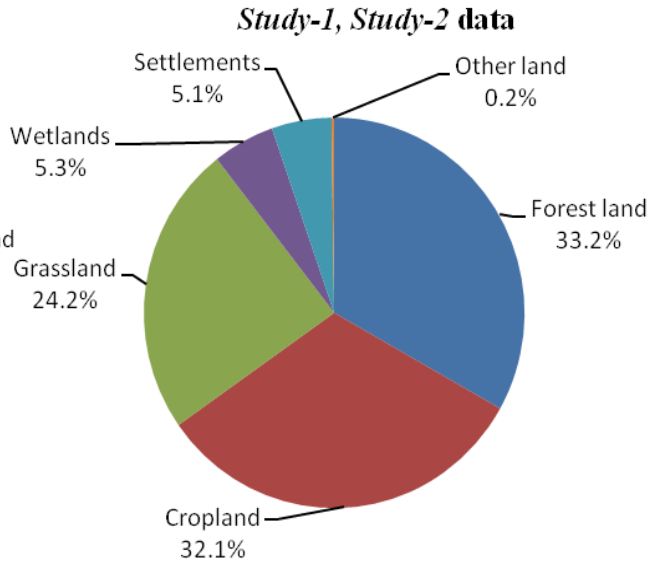


Figure 7-1. Composition of land-use categories by NLS and *Study-1, Study-2* data. 01.01.2011

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 categories in LULUCF sector in 2010

IPCC source category	Gas	Identification criteria
5.A.1. Forest Land remaining Forest Land	CO_2	L, T
5.A.2. Land Converted to Forest Land	CO_2	L, T
5.B. Cropland	CO_2	T
5.C. Grassland	CO_2	L, T

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 mid of April of 2012 and explicit study results are available in the prepared report[76].

The *Study-1* was aimed to identify annual forest land areas and the changes which occurred in Lithuania during the period of 1990-2011, following the *IPCC GPG LULUCF* (IPCC 2003) and the requirements of UNFCCC and the Kyoto Protocol for LULUCF.

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 the 1950s. Orthophotos based on the aerial photography 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 validated for any topological errors, like overlapping polygons, gaps, etc. In addition to forest land, the database includes polygons identified as wooded areas on peat lands, city forests and parks, etc.

Next, annual identification of forest land covers and forest land-uses was carried out on 16325 systematically distributed sample plots available from Lithuanian National Forest Inventory focusing on the period of 1990-2011 and using the definitions of valid versions of Lithuanian Forest Law and *IPCC GPG LULUCF*. 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

[76] 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.

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 beginning of NFI. All sample plots were manually inspected and the solutions taken were based on the decisions of experienced engineers with the practise on forest inventory.

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 (NPA) information on agriculture, non agriculture and abandoned land afforestation, Lithuanian forest resource database at a scale of 1:50 000, all the available country orthophotos that were developed during the analysis of the period, satellite maps from CORINE IMAGE, http://earthexplorer.usgs.gov/, 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 the 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 rise was estimated, subtracting the age of stand from 2011 (and adding 10 for naturally grown forests). After, 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 that: 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 done 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 currently available but missing 50 years ago (according to the database developed and referring to the 1950s). Extra solution to identify afforestation/reforestation was to use stand attribute coming from stand register and stating the forest compartment to be first time inventoried during the last stand-wise forest inventory. However, such approach faced some limitations to reflect the 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 the boundaries of stands, established already after the stand-wise inventory. Several solutions were used to fill such information gaps. First off all, information from the recent stand-wise forest inventories was acquired from forest inventory contractors, which had not been officially delivered to the SFS yet. 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 some facts on newly established forests. And, finally, data from National Paying Agency were acquired to represent the borders of afforestation, which 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 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 1950's.

Several techniques were used to detect deforested areas during the last two decades. First off all, deforestation accounted in the SFC was taken into account. Recently non-forest land types, identified as forest stands 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, 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 National Forest Inventory 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 to store the forest land-use polygons, distributed by feature classes representing forest land remaining forest land (F1), forest land remaining forest land but with the forest which 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) for the period 1990-2011 which fits the requirements of *IPCC GPG LULUCF*. The *Study-1* also resulted enhancement of forest inventory, introducing mandatory registration of all forest compartments fitting the afforestation/reforestation requirements of *IPCC GPG LULUCF*, and the development of GIS based forest cadastre information system following the principles of continuous forest management.

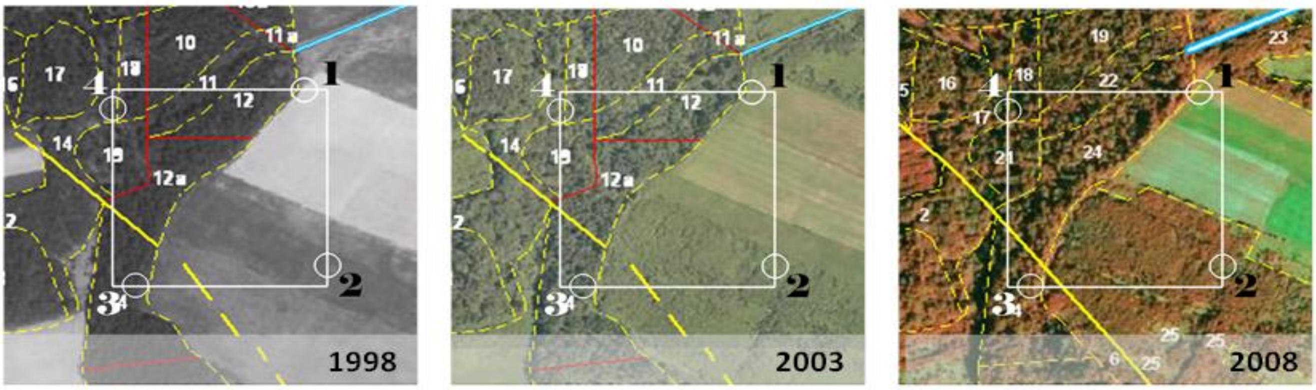


Figure 7-2. Land use changes according to NFI data

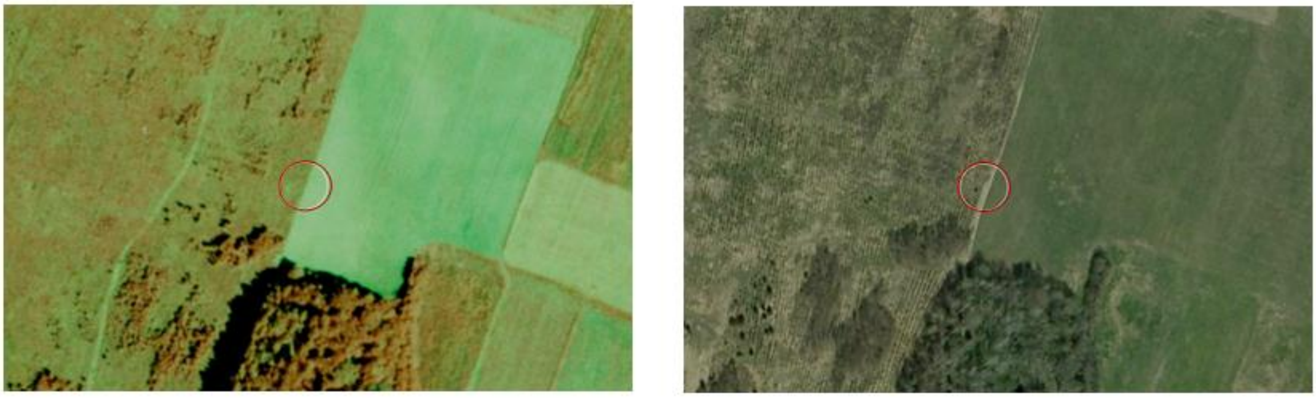


Figure 7-3. Grassland converted to Forest Land

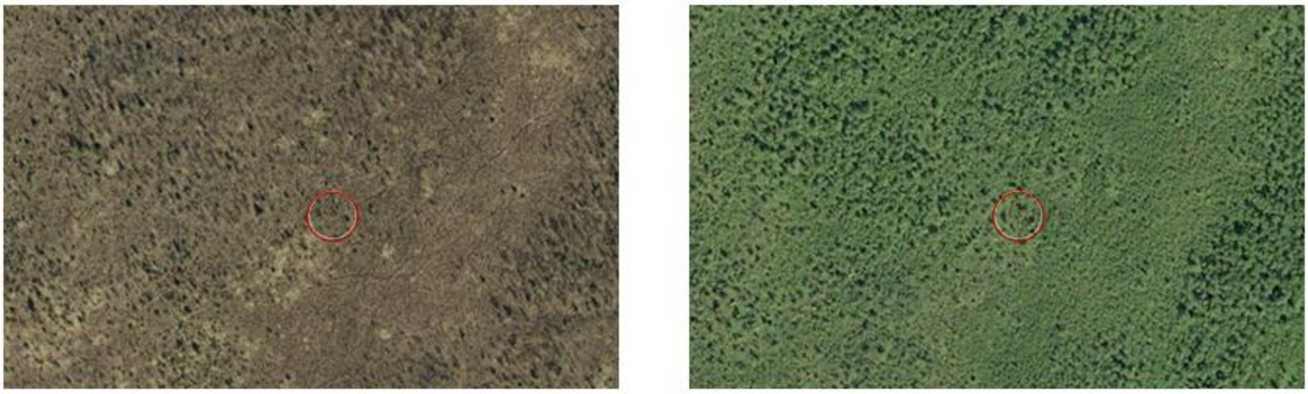


Figure 7-4. Wetland converted to Forest Land

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 S*tudy-2* was completed in the end of April 2012.

The *Study-2* 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 *IPCC GPG LULUCF*.

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 analyzing all available historical data on land uses in statistical and graphical form and 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, land areas and croplands declaration database.

Land areas and their changes were assessed based on National Forest Inventory sample plots grid and land fund statistical data together with digital orthophotomaps, satellite images and database of land areas and croplands declarations. 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. 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 is presented in Figure 7-5.

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 7-5. 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.

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 2010, ha (01.01.2010 - 01.01.2011)

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2159625	399	5592	399	0	0	**2166016**	6391
Cropland	0	2087731	5592	0	0	0	**2093323**	3196
Grassland	0	1997	1578879	1198	0	0	**1582074**	-7987
Wetlands	0	0	0	343096	0	0	**343096**	-1597
Settlements	0	0	0	0	330714	0	**330714**	0
Other land	0	0	0	0	0	14778	**14778**	0
Initial	***2159625***	***2090127***	***1590061***	***344693***	***330714***	***14778***	***6530000***	0

The summary of the carbon stoch 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*

7.1.3 National definitions for all categories used in the inventory

Forest land is defined according to Law on Forests 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 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 the reporting

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. 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. All grasslands are managed land.

Wetlands. 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.

Settlements. 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.

Other land. 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 the area of other land is reported.

Table 7-5. National definitions for land use categories and relevant land use category defined in *IPCC GPG LULUCF*

National definitions for land use categories and subcategories											
Agricultural land							Other land				
Arable land	Orchards and berry plantations	Meadows and natural pastures	Forest land	Roads	Settlements	Water bodies	Swamps (bogs)	Trees and bushes plantations in urban areas	Disturbed land	Unmanaged land	

Relevant category in IPCC GPG LULUCF 2003						
Cropland	Grassland	Forest land	Settlements	Wetlands	Settlements	Other land

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 7-6). Natural and human induced afforestation resulted 103,0 thousands ha of gain in Forest land category from 1990 till now (Table 7-7). Since 1946 forest area in Lithuania increased more than one third, in some counties almost twice.

Declared croplands area in Lithuania was decreasing since 1990 to 2005. Reasons for that are significant reforms that were introduced in the early 90s, particularly after the restoration of independence, to re-establish 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 small holdings, averaging 8,8 ha in size, often not large enough to be economically viable.

Exchange in places by cropland and grassland occupied area since 2005 could be mainly due to introduced Single Area Payment Scheme (SAPS) in Lithuania since 2004. This is a form of support whereby direct payment is made for agricultural land irrespective of the type of production carried out on the land, what might affected 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 4th 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 Investments into Agricultural Holdings measure. Both these measures resulted in peoples' take up in agricultural land management, though increment in croplands and decrease in grasslands that were ploughed etc.

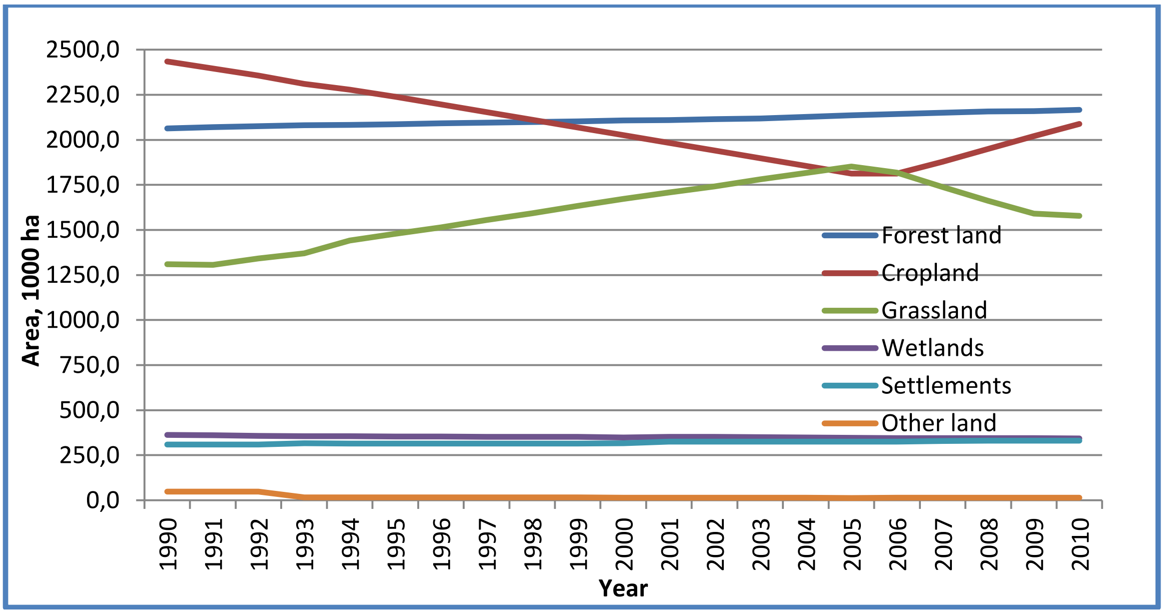


Figure 7-6. Land use changes

Table 7-6. National land use data for 1990-2010, thous. ha[77]

Years	Forest	Cropland	Grassland	Wetlands	Settlements	Other land	TOTAL
1990	2063,0	2435,2	1310,5	362,7	309,9	48,7	6530
1991	2069,8	2396,1	1345,6	360,3	309,5	48,7	6530
1992	2075,7	2356,9	1381,2	358,3	309,5	48,3	6530
1993	2080,9	2317,8	1443,5	355,9	316,0	16,0	6530
1994	2083,7	2278,7	1480,2	355,5	315,5	16,4	6530
1995	2086,1	2239,5	1517,8	354,7	315,5	16,4	6530
1996	2091,3	2196,9	1556,8	353,1	315,5	16,4	6530
1997	2094,9	2154,3	1596,2	352,7	315,5	16,4	6530
1998	2098,9	2111,7	1635,2	352,7	315,5	16,0	6530
1999	2101,7	2069,0	1675,9	351,9	315,5	16,0	6530
2000	2106,9	2026,4	1715,7	349,1	317,1	14,8	6530
2001	2110,1	1983,8	1745,1	351,5	325,5	14,0	6530
2002	2114,1	1941,2	1783,7	351,5	325,5	14,0	6530
2003	2119,3	1898,6	1822,4	350,7	325,1	14,0	6530
2004	2127,3	1856,0	1858,2	349,1	325,5	14,0	6530
2005	2135,7	1813,3	1894,4	347,5	325,5	13,6	6530
2006	2142,9	1882,5	1818,8	345,9	325,9	14,0	6530
2007	2151,2	1951,7	1738,4	344,3	329,9	14,4	6530
2008	2157,2	2020,9	1662,5	344,3	330,3	14,8	6530

[77] *Data used: Forest Land – Study-1; Cropland, Grassland, Wetland, Settlement, Other Land – Study-2.*

2009	2159,6	2090,1	1590,1	344,7	330,7	14,8	6530
2010	2166,0	2093,3	1582,1	343,1	330,7	14,8	6530

Table 7-7. Land use changes between 1990 and 2010

Land use	**1990**	**2010**	**LUC**	**Activity data provider**
	thous. ha			
Forest Land (FL)	2063,0	2166,0	103,0	*Study-1*
Cropland (CL)	2435,2	2093,3	-341,9	*Study-2*
Grassland (GL)	1310,5	1582,1	271,6	*Study-2*
Wetland (WL)	362,7	343,1	-19,6	*Study-2*
Settlements (SL)	309,9	330,7	20,8	*Study-2*
Other Land (OL)	48,7	14,8	-33,9	*Study-2*

7.1.5 GHG sinks and releases

Annual CO_2 emissions and removals for the period 1990-2010 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 1696,8 Gg CO_2 in 1996 and removals ranging from -97,0 Gg CO_2 to -11741,9 Gg CO_2 during the period of 1990 to 2010. In average -5761,6 Gg CO_2 are removed every year. Removal of CO_2 mainly corresponds to forest land. Changes in emissions/removals from cropland and grassland comparing with previous submission have been caused by new land categories estimations made by National Land Fund finalizing *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	-7207,5	354,8	461,5	72,7	NA,NO	NA,NO	-6318,4
1991	-7206,7	136,0	15,9	72,7	NA,NO	NA,NO	-6982,1
1992	-7119,3	140,1	28,4	72,7	NA,NO	NA,NO	-6878,0
1993	-7206,2	78,3	200,4	179,7	5301,2	629,5	-817,1
1994	-6733,2	141,5	58,4	75,3	NA,NO	242,6	-6215,4
1995	-4098,1	138,8	71,6	74,9	NA,NO	NA,NO	-3812,9
1996	1437,5	136,0	48,6	74,7	NA,NO	NA,NO	1696,8
1997	-360,2	128,9	67,2	67,1	NA,NO	NA,NO	-97,0
1998	-7943,0	132,8	71,3	68,0	NA,NO	NA,NO	-7670,9
1999	-7601,2	136,7	90,4	168,8	NA,NO	NA,NO	-7205,3
2000	-8545,2	171,6	118,8	74,5	567,8	1,8	-7610,7
2001	-11221,9	16,3	195,5	94,9	2661,7	383,4	-7870,1
2002	-2847,2	192,9	123,5	58,2	NA,NO	NA,NO	-2472,7
2003	-9122,0	3,8	146,4	157,3	NA,NO	NA,NO	-8814,5
2004	-5654,0	-3,5	155,7	160,7	NA,NO	NA,NO	-5341,1
2005	-3030,0	-3,9	167,3	55,8	NA,NO	NA,NO	-2810,9
2006	-4707,6	-463,3	657,9	57,6	251,9	251,9	-3951,7
2007	-3421,8	-645,7	612,6	66,6	1335,0	278,5	-1774,8
2008	-8243,0	-616,7	586,5	62,8	372,5	275,0	-7562,7

2009	-11316,1	-564,8	565,1	80,0	255,4	NA,NO	-10980,3
2010	-12303,6	-30,3	535,5	56,5	NA,NO	NA,NO	-11741,9

7.2 Forest land (CRF 5.A)

As it was stated above forest definition used in submissions is 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. All forest land is considered as managed.

7.2.1 Source category description

Estimations of forest land area were based on *Study-1* – "Forest land changes in Lithuania during 1990-2011" that was launched implementing UNFCCC and its Kyoto Protocol requirements in order to comprehensively identify and quantify areas specific to LULUCF activities annually in the period of 1990-2011.

The main objective of the study was, to identify forest land areas and their changes in Lithuania during 1990-2011 following the requirements of *IPCC GPG LULUCF*. 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 areas – where forest has never been growing before the afforestation for at least 50 years (A1), and where forest has been growing before the afforestation for at least 50 years (R1);
- naturally afforested areas, where forest has never been growing before the afforestation for at least 50 years (A2), and where forest has been growing before the afforestation for at least 50 years (R2);
- deforested areas (D).

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 were not included.

Following the recommendations of *Study-1* forest area submitted:
1) Using sampling data: whole forest land, FF, FM, LF, A2, R2;
2) Using compartment data with forest units boundaries: A1, R1, D.

The main data sources used:

1. National forest inventory (NFI) data, executed on 16325 systematically distributed permanent sample plots[78];
2. State Forest Cadastre database[79] of 1,3 mill forest compartments (01.01.2010);
3. Standwise forest inventory data (1987-1998);
4. National Paying Agency data of declarations on afforestated areas (2010-2011).

Other data sources used for estimation of forest area are listed in table 7-9.

Table 7-9. Cartographical data sources used for forest area estimations

Sources used	Data presented	Scale
Orthophoto maps	*SFI*[80]: 2001-2005; 2008-2010. *NLF*[81]: 1995-1999; 2005, 2009, 2010	1:10000
Standwise Forest Inventory maps	1982-2010	1:10000
Maps of Lithuanian Forest Resources	1998-1999	1:50000
Topographical maps	1973-1990	1:50000
Archive cartographical material	1946-1949	1:50000

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[82].) and it is conducted by the State Forest Service following the Regulations of National Forest Inventory, approved in 2004 and revised in 2012.

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 7-7) 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.

[78] *NFI field manual, 1998*

[79] Dėl Lietuvos Respublikos miškų valstybės kadastro duomenų rinkimo, saugojimo ir teikimo tvarkos aprašo patvirtinimo. 2010-01-14. [*en. Adoption of description of order for collection, storage and provision of cadastral data under Lithuanian State Forest Cadastre*]

[80] *Standwise Forest Inventory*

[81] *National Land Fund*

[82] *Forest Law of the Republic of Lithuania. 10.04.2010. Nr. IX-240, Žin., 2001, Nr. 35-1161 (2001 04 25).*

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.

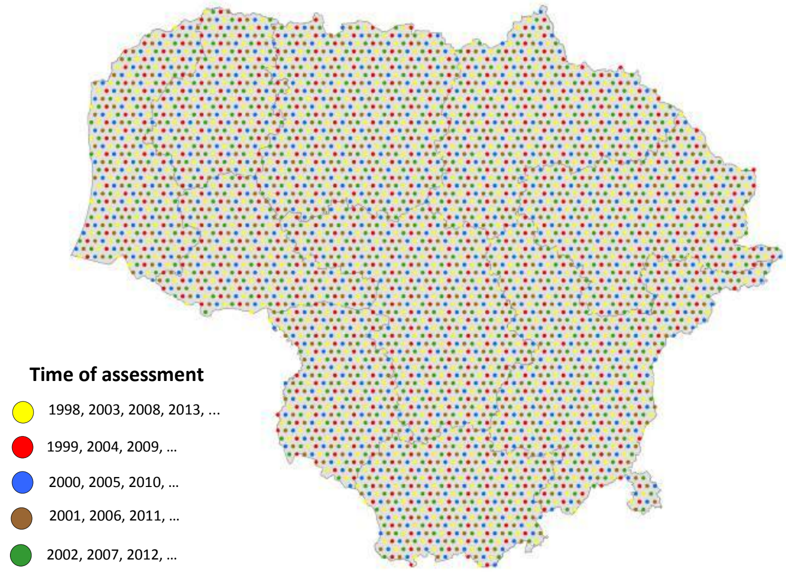


Figure 7-7. Distribution of NFI clusters of plots on Lithuanian territory

The aim of establishment of permanent sample plots is to reliably estimate (by direct measurements) growing stock volume, gross increment, mortality and trees cut, to control the dynamics of forest areas in the country.

Following the order of the Minister of Environment[83] and renewed Regulations of National Forest Inventory[84] field measurements in all land use categories of Lithuania has started in 2012. The main aim of these measurements is to monitor land use changes and living trees resources in non forest land.

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.

[83] Order of the Minister of Environment on Approval of Harmonised Principles for data collection and reporting on LULUCF. 12.01.2012. No. D1/27

[84] Regulation of National forest inventory by sampling method. 08.11.2004. Order No D1-570. Adobted by the Minister of Environment of the Republic of Lithuania on 08 November 2004.

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.

Forest land area

Forest coverage in Lithuania was expanding continuously since 1990 (Figure). Average annual increase in forest area is more than 5 thous. ha. Today forest land coverage in Lithuania amounts to 33,3% of the total land area.
Following the official data of Forest Assessment[85] annual increase was more than 10 thous. ha. Twice bigger changes in forest coverage are explained by insufficient data of forest assessment. The up-to-date Forest Assessment that is based on data of State Forest Cadastre shows the same forest coverage as the NFI permanent sample plots data.

[85] Kuliešis, A., Vižlenskas, D., Butkus, A. *et al*. 2010. Forest Assessment. State Forest Service.

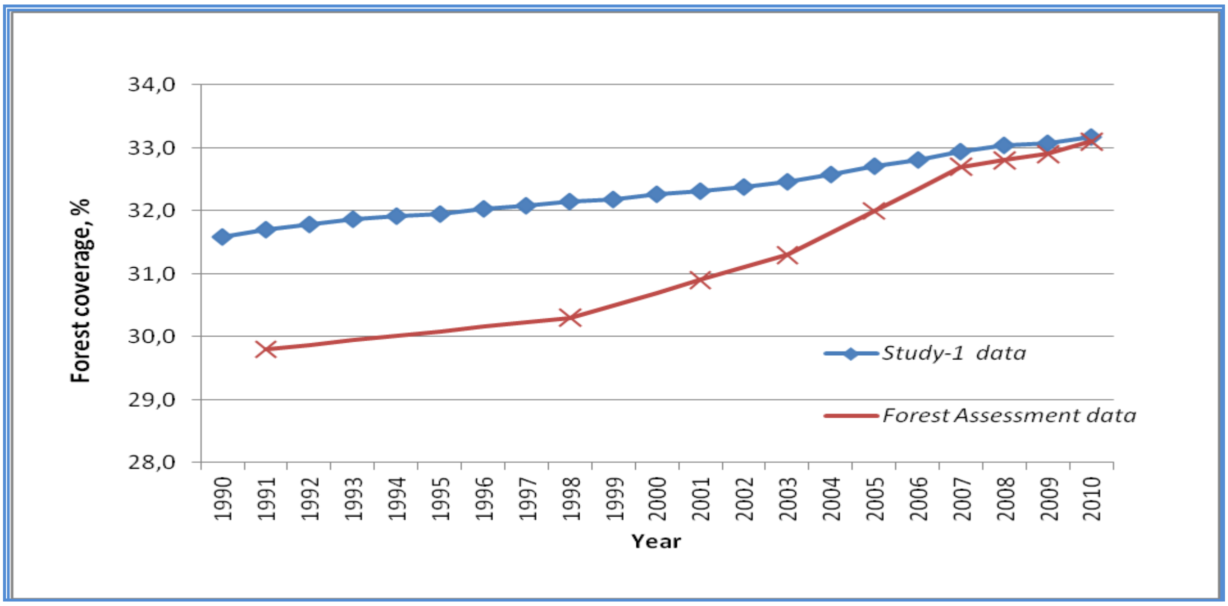


Figure 7-8. Changes in forest coverage in Lithuania 1990-2010[86]

Variations in total forest land area, 'Forest Land remaining Forest Land', and area of 'Land converted to Forest land' are provided in Table below.

Table 7-10. Forest land area variations in 1990-2010, thous. ha

Year	Forest land	Forest land remaining forest land	Land converted to forest land (≤ 20 years stands)
	Total		
1990	2063,0	1951,1	111,9
1991	2069,8	1953,9	115,9
1992	2075,7	1956,3	119,4
1993	2080,9	1962,7	118,2
1994	2083,7	1966,3	117,4
1995	2086,1	1969,9	116,2
1996	2091,3	1974,3	117,0
1997	2094,9	1978,7	116,2
1998	2098,9	1984,7	114,2
1999	2101,7	1988,7	113,0
2000	2106,9	1997,9	109,0
2001	2110,1	2003,5	106,6
2002	2114,1	2009,0	105,1
2003	2119,3	2015,4	103,9
2004	2127,3	2019,4	107,9
2005	2135,7	2025,0	110,7
2006	2142,9	2030,2	112,7
2007	2151,2	2035,8	115,4
2008	2157,2	2041,4	115,8
2009	2159,6	2048,6	111,0
2010	2166,0	2059,8	106,2

[86] *Data from Study-1* and *Forest Assessment (2010).*

NFI provides data on forest land distribution by forest soils (Table 7-11). According to NFI[87] 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 comprise 7,8% of the total forest land. This area consists of 2,58% infertile and 5,22% of fertile drained organic forest soils.

Table 7-11. Forest land area by mineral and organic soils 1990-2010, thous. ha

Year	Mineral soils	Organic soils			Total forest land
		Not drained	Drained	Total	
1990	1739,1	160,9	163,0	323,9	2063,0
1991	1744,8	161,4	163,5	325,0	2069,8
1992	1749,9	161,9	164,0	325,9	2075,7
1993	1754,2	162,3	164,4	326,7	2080,9
1994	1756,6	162,5	164,6	327,1	2083,7
1995	1758,6	162,7	164,8	327,5	2086,1
1996	1763,0	163,1	165,2	328,3	2091,3
1997	1766,0	163,4	165,5	328,9	2094,9
1998	1769,4	163,7	165,8	329,5	2098,9
1999	1771,7	163,9	166,0	330,0	2101,7
2000	1776,1	164,3	166,4	330,8	2106,9
2001	1778,8	164,6	166,7	331,3	2110,1
2002	1782,2	164,9	167,0	331,9	2114,1
2003	1786,6	165,3	167,4	332,7	2119,3
2004	1793,3	165,9	168,1	334,0	2127,3
2005	1800,4	166,6	168,7	335,3	2135,7
2006	1806,4	167,1	169,3	336,4	2142,9
2007	1813,5	167,8	169,9	337,7	2151,2
2008	1818,5	168,3	170,4	338,7	2157,2
2009	1820,6	168,5	170,6	339,1	2159,6
2010	1826,0	168,9	171,2	340,1	2166,0

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.

The estimation of total growing stock volume in the period of 1990-2001 was done using: 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 7-12). Percentage of forest stands area from total forest land area varied from 96,5 to 97,0 depending on the assessment year. It shows 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

[87] *Lithuanian National Forest Inventory 2003 – 2007. Forest resources and their dynamics*

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 data of these time points.

Mean growing stock volume per hectare in stands for 1988 and 1999 were taken from the forest study[88]. Forest stand yield was estimated based on Standwise Forest Inventory (SFI) data and data on cuttings during 1922-1999. To proof reliability of SFI data during 1958-1999, forest stand yield balance model and data from SFI by sampling method in 1969 was applied by authors. Based on earlier mentioned methods mean growing stock volume in 1988 resulted 194 m^3/ha, in 1999 - 214 m^3/ha.

Data on mean growing stock volume per hectare for 1992 and 1995 were used from Lithuanian forest resources assessment[89]. Mean growing stock volume for 1997 was taken from Lithuanian forest statistics[90]. Data for 2000 presented from Lithuanian Statistical Yearbook of Forestry 2009[91]. Taking into account underestimation of mean growing stock volume of 1992, 1995, 1997 and 2000 and harmonising these data with data of forest study[92] of 1988 and 1999 as well as with National forest inventory data of 2002 it is corrected by 13%.

As it was mentioned, total growing stock for the period of 2002-2010 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.

Table 7-12. Growing stock volume identified according to *Study-1*, Forest assessment data and other research results

Year	Mean volume identified, m^3	Mean annual volume change, thous. m^3	Forest land area, thous. ha.	Percentage of forest stands area, %	Total growing stock volume, m^3
1988	194,0	-	-	-	-
1989	196,4	2,3	-	-	-
1990	198,7	2,3	2063,0	97,0	397614,2
1991	201,1	2,3	2069,8	97,0	403640,9
1992	203,4	2,3	2075,7	97,0	409540,9
1993	205,7	2,3	2080,9	97,0	415127,3
1994	207,9	2,3	2083,7	97,0	420253,1

[88]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].*

[89]Valstybinis miškotvarkos institutas. 1993 (1996) *Lietuvos miško ištekliai*. 1993 (1996). [en. *Forest Inventory and Management Institute*. *Lithuanian Forest resources 1993 (1996)*].

[90] Valstybinis miškotvarkos institutas.1998. *Lietuvos miškų statistika*. [en. *Forest Inventory and Management Institute. Lithuanian Forest statistics.1998].*

[91] Valstybinė miškų tarnyba. Lietuvos miškų ūkio statistika. 2009. [en. *State Forest Service. Lithuanian Statistical Yearbook of Forestry. 2009*].

[92]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].*

1995	210,2	2,3	2086,1	96,5	423117,2
1996	209,1	-1,1	2091,3	96,5	421889,8
1997	207,9	-1,1	2094,9	97,0	422508,5
1998	211,0	3,0	2098,9	97,0	429503,3
1999	214,0	3,0	2101,7	97,0	436273,0
2000	218,1	4,1	2106,9	96,5	443412,2
2001	222,4	4,3	2110,1	96,5	452850,6
2002	226,7	4,3	-	-	-

Based on data presented above, total growing stock volume for the period of 1990-2010 was estimated (Table 7-13).

Table 7-13. Changes of total growing stock volume estimated on growing stock volume analysis during 1988 – 2001 and NFI permanent sample plots data during 2002 – 2010

	Volume, thous. m^3	**Annual volume change, thous. m^3**
1990	397614,2	6026,7
1991	403640,9	6026,7
1992	409540,9	5900,0
1993	415127,3	5586,4
1994	420253,1	5125,7
1995	423117,2	2864,1
1996	421889,8	-1227,4
1997	422508,5	618,7
1998	429503,3	6994,8
1999	436273,0	6769,7
2000	443412,2	7139,2
2001	452850,6	9438,4
2002	454588,4	1737,8
2003	461979,4	7391,0
2004	465794,6	3815,2
2005	467095,0	1300,4
2006	469471,5	2376,5
2007	470875,7	1404,2
2008	476053,5	5177,8
2009	484616,3	8562,7
2010	494285,3	9669,0

The figure below shows comparison between the total growing stock volume declared in the last 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 during 2002-2010.

Main differences of these two trends appear to be in the period of 1990-2000, especially in 1996-1999. On the last submission total growing stock volume estimations were based mainly on expert assumptions and the rough linear trend. Using *Study-1* data, total forest area was revised. This revision made an impact on total growing stock volume data as well. Decrease in annual volume change in 1996-1997 (-1227 and 619 thous. m^3) was explained by spruce dieback, caused by bark beetle *Ips Typographus* what resulted a huge damages on spruce stands[93].

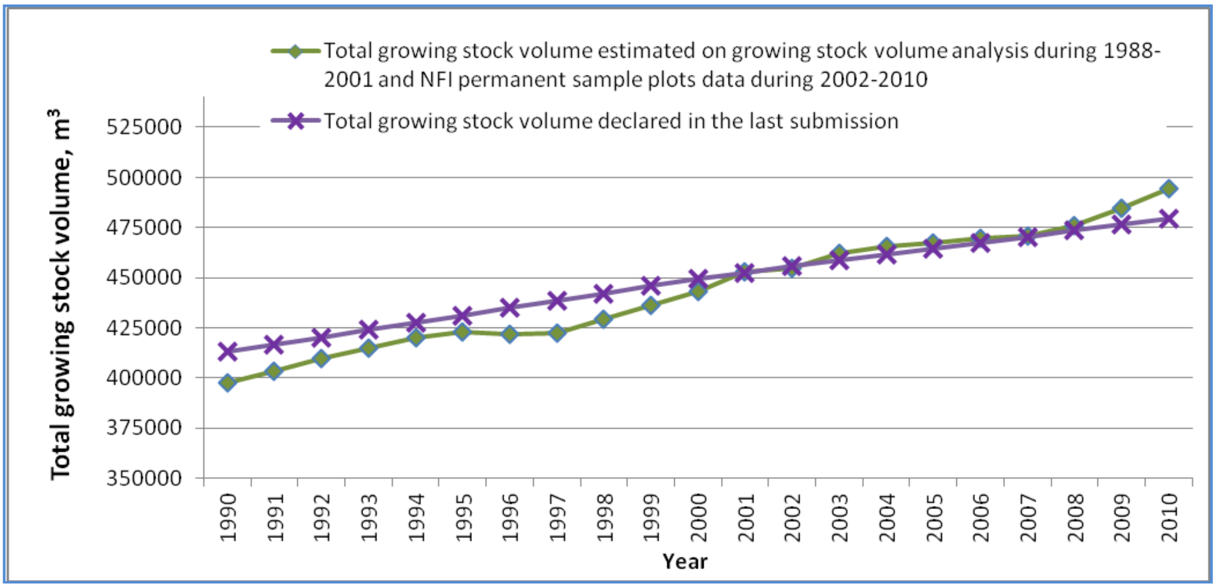


Figure 7-9. Comparison of total growing stock volume between estimated and submitted on 2011.11.04

In the Table 7-14, 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 2002-2010 annual NFI data was used, and for the period 1990-2001 – NFI data of 2002.

Note: Negative annual growing stock volume change stands for decrease between two periods here.

Table 7-14. Annual change of growing stock volume, thous. m^3

Year	Growing stock volume			Annual change of growing stock volume		
	Coniferous	Deciduous	Total	Coniferous	Deciduous	Total
1990	222664,0	174950,2	397614,2	3374,9	2651,8	6026,7
1991	226038,9	177602,0	403640,9	3374,9	2651,8	6026,7
1992	229342,9	180198,0	409540,9	3304,0	2596,0	5900,0
1993	232471,3	182656,0	415127,3	3128,4	2458,0	5586,4
1994	235341,7	184911,4	420253,1	2870,4	2255,4	5125,8
1995	236945,6	186171,6	423117,2	1603,9	1260,2	2864,1
1996	236258,3	185631,5	421889,8	-687,3	-540,1	-1227,4
1997	236604,8	185903,7	422508,5	346,5	272,2	618,7
1998	240521,8	188981,4	429503,2	3917,0	3077,7	6994,7

[93] 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").*

1999	244312,9	191960,1	436273,0	3791,1	2978,7	6769,8
2000	248310,8	195101,4	443412,2	3997,9	3141,3	7139,2
2001	253596,3	199254,3	452850,6	5285,5	4152,9	9438,4
2002	254751,3	199837,1	454588,4	1155,0	582,8	1737,8
2003	259262,8	202716,6	461979,4	4511,5	2879,5	7391,0
2004	261683,4	204111,2	465794,6	2420,6	1394,6	3815,2
2005	263208,0	203887,0	467095,0	1524,6	-224,2	1300,4
2006	265627,0	203844,5	469471,5	2419,0	-42,5	2376,5
2007	268399,2	202476,6	470875,8	2772,2	-1367,9	1404,3
2008	272826,3	203227,3	476053,6	4427,1	750,7	5177,8
2009	278266,7	206349,6	484616,3	5440,4	3122,3	8562,7
2010	284461,2	209824,1	494285,3	6194,5	3474,5	9669,0

Volume of dead tree stems was assessed for two periods as well as growing stock volume. The estimation of total dead tree stems volume for the period of 1990-2001 was done using forest land area determined during the *Study-1,* percentage of forests stands area from 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 of 1993-1996[94].

For 2002-2010 total standing and lying volume of dead tree stems was estimated using objective data of NFI permanent sample plots. Broadleaves and coniferous were separated using NFI data of dead tree stems species composition.

The biomass of needles and foliage biomass was estimated as percentage of the total stem volume, using the models (designed by V. Usolcev for separate tree species, that later were adapted to Lithuanian stands) and forest area by dominant tree species (Lithuanian Statistical Yearbook of Forestry, 2011). Multiplying these two indicators and dividing by total forest area by dominant tree species resulted in 7% for coniferous and 3% for broadleaves needle and foliage biomass from the total stem volume. The biomass of needles and foliage was not included into dead tree stems biomass (Table 7-15).

Table 7-15. Total and mean dead tree stems volume changes during 1990-2010

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	10755,0	5752,3	5002,7	5,4
1991	10991,2	5972,0	5019,2	5,5
1992	11325,0	6291,3	5033,7	5,6
1993	11757,0	6710,8	5046,3	5,8
1994	12480,3	7427,2	5053,1	6,2

[94] 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").*

1995	13235,5	8202,7	5032,8	6,6
1996	13268,4	8223,1	5045,3	6,6
1997	12953,7	7873,5	5080,2	6,4
1998	12571,2	7481,3	5089,9	6,2
1999	12282,1	7185,5	5096,6	6,0
2000	12045,7	6962,8	5082,9	5,9
2001	12063,9	6973,3	5090,6	5,9
2002	12712,9	7239,9	5473,0	6,0
2003	12956,9	7181,3	5775,6	6,1
2004	14034,6	7706,3	6328,2	6,6
2005	15300,7	7979,5	7321,2	7,2
2006	16972,6	8286,9	8685,7	7,9
2007	18526,8	8591,6	9935,2	8,6
2008	20411,3	9333,7	11077,6	9,5
2009	21322,4	9627,4	11695,0	9,9
2010	21645,8	9749,3	11896,5	10,0

Volumes of standing and lying dead tree stems in forests, were increasing starting from 1990 and reached the peak in the period of 1994-1997 (Table 7-16). That could be 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 7-10). Volume of dead tree stems were stabilised after 1998.

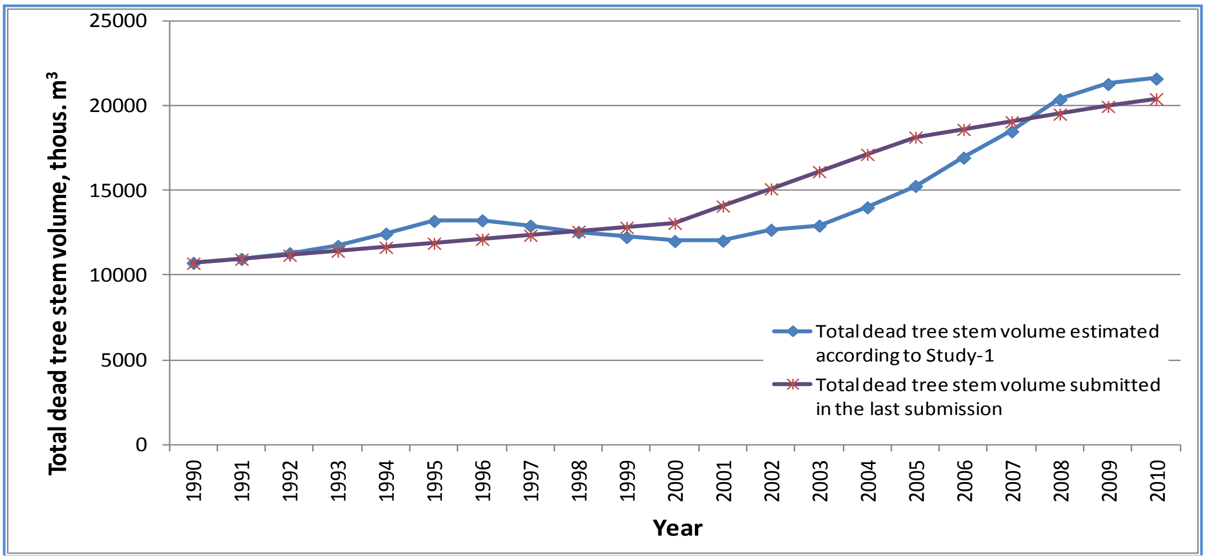


Figure 7-10. Comparison of total dead tree stems stock volume between estimated according to *Study-1* and earlier submitted data (2011.11.04)

Volume of dead tree stems were increasing steadily again since 2001. This could be explained by storm damages in 2000-2005[95], decreased volume of thinning and by various international environmental agreements according to which Lithuania committed to leave more deadwood in stands to maintain biodiversity (Natura2000[96] etc.). In 2011 more than

[95] Information available on: *http://www.msat.lt/lt/miskai/misku-bukle/vejo-pazeidimai-istorija-ir-prognoze/*
[96] Informaition available on: *http://www.natura.org/sites.html*

10 m^3/ha of merchantable dead tree stems are accumulated in stands to decay, what is almost twice more comparing with 1990.

Table 7-16. Total dead tree stems volume and their changes during 1990-2010, thous. m^3

Year	Dead tree stems volume			Annual change of dead tree stems volume		
	Coniferous	**Deciduous**	**Total**	**Coniferous**	**Deciduous**	**Total**
1990	5752,3	5002,7	10755,0	219,7	16,5	236,2
1991	5972,0	5019,2	10991,2	219,7	16,5	236,2
1992	6291,3	5033,7	11325,0	319,3	14,5	333,8
1993	6710,8	5046,3	11757,0	419,5	12,6	432,1
1994	7427,2	5053,1	12480,3	716,4	6,8	723,2
1995	8202,7	5032,8	13235,5	775,5	-20,3	755,2
1996	8223,1	5045,3	13268,4	20,4	12,5	32,9
1997	7873,5	5080,2	12953,7	-349,6	34,9	-314,7
1998	7481,3	5089,9	12571,2	-392,2	9,7	-382,5
1999	7185,5	5096,6	12282,1	-295,8	6,7	-289,1
2000	6962,8	5082,9	12045,7	-222,7	-13,7	-236,4
2001	6973,3	5090,6	12063,9	10,5	7,7	18,2
2002	7239,9	5473,0	12712,9	266,6	382,4	649,0
2003	7181,3	5775,6	12956,9	-58,6	302,6	244,0
2004	7706,3	6328,2	14034,6	525,0	552,6	1077,6
2005	7979,5	7321,2	15300,7	273,2	993,0	1266,2
2006	8286,9	8685,7	16972,6	307,4	1364,5	1671,9
2007	8591,6	9935,2	18526,8	304,7	1249,5	1554,2
2008	9333,7	11077,6	20411,3	742,1	1142,4	1884,5
2009	9627,4	11695,0	21322,4	293,7	617,5	911,2
2010	9749,3	11896,5	21645,8	121,9	201,5	323,4

Fellings

Gross mean annual volume increment in stands, volume of fellings, mortality, accumulation and other parameters constituting wood balance of all Lithuanian forests was assessed by State Forest Service. During 1990-2010 intensity of fellings in commercial forests increased from 35% to 65% of mean gross annual increment. Annual growing stock volume accumulation in stands during analysis period decreased from 50% to 20%. Increasing fellings volume is closely related to increasing commercial mature stands area since 1990 to 2010. Dynamics of total gross annual volume increment structure, its distribution into fellings, mortality and accumulation in forest stands during 1990-2010 is provided in Figure 7-11[97].

Changes in growing stock volume accumulation and dead trees stems volume were used for estimation of annual carbon stock changes.

[97] *Wood occurring from: Dead trees felled, Living trees felled for fuel and Living trees felled for industrial wood is consumed during fellings*

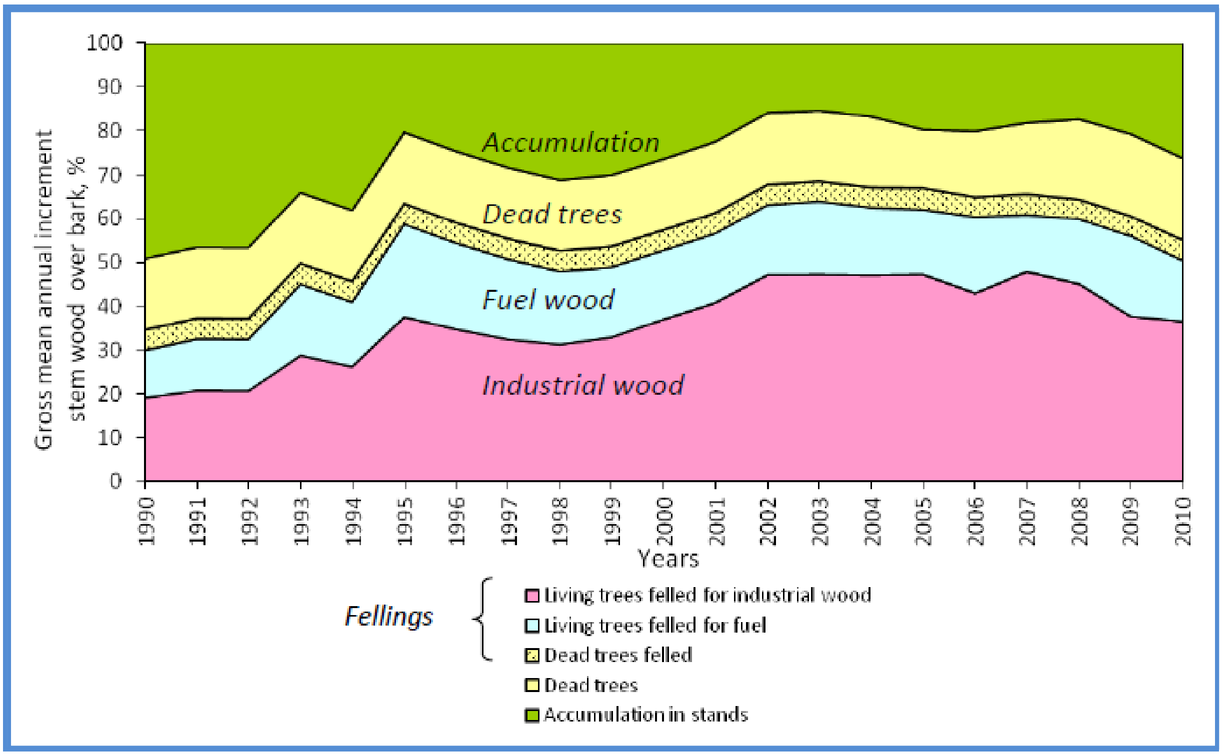


Figure 7-11. Dynamics of gross mean annual volume increment (fellings, mortality and accumulation) 1990-2010

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 activity as well as establisher of mandatory norms for state forest enterprises regarding reforestation, protection and management of forests.

The uniform system of state fire prevention measures, comprising monitoring, preventive and fire control measures, is 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.

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 rules 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 few studies done in Lithuania, evaluating impact of ashes application on forest land, and there is no clear evidence of such application efficiency[98].
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

The algorithm for assessment of carbon stock (*IPCC GPG LULUCF* 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}.

Change in carbon stock in living biomass

Lithuania has chosen Method 2 which also called as the stock change method (*IPCC GPG LULUCF* Eq. 3.2.3, p. 3.24):

$$\Delta C_{LB} = (C_{t2} - C_{t1})/(t_2 - t_1) \text{ and } C = (AGB + BGB) \times CF \text{ (modified eq. 3.2.3, p 3.24)} \quad (7.2)$$

where:
ΔC_{LB} – annual change in carbon stock in living biomass (includes above- and below-ground 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;
AGB – above-ground biomass, t d. m.;
BGB – below-ground biomass, t d. m.;
CF – carbon fraction of dry matter (default = 0,5), t C (tonne d.m.)$^{-1}$.

Above-ground biomass

Calculation of above-ground biomass is based on volume of living trees stems with bark:

$$AGB = GS \times WD \times BEF \text{ (modified IPCC GPG } LULUCF \text{ eq. 3.2.3, p 3.24)} \quad (7.3)$$

where:
AGB – above-ground biomass, t d.m.;
GS – trees stems volume with bark, m^3;

[98] Ozolinčius R., Armolaitis K., Mikšys V., Varnagirytė-Kabašinskienė I. 2010. Recommendations for compensating wood ash fertilization (2nd revised edition).

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 GPG LULUCF*. Density values for coniferous and deciduous were calculated as weighted average values related to growing stock volume (Table 7-17).

Table 7-17. 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). Rate of BEF for coniferous was estimated – 1,221 and for deciduous – 1,178. The rates of BEF accepted for Lithuania are very close to the rates of *IPCC GPG LULUCF* in Table 3A.1.10.

Below-ground biomass

BGB = AGB × (1 + R) (modified IPCC GPG *LULUCF* eq. 3.2.3, p 3.24) (7.4)

where:
BGB – below-ground biomass, t d. m.;
AGB – above-ground biomass, t d. m.;
R – root-to-shoot ratio, dimensionless.

Default values of root-to-shoot ratios R were estimated using data of Usolcev and Table 3.A.1.8 of *IPCC GPG LULUCF*: for coniferous – 0,26, for deciduous – 0,19.

Carbon fraction of dry matter

Default value (CF) 0,5 tonne C (tonne d.m.)$^{-1}$ provided in the *IPCC GPG LULUCF* was used for estimation of carbon fraction in dry biomass matter.

Change in carbon stock in dead organic matter

IPCC Guidelines provided two types of dead organic matter pools: dead wood and forest litter.
Annual change in carbon stocks in dead organic matter in Forest Land remaining Forest Land is calculated following the equation (*IPCC GPG LULUCF,* Eq. 3.2.10, p. 3.32):

$$\Delta C_{DOM} = C_{DW} + C_{LT} \quad (7.5)$$

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, t C yr^{-1};
C_{LT} – change in carbon stocks in litter, t C yr^{-1}.

Biomass of dead trees stems is calculated by using stock change method and employing equation 3.2.12 from *IPCC GPG LULUCF*:

$$\Delta C_{FF_{DW}} = [A \times (B_{t2} – B_{t1}) / T] \times CF \quad (7.6)$$

where:
$\Delta C_{FF_{DW}}$ – annual change in carbon stocks in dead wood in forest land remaining forest land, t C $yr\text{-}^{1}$;
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.)$^{-1}$.

For Land converted to Forest Land it was assumed that carbon inputs and losses in dead wood balance is equal one to another and net changes are close to zero.

It was assumed that carbon inputs and losses in litter of Forest Land remaining Forest Land balance is equal one to another and net changes are close to zero too. But some increase of litter carbon is closely connected with increase or decrease in area of Forest Land remaining Forest Land. The area of Land converted to Forest Land was not stable over the period of 1990-2010. It was increasing from 1990 to 1992 about 3,7 thous. ha annually. After 1992 area of Land converted to Forest Land plummeted down. In 2003 area of Land converted to Forest Land decreased by 8 thous. ha comparing with 1990, and by 15,6 thous. ha comparing with 1992. After 2003 area of land converted to forest land increased by 2,4 thous. ha annually and almost reached the level of 1990-1992. After 2008 area converted to forest land is decreasing.

The average value of carbon stock in litter is 24 t per ha. This value was accepted for Forest land, using values for cold temperate dry and moist region from Table 3.2.1 of *IPCC GPG LULUC* (*Lithuanian Country Report on Global Forest Resources Assessment 2005. 2010).* It was also assumed that such average value of carbon stock in litter has been accumulated in area of Land converted to Forest Land in 20 year period, and after that comes as inputs in area of Forest Land remaining Forest Land. The carbon losses in litter defined with losses in area of Forest Land remaining Forest Land by Deforestation (0,01 – 0,29 thous. ha per year in 1990-2010).

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 soils

It was assumed that carbon inputs and losses in mineral soil balance in Forest Land remaining Forest Land and Land converted to Forest Land are equal one to another and the net changes are close to zero, therefore reported NA.

Carbon stock change in drained organic forest soils was calculated using equation 3.2.15 of the *IPCC GPG LULUCF*:

$$\Delta C_{FOS} = A_{Drainage} \times EF_{Drainage} \qquad (7.7)$$

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 GPG LULUFC* (p. 3.42) was accepted in calculations. Default $EF_{Drainage}$ for temperate forests is 0,68 tonnes C ha^{-1} yr^{-1}.

Biomass Burning

Carbon release from burnt biomass was calculated using equation 3.2.19 of the *IPCC GPG LULUCF*:

$$L_{fire} = A \times B \times C \times D \times 10^{-6} \qquad (7.8)$$

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 GPG LULUCF*. Mean value for wildfire 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 GPGLULUCF*. The emission ratios of CH_4 (0,012) and N_2O (0,007) are taken from Table 3A.1.15 of the *IPCC GPG LULUCF*.

7.2.3 Quantitative overview of carbon emissions/removals from the sector

Carbon stock change in living biomass

Area and growing stock volume in Forest Land remaining Forest Land were increasing annually since 1990 to 2010 except 1996 when total growing stock volume resulted in losses comparing to previous years due to spruce dieback (
Table 7-18). Area of Land converted to Forest Land had no stable increasing or decreasing tendency and was fluctuating from 4,0 to -4,8 thous. ha per year during 1990-2010. The fluctuation of growing stock volume was closely connected with area changes in Land converted to Forest Land.

Table 7-18. Annual change in area and 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
	Annual change in area, thous. ha	Coniferous thous. m^3	Deciduous, thous. m^3	Total, thous. m^3	Annual change in area, thous. ha	Coniferous thous. m^3	Deciduous, thous. m^3	Total, thous. m^3	
1990	2,8	219311,1	172315,9	391627,0	4,0	724,5	5262,8	5987,2	397614,2
1991	2,8	222566,3	174873,5	397439,8	4,0	750,3	5450,7	6201,1	403640,9
1992	2,4	225762,6	177384,9	403147,5	3,6	773,6	5619,9	6393,5	409540,9
1993	6,4	228926,9	179871,1	408798,0	-1,2	765,8	5563,5	6329,3	415127,3
1994	3,6	231821,3	182145,3	413966,5	-0,8	760,7	5525,9	6286,6	420253,1
1995	3,6	233461,1	183433,7	416894,8	-1,2	752,9	5469,5	6222,4	423117,2
1996	4,4	232749,8	182874,8	415624,6	0,8	758,1	5507,1	6265,2	421889,8
1997	4,4	233120,2	183165,9	416286,1	-0,8	752,9	5469,5	6222,4	422508,5
1998	6,0	237097,2	186290,6	423387,8	-2,0	740,0	5375,5	6115,5	429503,2
1999	4,0	240924,1	189297,5	430221,6	-1,2	732,2	5319,2	6051,4	436273,0
2000	9,2	245041,8	192532,8	437574,6	-4,0	706,3	5131,2	5837,5	443412,2
2001	5,6	250399,2	196742,2	447141,4	-2,4	690,8	5018,4	5709,2	452850,6
2002	5,6	251543,0	197320,3	448863,3	-1,6	749,8	4975,3	5725,1	454588,4
2003	6,4	256098,1	200242,1	456340,2	-1,2	839,4	4799,8	5639,2	461979,4
2004	4,0	258284,8	201460,3	459745,1	4,0	761,2	5288,4	6049,5	465794,6
2005	5,6	259753,2	201210,8	460963,9	2,8	831,5	5299,6	6131,1	467095,0
2006	5,2	262264,3	201264,0	463528,3	2,0	863,4	5079,8	5943,2	469471,5
2007	5,6	265182,4	200049,9	465232,4	2,8	816,0	4827,3	5643,4	470875,8
2008	5,6	269606,0	200828,5	470434,5	0,4	889,9	4729,2	5619,1	476053,6
2009	7,2	275132,3	204025,3	479157,6	-4,8	800,1	4658,6	5458,7	484616,3
2010	11,2	281117,3	207357,6	488474,9	-4,8	709,3	5101,1	5810,4	494285,3

The total living biomass was fluctuating in Forest land remaining Forest Land from -816,9 thous. t d.m. up to 6152,6 thous. t d.m. during the period of 1990-2010. Living biomass losses of 816,9 thous. t d.m. were inventoried in 1996 due to spruce dieback. The mean value of annual carbon stock change is about 1500 Gg. The largest living biomass decrease for Land converted to Forest land was observed in 1993-2001 and 2006-2009. This is closely connected to decrease in area of Land converted to Forest Land category. The carbon stock change values are varying between -98,0 and 136,5 Gg per year (Table 7-19).

Table 7-19. Annual carbon stock change due to living biomass change in Forest Land

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	3045673,6	692749,6	3738423,2	1869,2	117012,2	23139,0	140151,2	70,1	1939,2
1991	3045673,6	692749,6	3738423,2	1869,2	117012,2	23139,0	140151,2	70,1	1939,2
1992	2990516,6	680203,9	3670720,5	1835,4	105293,4	20821,6	126115,0	63,0	1898,4
1993	2960613,5	673402,3	3634015,8	1817,0	-35097,8	-6940,5	-42038,3	-21,0	1796,0
1994	2708055,3	615957,1	3324012,4	1662,0	-23408,3	-4629,0	-28037,3	-14,0	1648,0
1995	1534273,2	348976,0	1883249,2	941,6	-35097,8	-6940,5	-42038,3	-21,0	920,6
1996	-665523,7	-151375,8	-816899,5	-408,4	23408,3	4629,0	28037,3	14,0	-394,4
1997	346583,5	78831,7	425415,2	212,7	-23408,3	-4629,0	-28037,3	-14,0	198,7
1998	3720954,2	846344,6	4567298,8	2283,6	-58506,1	-11569,5	-70075,6	-35,0	2248,6
1999	3580587,0	814417,6	4395004,5	2197,5	-35097,8	-6940,5	-42038,3	-21,0	2176,5
2000	3852634,2	876295,7	4728929,9	2364,5	-117012,2	-23139,0	-140151,2	-70,0	2294,4
2001	5012527,2	1140117,6	6152644,8	3076,3	-70224,9	-13886,9	-84111,8	-42,0	3034,3
2002	892655,9	209686,3	1102342,2	551,2	5678,8	3146,1	8824,9	4,3	555,4
2003	3898006,3	900245,0	4798251,2	2399,1	-52313,4	-6799,6	-59113,0	-29,8	2369,4
2004	1769170,0	412770,0	2181939,9	1091,0	231321,2	41209,7	272530,8	136,5	1227,4
2005	596928,9	164872,7	761801,6	380,9	41405,8	10331,5	51737,3	25,7	406,6
2006	1286544,4	332439,4	1618983,8	809,5	-105697,4	-18963,5	-124660,9	-62,4	747,1
2007	788685,4	252110,3	1040795,8	520,4	-163502,3	-32727,4	-196229,7	-98,0	422,4
2008	2645529,9	657663,8	3303193,6	1651,6	-17358,8	-708,5	-18067,4	-9,2	1642,4
2009	4536458,6	1055582,8	5592041,5	2796,0	-84017,9	-19109,4	-103127,3	-51,4	2744,7
2010	4841135,5	1129547,6	5970683,2	2985,3	199509,7	34723,6	234233,3	117,2	3102,5

Carbon stock change in dead organic matter

Dead wood is inventoried for Forest Land remaining Forest Land. For Land converted to Forest Land it was assumed that carbon gains and losses in dead wood are equal to one another and net changes are close to zero, therefore reported NA. Table 7-20 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 2010. Carbon stock change in forest litter is closely connected to area expansion in category Forest Land remaining Forest land.

Table 7-20. Annual carbon stock change in Forest Land remaining Forest Land due to change in dead organic matter

Year	Dead wood				Forest litter			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	Increase in area, thous. ha	Carbon stock, t ha^{-1}	Carbon stock change, Gg	
1990	112397,9	28600,5	140998,4	70,5	2,8	24,0	67,1	137,6
1991	112397,9	28600,5	140998,4	70,5	2,8	24,0	67,1	137,6
1992	158275,1	40601,8	198876,9	99,4	2,4	24,0	57,5	157,0
1993	204401,4	52667,9	257069,3	128,5	6,4	24,0	153,4	281,9
1994	341175,0	88449,0	429624,0	214,8	3,6	24,0	86,3	301,1

1995	354357,0	92899,6	447256,6	223,6	3,6	24,0	86,3	309,9
1996	16387,4	3786,8	20174,2	10,1	4,4	24,0	105,5	115,5
1997	-145851,1	-39240,2	-185091,3	-92,5	4,4	24,0	105,4	12,9
1998	-179516,3	-47040,7	-226557,0	-113,3	6,0	24,0	143,8	30,5
1999	-135699,1	-35538,3	-171237,4	-85,6	4,0	24,0	95,9	10,2
2000	-112336,2	-28687,4	-141023,6	-70,5	9,2	24,0	220,5	150,0
2001	9140,2	2084,8	11225,0	5,6	5,6	24,0	134,2	139,8
2002	332249,5	71918,8	404168,2	202,1	5,6	24,0	134,2	336,3
2003	135934,9	23894,3	159829,2	79,9	6,4	24,0	153,4	233,3
2004	546072,9	121068,0	667140,9	333,6	4,0	24,0	95,9	429,4
2005	665385,1	135431,0	800816,1	400,4	5,6	24,0	134,2	534,6
2006	882300,4	177772,9	1060073,3	530,0	5,2	24,0	124,6	654,6
2007	818892,9	165638,9	984531,9	492,3	5,6	24,0	134,2	626,5
2008	967050,6	208210,5	1175261,1	587,6	5,6	24,0	134,2	721,8
2009	472095,1	99383,3	571478,4	285,7	7,2	24,0	172,5	458,3
2010	166334,2	35623,6	201957,9	101,0	11,2	24,0	268,4	369,4

Carbon stock change in soil

Carbon stock in dead organic matter increases due to expansion of mineral soils in Forest Land remaining Forest Land and Land converted to Forest Land' categories.

Table 7-21. Annual CO_2 emission from drained organic soils

Year	**Drained organic soils**	
	Area, thous. ha	**Carbon emissions, Gg**
1990	163,0	-110,8
1991	163,5	-111,2
1992	164,0	-111,5
1993	164,4	-111,8
1994	164,6	-111,9
1995	164,8	-112,1
1996	165,2	-112,3
1997	165,5	-112,5
1998	165,8	-112,8
1999	166,0	-112,9
2000	166,4	-113,2
2001	166,7	-113,4
2002	167,0	-113,6
2003	167,4	-113,8
2004	168,1	-114,3
2005	168,7	-114,7
2006	169,3	-115,1
2007	169,9	-115,6
2008	170,4	-115,9
2009	170,6	-116,0
2010	171,1	-116,4

Biomass burning

The default mean burned biomass values per ha were used and carbon emissions are closely connected to burned area (
Table 7-22). The largest carbon emissions were observed in 1992 (8,07 Gg CO_2) and in 2006 (9,97 Gg CO_2). This could be explained by repetitive draughts (1992, 1994, 2002, 2006)[99].

Table 7-22. Annual carbon stock change due to biomass burning

Year	Area burned, ha	Burned biomass, t d.m.	Carbon emissions, Gg CO_2
1990	134,0	2653,2	1,11
1991	64,0	1267,2	0,53
1992	971,0	19225,8	8,07
1993	355,0	7029,0	2,95
1994	355,0	7029,0	2,95
1995	355,0	7029,0	2,95
1996	355,0	7029,0	2,95
1997	355,0	7029,0	2,95
1998	54,0	1069,2	0,45
1999	342,9	6789,8	2,85
2000	327,1	6476,0	2,72
2001	111,1	2200,6	0,92
2002	716,8	14192,8	5,96
2003	436,2	8636,2	3,63
2004	253,2	5013,4	2,11
2005	50,8	1006,6	0,42
2006	1199,0	23740,2	9,97
2007	38,0	752,4	0,32
2008	112,4	2225,5	0,93
2009	315,3	6242,9	2,62
2010	21,5	425,7	0,18

7.2.4 Uncertainty assessment

The growing stock volume per 1 ha of all Lithuanian forests was estimated with 0,9% accuracy (under probability of 0,683). The lowest standard error (1,3%) was estimated for pine (dominant tree species in Lithuania) stands and the highest (5,1%) for ash and oak stands.

Gross volume increment estimations error is close to growing stock volume errors. Gross volume increment was estimated with 0,8% accuracy, while the least error was estimated for pine stands – 1,2%, the highest for ash stands – 4,8% and oak stands – 4,4%.

For Forest Land remaining Forest Land it was assumed that uncertainty of overall activity data is 1%. Uncertainty of emission factor was assumed to be about 5%.

[99] *Lithuanian Hydrometeorological Service (available on-line: www.meteo.lt)*

For Land converted to Forest Land it was assumed that uncertainty of overall activity data is 25%. Uncertainty of emission factor was assumed to be about 10%.

Table 7-23. Uncertainty of assessment values

Indicator	Unit	Uncertainty, %
Growing stock volume	m^3/ha	0,9%
	m^3	1,4%
Gross volume increment	$m^{3/}$ha	0,8%
	m^3	1,4%
Forest land remaining Forest land	ha	1%
Forest land remaining Forest land emissions factor	Gg CO_2	5%
Land converted to Forest land	ha	25%
Land converted to Forest land emissions factor	Gg CO_2	10%

7.2.5 Source-specific QA/QC and verification

The following procedures were carried out to ensure QC/QA described in *IPCC GPG*:

- **periodical trainings** of field crews and individual training of new staff;
- **data consistency and completeness control** – carried out during measurements by field crews 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 GPG LULUCF*.

7.2.6 Source-specific recalculations

Recently implemented studies (*Study-1* and *Study-2*) provided data of improved accuracy on forest and other land use areas on which basis all recalculations were made in this submission. In addition, accounting for GHG emissions from biomass burning (wildfires) in Forest Land was improved.

The tables below present impact of recalculations that were made considering forest area changes due to completed studies.

Table 7-24. Impact of recalculation on CO_2 emissions/removals from Forest Land, Gg

Year	Previous submission	This submission	Difference	
			Gg	%
1990	-5068,55	-7207,49	-2138,94	29,68
1991	-5109,18	-7206,73	-2097,55	29,11
1992	-5108,25	-7119,26	-2011,01	28,25
1993	-5107,33	-7206,22	-2098,89	29,13
1994	-5106,40	-6733,19	-1626,79	24,16
1995	-5104,47	-4098,09	1006,38	-24,56
1996	-5103,55	1437,52	6541,07	>100,00
1997	-5103,62	-360,23	4743,39	>100,00
1998	-5025,09	-7943,00	-2917,91	36,74
1999	-5022,34	-7601,21	-2578,87	33,93
2000	-5019,58	-8545,17	-3525,59	41,26
2001	-5213,93	-11221,90	-6007,97	53,54
2002	-5236,21	-2847,23	2388,98	-83,91
2003	-5125,56	-9122,00	-3996,44	43,81
2004	-5137,53	-5653,98	-516,45	9,13
2005	-5066,44	-3030,05	2036,39	-67,21
2006	-4377,15	-4707,62	-330,47	7,02
2007	-4440,95	-3421,80	1019,15	-29,78
2008	-4439,57	-8242,98	-3803,41	46,14
2009	-4413,14	-11316,12	-6902,98	61,00

Table 7-25. Impact of recalculation on CO_2, CH_4, N_2O emissions from biomass burning in Forest Land, Gg CO_2 eq.

Year	CO_2			CH_4			N_2O		
	Previous submission	This submission	Difference	Previous submission	This submission	Difference	Previous submission	This submission	Difference
1990	0,50	1,11	0,61	0,17	0,02	-0,15	0,02	0,00	-0,02
1991	0,24	0,53	0,29	0,08	0,01	-0,07	0,01	0,00	-0,01
1992	3,63	8,07	4,44	1,22	0,13	-1,09	0,12	0,00	-0,12
1993	1,33	2,95	1,62	0,45	0,05	-0,40	0,05	0,00	-0,05
1994	1,33	2,95	1,62	0,45	0,05	-0,40	0,05	0,00	-0,05
1995	1,33	2,95	1,62	0,45	0,05	-0,40	0,05	0,00	-0,05
1996	1,33	2,95	1,62	0,45	0,05	-0,40	0,05	0,00	-0,05
1997	1,33	2,95	1,62	0,45	0,05	-0,40	0,05	0,00	-0,05
1998	0,20	0,45	0,25	0,07	0,01	-0,06	0,01	0,00	-0,01
1999	1,28	2,85	1,57	0,43	0,05	-0,38	0,04	0,00	-0,04
2000	1,22	2,72	1,50	0,41	0,04	-0,37	0,04	0,00	-0,04
2001	0,42	0,92	0,50	0,14	0,01	-0,13	0,01	0,00	-0,01
2002	2,68	5,96	3,28	0,90	0,10	-0,80	0,09	0,00	-0,09
2003	1,63	3,63	2,00	0,55	0,06	-0,49	0,06	0,00	-0,06
2004	0,95	2,11	1,16	0,32	0,03	-0,29	0,03	0,00	-0,03
2005	0,19	0,42	0,23	0,06	0,01	-0,05	0,01	0,00	-0,01
2006	4,49	9,97	5,48	1,51	0,16	-1,35	0,15	0,00	-0,15
2007	0,14	0,32	0,18	0,05	0,01	-0,04	0,00	0,00	-0,00
2008	0,42	0,93	0,51	0,14	0,01	-0,13	0,01	0,00	-0,01
2009	1,18	2,62	1,44	0,40	0,04	-0,36	0,04	0,00	-0,04

7.2.7 Source specific planned improvements

In 2012 Lithuania will finish the third cycle (second re-measurement of permanent plots) of NFI inventory and will have possibility to improve activity data provided in this submission relating dead stem stock volume.

Starting with 2012, inventory of all permanent NFI sample plots, for the purpose of improved estimation of carbon stock change in different land use categories will start. In addition, sector-specific quality control procedures and improvements of uncertainty estimates are planned for the next submission.

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. 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). All croplands are considered as 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.

Table 7-26. 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

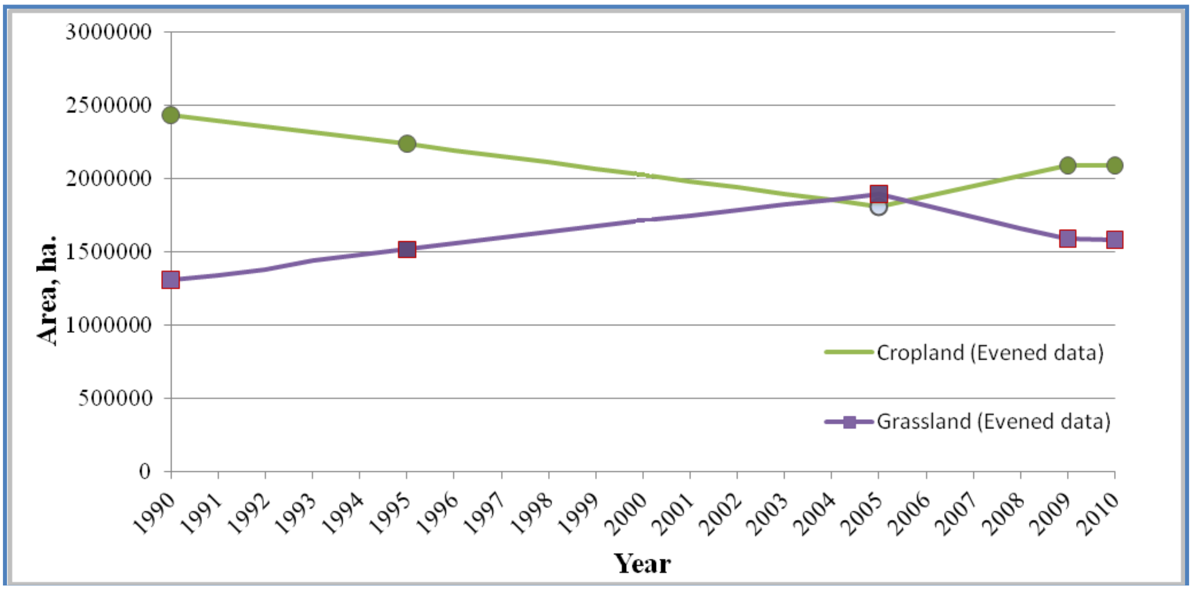


Figure 7-12. Comparison between estimated cropland and grassland area based on study and evened data

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 7-12).

7.3.2 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.

Equation 3.3.1 of the *IPCC GPG LULUCF* (P. 3.70) was used for calculation:

$$\Delta Ccc = \Delta Ccc_{LB} + \Delta Ccc_{Soils} \quad (7.9)$$

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}.

7.3.2.1 Change in carbon stocks in living biomass

The change in living biomass was only estimated for perennial woody crops. Statistics Lithuania reports the total area of orchards and berry plantations in Lithuania from 45 thous. ha in 1990 to 29,4 thous. ha in 2010. 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 GPG LULUCF*, must be reported in

Settlements (Section 7.6). Therefore, Lithuania reports only about 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. Area of commercial orchards in 1990 obtained from scientific publication of Venskutonis[100]. Data on area of commercial orchards between 1990 and 1999 obtained using data interpolation.

7.3.2.1.1 Methodological issues

Tier 1 method was chosen for calculations according to available activity data. Default factors have been 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 have been taken from Table 3.3.2 of the *IPCC GPG LULUCF* (p. 3.71).

Equation 3.2.2 of the *IPCC GPG LULUCF* (p. 3.24) was used for calculation of living biomass in perennial woody crops on cropland (ΔCcc_{LB}):

$$\Delta Ccc_{LB} = (\Delta Ccc_{G} - \Delta Ccc_{L}) \qquad (7.10)$$

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}.

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.

7.3.2.2 Change in carbon stocks in soils

CO_2 emissions or removals from organic carbon stock changes includes 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 Guidelines, 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 GPG LULUCF*, p. 3.74, eq. 3.3.2):

$$\Delta Ccc_{Soils} = \Delta C_{CCMineral} - \Delta C_{CCOrganic} - \Delta C_{CCLime} \qquad (7.11)$$

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};

[100] Venskutonis,Vladas. Sodininkystė. Vilnius 1999 [*en. Horticulture*]

$\Delta C_{CCOrganic}$ – 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}.

7.3.2.2.1 Methodological issues

Mineral soils
According to the report of available soil data in Lithuania[101] 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 GPG LULUCF* Table 3.3.3 (p. 3.76). Reference carbon content of HAC soils reported at 95 tonnes C per ha, sandy soils has 71 tonnes C per ha, spodic soils has 115 tonnes C per ha and wetland soils has 87 tonnes C per ha.

Carbon stock change in mineral soils was calculated using equation 3.3.3 of the *IPCC GPG LULUCF* (p. 3.75):

$$\Delta C_{CCMineral} = [(SOC_0 - SOC_{(0-T)}) \times A] / T \qquad (7.12)$$
$$SOC = SOC_{REF} \times F_{LU} \times F_{MG} \times F_I$$

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 GPG LULUCF* Table 3.3.4 (p. 3.77).

Cropland in Lithuania represents 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.

[101] Buivydaite, V.V. 2005. Soil Survey and Available Soil Data in Lithuania. ESB-RR9, p.211-223

2005)[102]. Statistics for such land accounting does not exist, therefore not included into calculations.

Cropland in Lithuania mainly has 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 GPG revised F_I factor for such input in temperate wet climatic conditions is 1,0 (error NA).

Organic soils

National land service did not account soil type distribution among different land uses. The activity data were calculated and harmonized based on information obtained from Lithuanian Nature Heritage Fund (NHF), reporting organic soils (histosols) cover ~0,4% of the total Lithuania's cropland area [103].

Tier 1 approach was used in order to calculate carbon stock change in organic soils. Default emission factors (*IPCC GPG LULUCF* Table 3.3.5, p. 3.79) were used along with area estimates for cultivated organic soils in cold temperate climate region present in the Lithuania (Equation 3.3.5). Default emission factor for cold temperate regions – 1 tonne 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% natiowide (Eidukeviciene et al. 2010)[104]. It 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)[105]. 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 the liming of acid soils has virtually ceased, except on large farms using various liming agents, but statistical data on liming of agricultural land in Lithuania is not available. The overview of annual application rates and annual C emissions are presented in Table 7-27. 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. "Naujasis kalcitas" subsidiary company of AB „Akmenės cementas" which nowadays producing limestone based soil liming agents reports 4000-6000 tonnes annual limestone sales in recent years.

[102] Šiuliauskas A.,Liakas V. Beplūgė žemdirbystė Lietuvos ūkiuose / Žemės ūkis. 2005. Nr. 2. –P.4-5. *[en. Ploughless agriculture in Lithuanian farms]*

[103] Lietuvos pelkių ekonominis vertinimas. Ataskaita, Aplinkos apsaugos politikos centras, 2010 [*en. Report on economical estimation of Lithuanian wetlands*]

[104] 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.

[105] Knašys V. (1985). Dirvožemių kalkinimas. Vilnius: Mokslas. 262 p. [*en. Soil liming*]

Table 7-27. Annual amount of limestone and dolomite used for liming in 1990-2010, tonnes

Reporting year			± change 1990-2010
1990	1996	2010	
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. Equation 3.3.6 of the *IPCC GPG LULUCF* (p. 3.42) was used for calculation of annual C emissions from agricultural lime application:

$$\Delta C_{CCLime} = M_{Limestone} \times EF_{Limestone} \quad (7.13)$$

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 Gg CO_2 by multiplying conversion factor by 44/12 and 10^{-3}.

Annual CO_2 emissions in recent years found to be ~150 times lower compare with 1990. CO_2 emission in 2010 from agricultural lime application was 2,64 Gg CO_2.

7.3.3 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 NO_2 emissions and removals are reported from Land converted to Cropland (LC) using Tier 1 method.

Equation 3.3.7 of the *IPCC GPG LULUCF* (p. 3.83) was used for calculation of total change in carbon stocks in Land converted to Cropland:

$$\Delta C_{LC} = \Delta C_{LCLB} + \Delta C_{LCSoils} \quad (7.14)$$

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}.

7.3.3.1 Change in carbon stock in living biomass

Tier 1 was used to estimate annual change in carbon stocks in living biomass on Lands 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. Equation 3.3.8 of the *IPCC GPG LULUCF* (p. 3.85) was used for calculation

$$\Delta C_{LCLB} = A_{Conversion} \times (L_{Conversion} + \Delta C_{Growth}) \quad (7.15)$$
$$L_{Conversion} = C_{After} - C_{Before}$$

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 all biomass is cleared when preparing a site for cropland use, thus, 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). 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).

7.3.3.2 Change in carbon stock in soils

Tier 1 was used to estimate annual change in carbon stocks in soils on Lands converted to Cropland. Equation 3.3.12 of the *IPCC GPG LULUCF* (p. 3.89) was used for calculation:

$$\Delta C_{LCSoils} = \Delta C_{LCMineral} - \Delta C_{LCOrganic} - \Delta C_{LCLiming} \quad (7.16)$$

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 based on same methodological approaches as for Cropland remaining Cropland detailed in paragraph

7.3.2.2.1 Methodological issues

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, p. 3.79) was used along with area estimates for Wetlands converted to Croplands in cold temperate climate region present in Lithuania (Equation 3.3.5).

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.

7.3.4 Non-CO_2 greenhouse gas emissions

Emissions of non-CO_2 greenhouse gases resulting from fires in Cropland and Grassland land use categories were estimated employing equation 2.27 from *IPCC Guidelines for National Greenhouse Gases Inventories, 2006*:

$$L_{fire} = A \times M_b \times C_f \times G_{ef} \times 10^{-3} \qquad (7.17)$$

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 (default values in Table 2.6, *IPCC 2006*);
G_{ef} – emission factor, g kg^{-1} dry matter burnt (default values in Table 2.5, *IPCC 2006*).

Note: Where data for M_B and C_f are not available, a default value for the amount of fuel actually burnt (the product of M_B and C_f) can be used (Table 2.4, *IPCC 2006*) under Tier 1 methodology.

Tier 2 methods employ the same general approach as Tier 1 but make use of more refined country-derived emission factors and/or more refined estimates of fuel densities and combustion factors than those provided in the default tables. Tier 3 methods are more comprehensive and include considerations of the dynamics of fuels (biomass and dead organic matter).

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 NO_2 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).

N_2O emissions from drained organic soils were calculated employing equation 3A.2.1 (Appendix 3A.2, IPCC GPG 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 GPG 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.

7.3.5 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 GPG LULUCF*. The uncertainty rates in the activity data and the emission factors used in the estimates are reported in Table 7-28.

Table 7-28. Estimated values of uncertainties

Input	Uncertainties, %	References
Activity data		
Cropland area	±1	*Study 2*
Emission factors		
G (biomass accumulation)	±75	GPG LULUCF 2003, p. 3.71
L (biomass loss)	±75	GPG LULUCF 2003, p. 3.71
SOC_{REF}	±95	GPG LULUCF 2003, p. 3.76
F_{LU} F_{MG} F_I	NA	GPG LULUCF 2003, p. 3.77
EF (organic soils)	±90	GPG LULUCF 2003, p. 3.79

7.3.6 Source-specific QA/QC and verification

The QC/QA includes the QC activities described in the IPCC GPG. Activity data and emission values are compared with emission values of other countries. If errors were found they were corrected.

7.3.7 Source-specific recalculation

Emissions from Cropland reported for the first time using recently implemented *Study-2* results.

In the tables below comparison of previously submitted and currently estimated data is depicted.

Table 7-29. Impact of recalculations on cropland area, thous. ha

Year	Previous submission	This submission	Difference
1990	NE	2435,2	2435,2
1991	NE	2396,1	2396,1
1992	NE	2356,9	2356,9

1993	NE	2317,8	2317,8
1994	NE	2278,7	2278,7
1995	NE	2239,5	2239,5
1996	NE	2196,9	2196,9
1997	NE	2154,3	2154,3
1998	NE	2111,7	2111,7
1999	NE	2069,0	2069,0
2000	NE	2026,4	2026,4
2001	NE	1983,8	1983,8
2002	NE	1941,2	1941,2
2003	NE	1898,6	1898,6
2004	NE	1856,0	1856,0
2005	NE	1813,3	1813,3
2006	NE	1882,5	1882,5
2007	NE	1951,7	1951,7
2008	NE	2020,9	2020,9
2009	NE	2090,1	2090,1

Table 7-30. Impact of recalculations on CO_2 emissions/removals from cropland, Gg

Year	Previous submission	This submission	Difference
1990	NE	354,8	354,8
1991	NE	136,0	136,0
1992	NE	140,1	140,1
1993	NE	78,3	78,3
1994	NE	141,5	141,5
1995	NE	138,8	138,8
1996	NE	136,0	136,0
1997	NE	128,9	128,9
1998	NE	132,8	132,8
1999	NE	136,7	136,7
2000	NE	171,6	171,6
2001	NE	16,3	16,3
2002	NE	192,9	192,9
2003	NE	3,8	3,8
2004	NE	-3,5	-3,5
2005	NE	-3,9	-3,9
2006	NE	-463,3	-463,3
2007	NE	-645,7	-645,7
2008	NE	-616,7	-616,7
2009	NE	-564,8	-564,8

7.3.8 Source-specific planned improvements

The possibility to use country–specific values for reference carbon stocks estimates and more detailed stratification of management systems will be investigated in the next submission.

7.4 Grassland (CRF 5.C)

According to national definitions - grassland includes meadows and natural pastures planted with perennial grasses or naturally developed, on a regular basis used for moving and grazing. Only carbon stocks in mineral soils and 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.

Two source categories are accounted under this category: emissions from Grassland remaining Grassland and emissions from Land converted to Grassland.

7.4.1 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 grassland remaining grassland 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 3.4.1 of the *IPCC GPG LULUCF* (p. 3.105).

$$\Delta C_{GG} = \Delta C_{GGLB} + \Delta C_{GGSoils} \quad (7.18)$$

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}.

7.4.1.1 Change in carbon stocks in living biomass

Grassland management practices in Lithuania mainly are static. Default Tier 1 method was used assuming no carbon stocks change in living biomass. Because the 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.

7.4.1.2 Change in carbon stocks in soils

Organic carbon stock changes (CO_2 emissions or removals) for mineral soils and CO_2 emissions from 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.

For carbon stock changes in mineral soils, the IPCC Guidelines 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 following equation (*IPCC GPG LULUCF*. Equation 3.4.7, p. 3.111):

$$\Delta C_{GGSoils} = \Delta C_{GGMineral} - \Delta C_{GGOrganic} - \Delta C_{GGLiming} \quad (7.19)$$

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}.

7.4.1.2.1 Methodological issues

Mineral Soils

Mineral soils occupy ~62% of all grasslands in Lithuania[106]. The distribution of mineral soils is proportional to previously reported in section 7.3.2.2.1 Methodological issues.
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. Carbon inputs and losses from mineral soil are calculated for Land converted to Grassland category only.
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 equation 3.4.8 of the *IPCC GPG LULUCF*:

$$\Delta C_{GGMineral} = [(SOC_0 - SOC_{(0-T)}) \times A] / T \quad (7.20)$$
$$SOC = SOC_{REF} \times F_{LU} \times F_{MG} \times F_I$$

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};

[106] Lietuvos pelkių ekonominis vertinimas. Ataskaita, Aplinkos apsaugos politikos centras, 2010 [*en. Report on economical evaluation of Lithuanian wetlands*]

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 GPG LULUCF*);
F_{LU} – stock change factor for land use or land-use change type, dimensionless (Table 3.4.5 of *IPCC GPG LULUCF*);
F_{MG} – stock change factor for management regime, dimensionless (Table 3.4.5 of *IPCC GPG LULUCF*);
F_I – stock change factor for input of organic matter, dimensionless (Table 3.4.5 of *IPCC GPG LULUCF*).

Default reference soil organic carbon stocks (SOC_{REF}) were taken from *IPCC GPG LULUCF* 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.

Relative stock change factors (F_{LU}, F_{MG} and F_I) for grassland management were taken from *IPCC GPG LULUCF* 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).

Grassland in Lithuania mainly represents non-degraded and sustainably managed grassland, but without significant management improvements during the last decades. Corresponding GPG revised default F_{MG} factor in all climatic conditions is 1,0 (error NA).

Nominal level input (applied only to improved grassland) used. Corresponding GPG 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 interpolated based on information obtained from Lithuanian Nature Heritage Fund (NHF), accounting that organic soils cover almost 38,3% of Lithuania's grassland 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 fallowing Equation 3.4.10 (p. 3.114):

$$\Delta C_{GGOrganic} = \Sigma c\ (A \times EF)\ c \qquad (7.21)$$

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 (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 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.

Equation 3.4.12 of the *IPCC GPG LULUCF* (p. 3.120) was used for calculation of total change in carbon stocks in land converted to Grassland:

$$\Delta C_{LG} = \Delta C_{LGLB} + \Delta C_{LGSoils} \quad (7.22)$$

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}.

7.4.2.1 Change in carbon stock in living biomass

Tier 1 is used to estimate annual carbon stocks change in living biomass from Lands 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 3.4.13 of the *IPCC GPG LULUCF* (p. 3.122) was used for calculation:

$$\Delta C_{LGLB} = A_{Conversion} \times (L_{Conversion} + \Delta C_{Growth}) \quad (7.23)$$
$$L_{Conversion} = C_{After} - C_{Before}$$

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). 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).

7.4.2.2 Change in carbon stock in soils

Tier 1 method is used to estimate annual carbon stocks change in soils for Lands converted to Grassland. Equation 3.4.17 of the *IPCC GPG LULUCF* (p. 3.126) was used for calculation:

$$\Delta C_{LGSoils} = \Delta C_{LGMineral} - \Delta C_{LGOrganic} - \Delta C_{LGLime} \quad (7.24)$$

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 7.4.1.2.1 Methodological issues.

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).

All carbon emissions from lime application reported in Cropland remaining Cropland category, therefore CO_2 emissions from liming reported to be zero in Land converted to Grassland.

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 (see: *Section 7.3.4*)

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 were obtained from The National Land Service (NLS) and national Nature Heritage Fund (NHF). The emission factors were employed from *IPCC GPG LULUCF*. The uncertainty rates in the activity data and the emission factors used in the estimates are reported in Table 7-31.

Table 7-31. Estimated values of uncertainties

Input	Uncertainties, %	References
Activity data		
Grassland area	±1,2	*Study 2*
Emission factors		
SOC_{REF}	±95	GPG LULUCF 2003. P3.117
F_{LU} F_{MG} F_{I}	NA	GPG LULUCF 2003. P3.118
EF (organic soils)	±90	GPG LULUCF 2003. P3.118

7.4.5 Source-specific QA/QC and verification

The QC/QA includes the QC activities described in the IPCC GPG 2000. Activity data and emission values are compared with emission values of other countries. If errors are found they are corrected.

7.4.6 Source-specific recalculation

Emissions from Grassland reported for the first time using recently implemented *Study-2* results.

Table 7-32. Impact of recalculations on grassland area, thous. ha

Year	Previous submission	This submission	Difference
1990	NE	1310,5	1310,5
1991	NE	1345,6	1345,6
1992	NE	1381,2	1381,2
1993	NE	1443,5	1443,5
1994	NE	1480,2	1480,2
1995	NE	1517,8	1517,8
1996	NE	1556,8	1556,8
1997	NE	1596,2	1596,2
1998	NE	1635,2	1635,2
1999	NE	1675,9	1675,9
2000	NE	1673,1	1673,1
2001	NE	1715,7	1715,7
2002	NE	1745,1	1745,1
2003	NE	1822,4	1822,4
2004	NE	1858,2	1858,2

2005	NE	1894,4	1894,4
2006	NE	1818,8	1818,8
2007	NE	1738,4	1738,4
2008	NE	1662,5	1590,1
2009	NE	1590,1	1582,1

Table 7-33. Impact of recalculations on CO_2 emissions/removals from Grassland, Gg

Year	Previous submission	This submission	Difference
1990	NE	461,5	461,5
1991	NE	15,9	15,9
1992	NE	28,4	28,4
1993	NE	200,4	200,4
1994	NE	58,4	58,4
1995	NE	71,6	71,6
1996	NE	48,6	48,6
1997	NE	67,2	67,2
1998	NE	71,3	71,3
1999	NE	90,4	90,4
2000	NE	118,8	118,8
2001	NE	195,5	195,5
2002	NE	123,5	123,5
2003	NE	146,4	146,4
2004	NE	155,7	155,7
2005	NE	167,3	167,3
2006	NE	657,9	657,9
2007	NE	612,6	612,6
2008	NE	586,5	586,5
2009	NE	565,1	565,1

7.4.7 Source-specific planned improvements

The possibility to use country–specific values for reference carbon stocks estimates and more detailed stratification of management systems will be investigated in the next submission.

7.5 Wetland (CRF 5.D)

Wetlands include peat extraction areas and peat lands which do not fulfill 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). CO_2 emissions associated with peat extraction were evaluated.

In 2010 inland waters (lakes, rivers etc.) constituted to 196,0 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.

7.5.1 Source category description

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 7-13). From 2002 extraction area has been reduced by approximately 20%. It was assumed that peat extraction area in 1990 and 1991 was the same as in 1992.

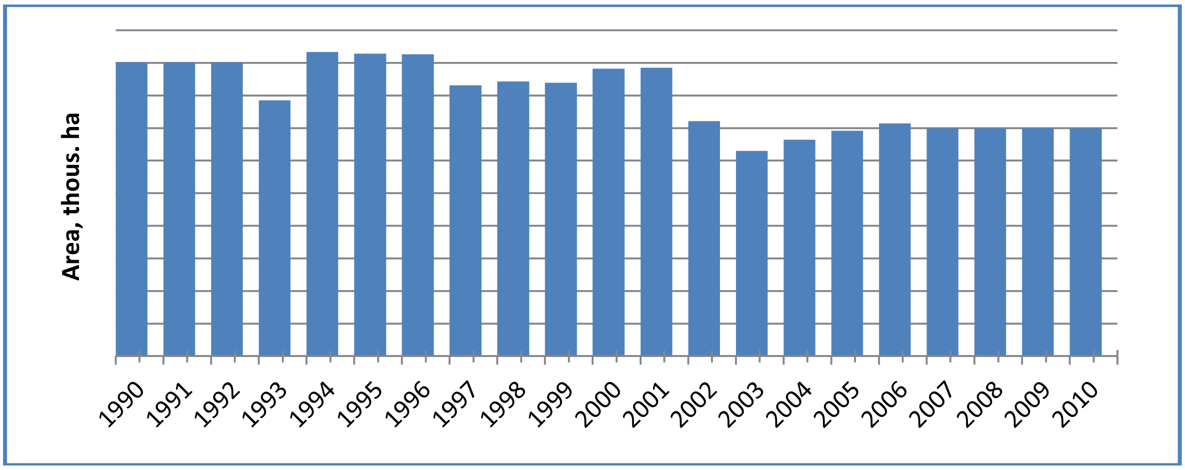


Figure 7-13. Changes of peat extraction areas[107]

7.5.2 Methodological Issues

The method provided in *IPCC GPG LULUCF* addresses the 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 3.5.5 of *IPCC GPG LULUCF*.

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 GPG LULUCF*).

For calculation of carbon stock changes caused by conversion of Forest land to Wetlands 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.

For calculation of carbon stock changes in living biomass by conversion of Cropland to Wetlands Tier 1 method and the associated default values are used. Default value of 10,0 tonnes d.m. ha^{-1} estimate for B_{Before} (Table 3.4.8) and 0 tonnes d.m. ha^{-1} estimate for B_{After} has been used.

[107] Lithuanian Geological Survey. [available on-line: www.lgt.lt]

For calculation of carbon stock changes in living biomass by conversion of Grassland, Settlements and Other Lands to Wetlands Tier 1 method and the associated default values are used. Default value of 2,4 tonnes d.m. ha^{-1} estimate for B_{Before} (Table 3.4.2) and 0 tonnes d.m. ha^{-1} estimate for B_{After} has been used.

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 it was assumed that uncertainty of activity data can be 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 GPG LULUCF were established, particularly, data on peat extraction areas was compiled from Lithuanian Geological Service.

7.5.5 Source-specific recalculation

Recently implemented studies (*Study-1* and *Study-2*) provided accurate information on which basis all recalculations were made.

Table 7-34. Impact of recalculations on CO_2 emissions/removals from wetlands, Gg

Year	Previous submission	This submission	Difference
1990	175,16	72,73	-102,43
1991	121,99	72,73	-49,26
1992	122,13	72,73	-49,40
1993	112,85	179,75	66,90
1994	124,95	75,27	-49,68
1995	124,67	74,85	-49,82
1996	124,65	74,70	-49,95
1997	117,17	67,08	-50,09
1998	217,26	67,96	-149,30
1999	217,10	168,83	-48,27
2000	220,64	74,51	-146,13
2001	220,98	94,94	-126,04
2002	175,88	58,16	-117,72
2003	307,29	157,30	-149,99
2004	288,52	160,70	-127,82
2005	375,31	55,78	-319,53
2006	217,36	57,60	-159,76
2007	131,14	66,57	-64,57
2008	130,85	62,80	-68,05
2009	163,42	80,02	-83,40

7.5.6 Source specific planned improvements

Emissions from wetlands are calculated as a result of forest land conversion to wetland. The results are not precise enough because of high rate of uncertainty due to very small areas converted. Future planned improvements consist of development of methodology for data collection etc. to reduce uncertainty level for reporting.

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' meanings are included under this category. According to national definitions - urban territories are squares, playgrounds, stadiums, airports, yards, grave lands and buildings. Roads are land areas with engineering structure for transport and its traffic. In rural areas, areas with no special road cover used for mechanical and non-mechanical transport traffic and bridleways for animals are also included.

7.6.2 Settlements remaining settlements

The general method was used to estimate changes in biomass carbon stocks as a result of tree growth, subtracting out losses in biomass carbon stocks as a result of 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, the estimation method assumes that the accumulation of carbon in biomass slows down with age and thus for trees greater than 20 years of age increases in biomass carbon are assumed as offset losses from pruning and mortality. This is conservatively accounted for by setting $\Delta B_{SSG} = \Delta B_{SSL}$ (*IPCC GPG LULUCF*, p. 3.298). Carbon stock changes in settlements remaining settlements assumed to be close to zero in Lithuania.

7.6.3 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.

7.6.4 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 it was assumed that uncertainty of activity data can be about 80%. Emission factor uncertainty was assumed to be about 20%.

7.6.5 Source-specific QA/QC and verification

Quality control procedures named in *IPCC GPG LULUCF* were established when calculating emissions from settlement land use category.

7.6.6 Source-specific recalculation

Recently implemented *Study-2* provided new primary information on which basis all recalculations were made. *Study-2* presented results only for those years (1993, 2000, 2001, 2006-2009) when any land changes happened and CO_2 emissions and removals occurred. Notation keys NA, NO used in "This submission" graph means that there were no changes in area and CO_2 balance in respective years.

Table 7-35. Impact of recalculations on CO_2 emissions/removals from settlements, Gg

Year	Previous submission	This submission	Difference
1990	165,21	NA,NO	165,21
1991	79,46	NA,NO	79,46
1992	79,68	NA,NO	79,68
1993	79,90	5301,21	5221,31
1994	80,13	NA,NO	80,13
1995	80,35	NA,NO	80,35
1996	80,57	NA,NO	80,57
1997	80,79	NA,NO	80,79
1998	240,81	NA,NO	240,81
1999	240,96	NA,NO	240,96
2000	241,12	567,81	326,69
2001	241,31	2661,66	2420,35
2002	189,87	NA,NO	189,87
2003	413,71	NA,NO	413,71
2004	378,90	NA,NO	378,90
2005	515,38	NA,NO	515,38
2006	257,68	251,88	-5,80
2007	120,44	1335,00	1214,56
2008	120,63	372,55	251,92
2009	172,49	255,44	82,95

7.6.7 Source-specific planned improvements

Additional studies and information research is planned to improve reporting of areas that are under NA, NO reporting in this submission.

7.7 Other land (CRF 5.F)

7.7.1 Source category description

This category is included for checking overall consistency of all land area. All other lands not classified as Forest land, Cropland, Grassland, 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 Other Land Remaining Other Land

Carbon stocks changes and non-CO_2 emissions and removals are not considered for this category as mentioned in IPCC 2003 guidelines.

7.7.3 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.

Equation 3.7.1 of the *IPCC GPG LULUCF* (p. 3.145) was used for calculation of total change in carbon stocks in Land converted to Other Land:

$$\Delta C_{LO} = \Delta C_{LOLB} + \Delta C_{LOSoils} \quad (7.25)$$

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}.

7.7.3.1 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. Equation 3.7.2 of the *IPCC GPG LULUCF* (p. 3.146) was used for calculation:

$$\Delta C_{LOLB} = A_{Conversion} \times (B_{After} - B_{Before}) \times CF \quad (7.26)$$

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) for conversions from Cropland, default 2,4 tonnes d.m. ha^{-1} estimate for B_{Before} has been used (Table 3.4.2) for conversions from Grassland.
The default assumption is that carbon stock after conversion is zero.

7.7.3.2 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.

7.7.4 Source-specific QA/QC and verification

Quality control procedures named in *IPCC GPG LULUCF* were established when calculating emissions from Other Land category.

7.7.5 Source-specific recalculation

Recently implemented *Study-2* provided new primary information on which basis all recalculations were made. Study-2 presented results only for those years (1993, 1994, 2000, 2001, 2006-2009) when any land changes happened and CO_2 emissions and removals occurred. Notation keys NA, NO used in "This submission" graph means that there were no changes in area and CO_2 balance in respective years.

Table 7-36. Impact of recalculations on CO_2 emissions/removals from other land, Gg

Year	Previous submission	This submission	Difference
1990	283,05	NA,NO	283,05
1991	136,14	NA,NO	136,14
1992	136,52	NA,NO	136,52
1993	136,90	629,49	492,59
1994	137,28	242,58	105,30
1995	137,66	NA,NO	137,66
1996	138,04	NA,NO	138,04
1997	138,42	NA,NO	138,42

1998	412,58	NA,NO	412,58
1999	412,85	NA,NO	412,85
2000	413,12	1,76	-411,36
2001	413,45	383,37	-30,08
2002	325,31	NA,NO	325,31
2003	708,82	NA,NO	708,82
2004	649,17	NA,NO	649,17
2005	883,01	NA,NO	883,01
2006	441,49	251,88	-189,61
2007	206,35	278,54	72,19
2008	206,68	275,03	68,35
2009	295,53	NA,NO	295,53

7.7.6 Source-specific planned improvements

Additional studies and information research is planned to improve reporting of areas that are under NA, NO reporting in this submission.

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 (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 Sector in 2010

IPCC source category	Gas	Identification criteria
6.A Solid waste disposal on land	CH_4	L, T

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	Wastewater handling	Humane sewage	Waste incineration	Total
1990	907,0	174,6	79,9	4,16	1165,7
1991	928,8	174,1	80,2	4,51	1187,7
1992	947,9	172,8	80,3	1,28	1202,4
1993	960,4	171,9	80,1	3,77	1216,1
1994	964,7	170,4	79,8	1,17	1216,0
1995	964,1	169,0	79,4	4,26	1216,7
1996	967,7	167,8	78,9	1,44	1215,8
1997	971,6	166,8	78,5	1,43	1218,3
1998	974,1	165,8	78,2	1,51	1219,6
1999	972,6	163,9	77,8	0,65	1214,9
2000	979,5	163,2	77,4	1,92	1222,1
2001	1010,1	151,9	77,2	2,54	1241,7
2002	1022,4	148,8	77,1	2,33	1250,6
2003	1032,6	140,9	77,5	6,27	1257,3
2004	1014,8	136,3	77,8	3,22	1232,1
2005	996,5	133,3	78,1	5,94	1213,9
2006	982,6	124,3	78,4	5,45	1190,8
2007	972,6	124,0	78,7	0,78	1176,0
2008	961,8	133,6	79,0	0,66	1175,0

2009	959,7	129,8	79,3	0,70	1169,5
2010	954,4	125,0	79,8	2,03	1161,3

During the period 1990-2003 total GHG emission from Waste Sector increased by 7,3 % but during 2003-2010 it decreased by 7,6 %. The average GHG emission for period 1990-2010 is 1207,8 Gg CO_2 eq.

Solid waste disposal on land including disposal of sewage sludge is the biggest GHG emission source from Waste Sector. It contributes around 82,% of the total GHG emission from Waste Sector in 2010. Fluctuations of GHG emission 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 2010 are shown in Figure 8-1.

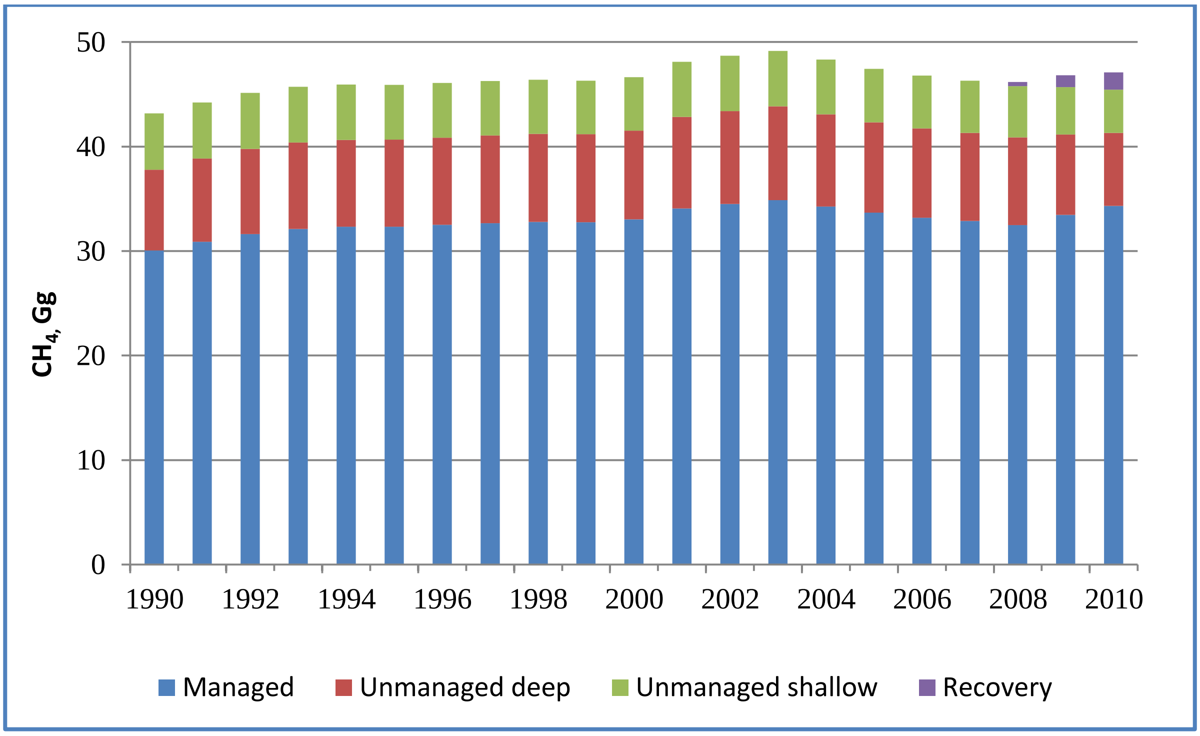


Figure 8-1. Variations of GHG emissions in Waste Sector

Wastewater handling contributes around 17,% of GHG emissions from Waste Sector in 2010,,. 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 for 6,9% of the total GHG emission from Waste Sector, fluctuating from 6,7% in 2006 to 6,9% in 1990.

Waste incineration is used in Lithuania on a very small scale contributing during the period 1990-2010 on average only 0,23% of the total GHG emission.

8.2 Solid waste disposal on land (CRF 6.A)

The amount of municipal waste disposed to landfills in 2010 was 1050 k tonnes, it is 5 k tonnes less than in 2009. Since 2000 the amount of disposed municipal waste remains comparatively stable.

The majority of landfills in the past were not complying with environmental and sanitary requirements because of poorly chosen sites, poor engineering equipment, improper operation and insufficient control of waste disposed to the landfills.

As a result of implementation of the landfill directive 1999/31/EC[108], 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 waste, including waste from small towns and rural areas, is currently disposed in new landfills. The fraction of waste disposed to the newly constructed regional landfills complying with the requirements of the landfill directive increased from 5,2% of the total amount of disposed municipal waste in 2007 to 72,2% in 2008, 84,1% in 2009, and 100% in 2010.

8.2.1 Source category description

Municipal waste generation and disposal

Data of waste generation and disposal are collected from 1991, earlier data on waste disposal are not available. Data from 2001 are available on the website of the Lithuanian Environmental Protection Agency (EPA)[109].

Data collection is regulated by the Rules on Waste Management approved by Order No.217 of the Minister of Environment of the Republic of Lithuania of 14th of July 1999 as last amended on 30th of December 2003. Pursuant to this legal act waste-generating and waste-managing companies must submit annual reports on waste generation and treatment to institutions subordinated to Ministry of Environment - Regional Environmental Protection Departments (REPDs). REPDS perform primary data check on regional level and checked data are forwarded to the EPA. The EPA performs the final validation, processing and aggregation at national level.

Data collected by the EPA includes specifically the fraction of Municipal Solid Waste (MSW) sent to solid waste disposal sites (SWDS), therefore in calculations factor MSW_F was taken as 100%.

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[108] Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1999:182:0001:0019:EN:PDF

[109] EPA website: http://gamta.lt/

According to data collected by the EPA, about 1,5 to 2 million tonnes of municipal waste was disposed of in landfills annually in 1991-1994, almost twice as much as in 1999-2009.

In the previous stages of data collection waste was not weighed and amount of waste disposed to landfills and dumps was evaluated on volume basis. 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[110] 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[111] 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[112]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 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.

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[110] State of the Environment 2001, p. 85th Ministry of Environment of the Republic of Lithuania, Vilnius, 2002

[111] Meeting at the Ministry of Environment with the Head of Waste Division Ingrida Kavaliauskienė and senior specialist Ingrida Rimaitytė, September 25, 2009

[112] 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

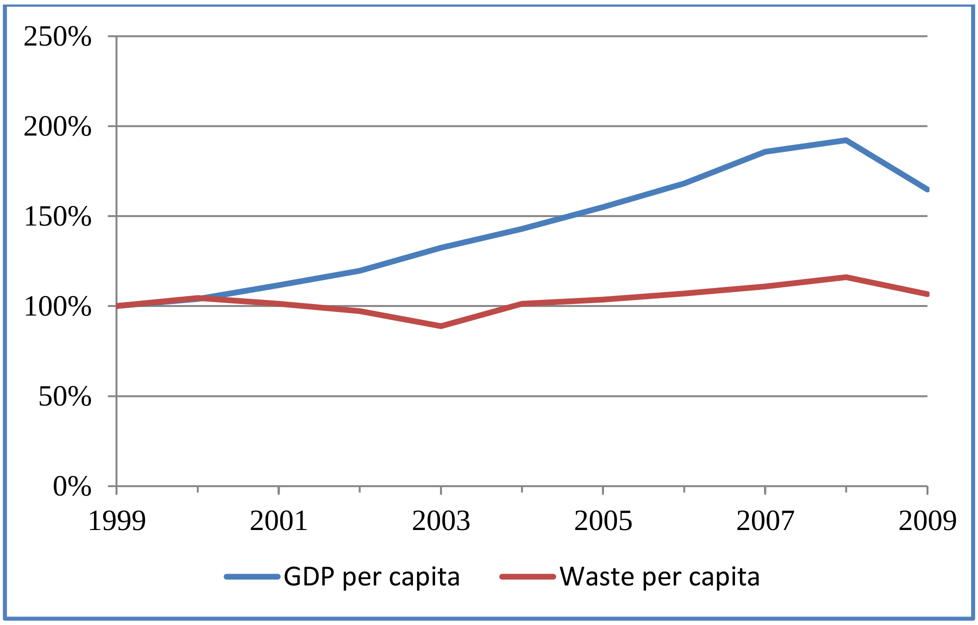


Figure 8-2. Variations of GDP and waste disposal per capita during 1999-2009

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 8-3. 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 and industrial 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 using estimated annual changes shown in Table 8-2 and population number provided by the Statistics Lithuania (Figure 8-3).

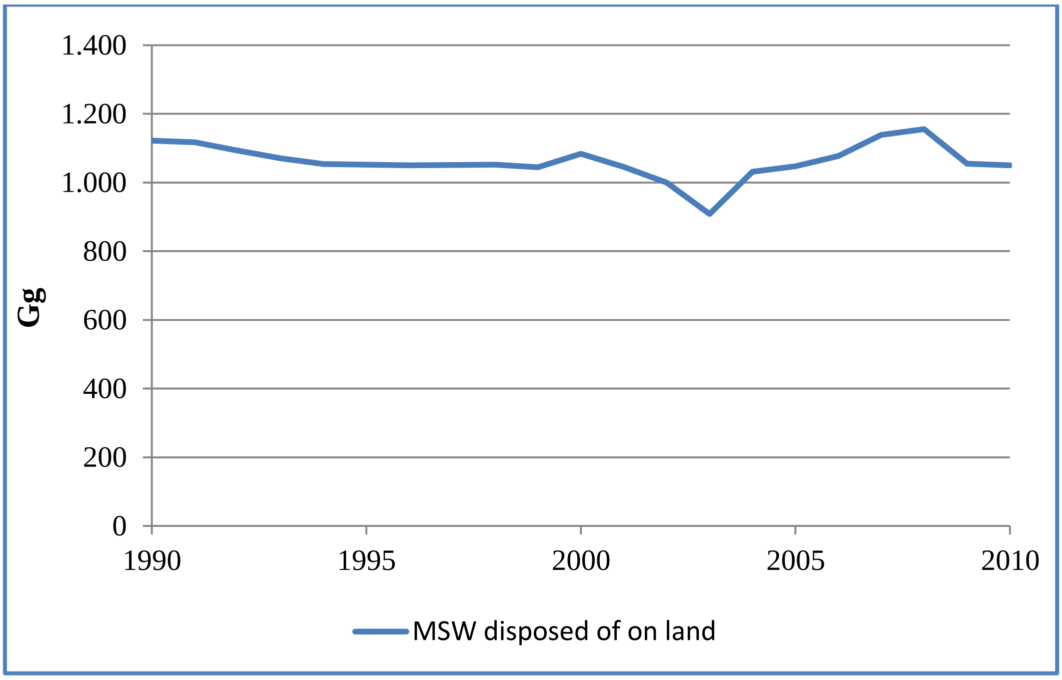


Figure 8-3. Total waste generation in 1990-2010

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[113] 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[114]. 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
- Waste of food preparation and products

[113] 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)
[114] *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

- Green waste
- Sewage sludge

Data reported on disposal of biodegradable waste of industrial and commercial origin in landfillsare provided in Table 8-4.

Table 8-4. Reported data on disposal of biodegradable waste of industrial and commercial origin in landfills in 1991-2010, thous tonne

Year	Paper and cardboard wastes	Wood wastes	Textile wastes	Waste of food preparation and products	Green wastes	Sewage sludge	Total
1991	12,93	33,02	12,37	45,32	30,38	302,5	436,5
1992	4,92	30,00	4,15	56,61	26,43	266,7	388,8
1993	7,77	19,23	6,75	31,60	29,65	243,3	338,3
1994	5,84	20,19	1,86	14,79	22,00	254,8	319,5
1995	4,68	42,83	1,04	15,98	26,24	292,2	383,0
1996	5,49	25,30	1,39	33,11	14,87	291,6	371,7
1997	5,10	27,31	1,25	13,65	9,68	334,0	391,0
1998	4,33	6,28	2,31	12,55	7,87	291,6	325,0
1999	5,34	4,80	2,23	68,10	7,33	303,9	391,7
2000	1,26	3,64	6,06	215,88	3,51	306,1	536,4
2001	0,82	2,00	3,14	151,09	4,27	308,2	469,6
2002	0,73	3,01	3,82	185,52	4,60	282,0	479,7
2003	1,44	2,94	1,70	88,50	3,84	205,3	303,8
2004	0,40	4,61	2,86	2,27	5,06	185,0	200,2
2005	0,53	24,05	2,50	1,91	7,59	149,9	186,5
2006	0,19	4,88	1,83	1,91	13,78	142,5	165,1
2007	0,67	0,81	1,96	3,30	9,32	124,3	140,4
2008	0,13	4,61	1,37	3,18	6,54	136,4	152,2
2009	0,05	5,12	2,02	2,57	8,02	146,7	164,5
2010	0,04	0,98	3,18	2,39	5,64	208,26	220, 5

Waste Composition

Average composition of MSW was evaluated by experimental measurements carried out from 1996 during the feasibility studies of development of regional waste management system and construction of new landfills in various regions of Lithuania (Table 8-5). 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.

Average composition of MSW in Lithuania is based on the review of experimental measurements which was published in the (MoE) report "Status of the Environment 2004[115] and was used for calculation of CH_4 emissions from waste disposed on land (Table 8-6).

[115] Ibid.

Table 8-5. Measured waste composition of various regions of Lithuania[116]

<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>

[116] Feasibility studies for establishment of regional waste management systems in Kaunas, Klaipėda, Vilnius, Utena, Panevėžys regions, Lithuania

Table 8-6. Average composition of MSW in Lithuania

Ingredient	Amount
Plastic	9%
Paper and cardboard	14%
Glass	9%
Metal	3%
Textile	4%
Biodegradable (kitchen) waste	42%
Composite packaging	2%
Construction and demolition waste	4%
Hazardous waste	2%
Leather, rubber	1%
Wood	2%
Sand, sweepings	4%
Other	4%

The final amount and composition of waste disposed on land was obtained by adding together municipal waste and biodegradable waste of industrial and commercial origin. Biodegradable components in landfilled waste evaluated for calculation of CH_4 generation are shown in Table 8-7.

Table 8-7. Biodegradable components in landfilled waste evaluated for calculation of CH_4 generation (Gg)

Year	Paper and cardboard wastes	Wood wastes	Textile wastes	Food waste	Green wastes	Sewage sludge	Total
1990	170,04	55,46	57,26	516,63	30,38	302,53	1132,30
1991	169,39	55,37	57,07	514,70	30,38	302,53	1129,44
1992	157,97	51,87	47,88	515,76	26,43	266,66	1066,57
1993	157,72	40,65	49,59	481,46	29,65	243,30	1002,37
1994	153,41	41,27	44,03	457,49	22,00	254,78	972,98
1995	151,92	63,87	43,10	457,69	26,24	292,25	1035,07
1996	152,48	46,30	43,38	474,10	14,87	291,57	1022,70
1997	152,24	48,33	43,29	455,06	9,68	334,01	1042,61
1998	151,64	27,33	44,40	454,48	7,87	291,62	977,34
1999	151,55	25,69	44,01	506,75	7,33	303,93	1039,26
2000	153,05	25,33	49,43	671,24	3,51	306,08	1208,64
2001	147,22	22,92	44,97	590,29	4,27	308,23	1117,90
2002	140,75	23,02	43,83	605,57	4,60	282,03	1099,80
2003	128,67	21,12	38,06	470,20	3,84	205,34	867,23
2004	144,83	25,25	44,12	435,55	5,06	184,98	839,79
2005	147,19	45,00	44,40	441,89	7,59	149,94	836,01
2006	150,96	26,41	44,91	454,22	13,78	142,55	832,83
2007	160,16	23,59	47,53	481,77	9,32	124,29	846,66
2008	161,86	27,72	47,58	488,37	6,54	136,37	868,44
2009	147,70	26,22	44,21	445,53	8,02	146,69	818,37
2010	147,09	21,98	45,19	443,53	5,64	208,26	871,69

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 8-4).

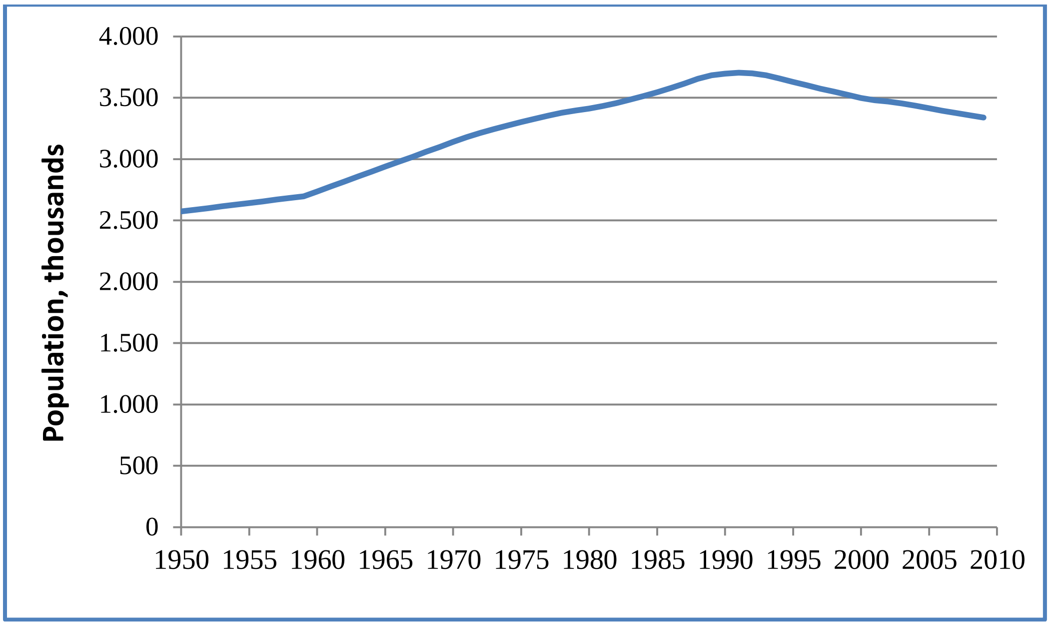


Figure 8-4. Variation of population in Lithuania in 1950-2010[117]

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 incorrect.

Economic development during the Soviet period was characterized by the "total public product". Changes of the total public product[118] evaluated by the Statistics Lithuania are shown in Figure 8-5. It should be noted, however, that it was measured in current prices and did not reflect correctly the change in living standard.

[117] Statistics Lithuania

[118] GDP: Conversion from material product balances to the system of national accounts in 1980-1990 at current prices. Lithuanian Department of Statistics, Vilnius, 1994

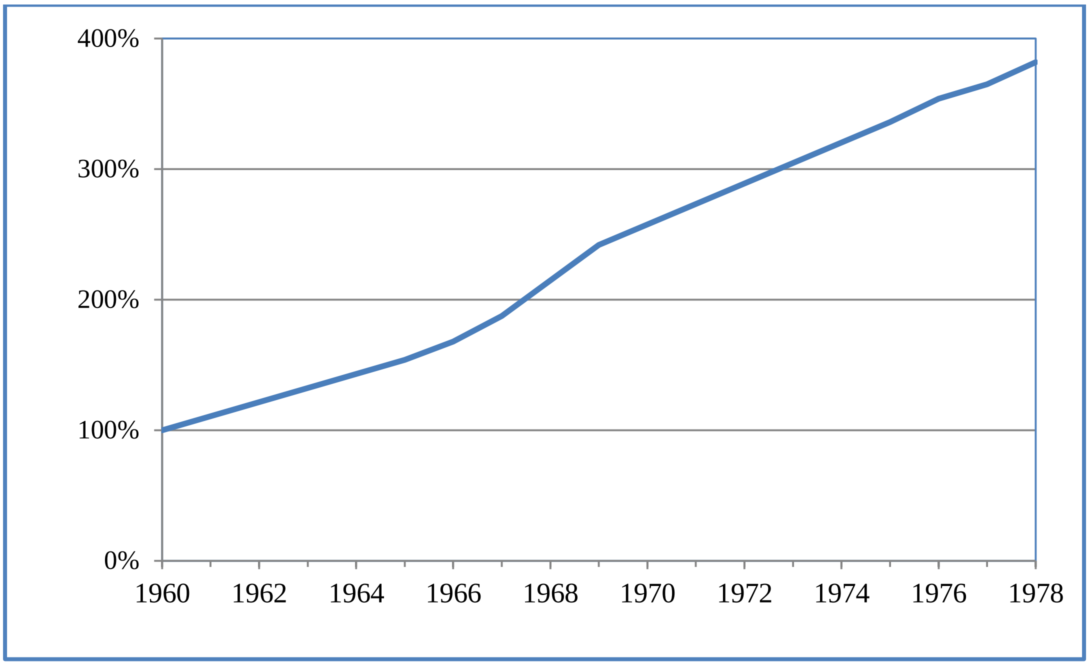


Figure 8-5. Variation of the total public product from 1960 to 1978

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[119]. Relative variations of population and GDP per capita from 1980 (1990 = 100%) are shown in Figure 8-6.

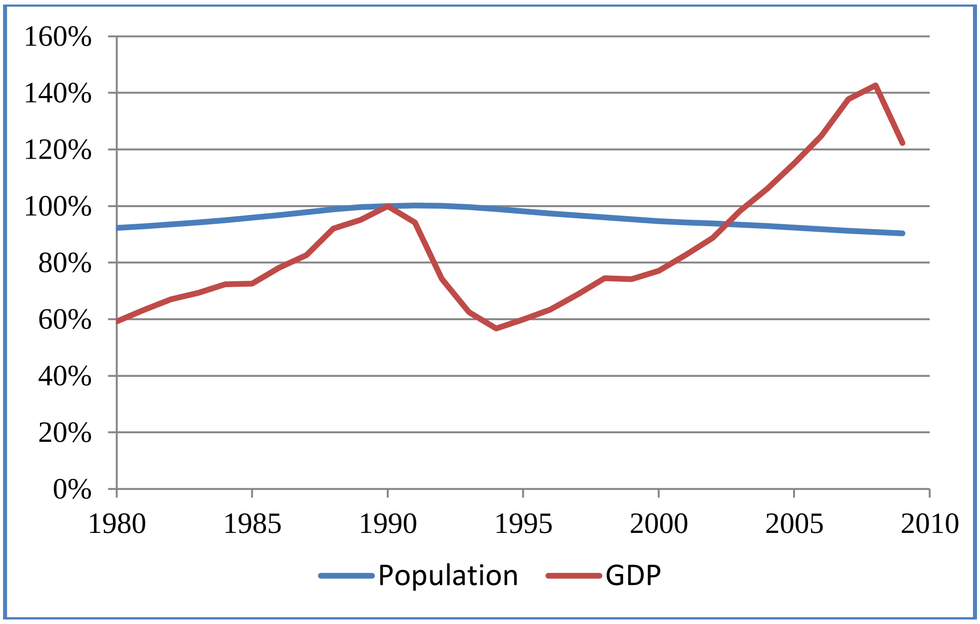


Figure 8-6. Relative variation of population and GDP per capita from 1980 (1990 = 100%)

It is obvious that generation of waste per capita depends on the standard of living but growth of waste generation rate grows slower than GDP.

[119] 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: population and standard of living. As it was quoted above, population growth during this period was close to 1% determining at least 1% growth in the total waste generation.

In addition, it was assumed that improvement of living standards caused further increase of waste generation per capita by 1% annually.

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 shown in Figure 8-7.

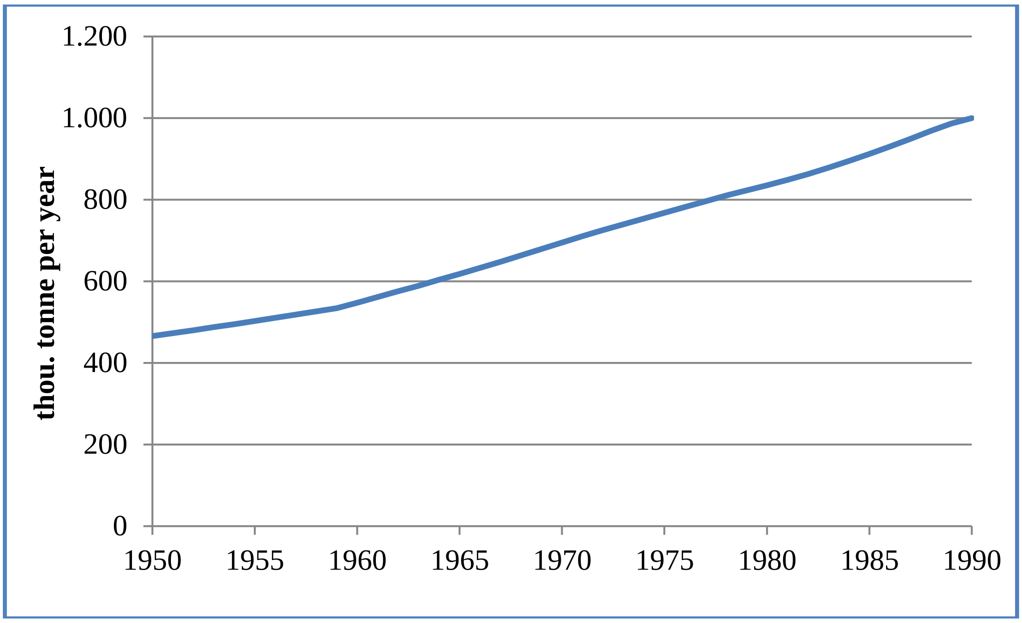


Figure 8-7. Assumed variation of municipal waste disposal from 1950 to 1990

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 8-8.

Table 8-8. Variations of urban and rural population (k) in Lithuania during 2001-2008[13]

Year	Major cities	Towns	Total urban	Rural	Total
2001	1629	702	2330	1151	3481
2002	1622	699	2322	1147	3469
2003	1616	691	2307	1147	3454
2004	1604	685	2289	1146	3436
2005	1593	682	2275	1139	3414
2006	1585	679	2265	1130	3394
2007	1580	676	2256	1120	3376
2008	1574	672	2246	1112	3358

Source: Statistics Lithuania

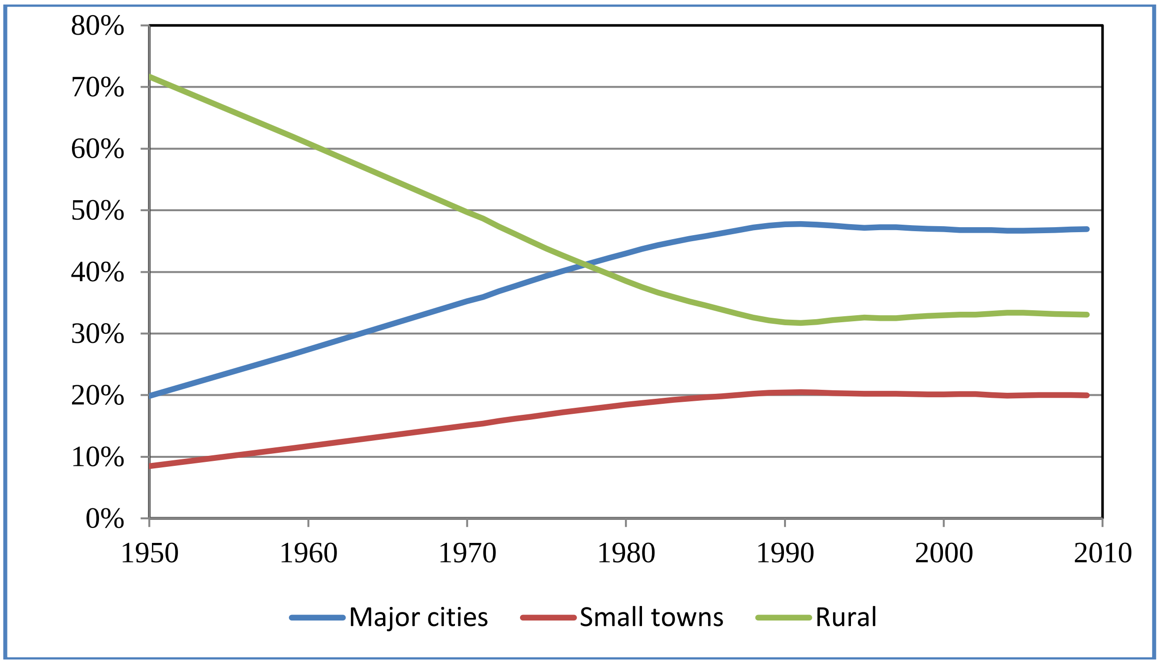


Figure 8-8. Estimated variations of population in major cities, towns and rural areas from 1950[120]

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.

[120] Statistics Lithuania

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 8-9.

Table 8-9. 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

Evaluated disposal of municipal waste in new regional landfills are shown in Table 8-10.

Information of waste disposal in new modern landfills was provided by regional waste management companies responsible for the operation of regional waste management systems.

Table 8-10. 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 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 discussion at the Ministry of Environment[121] 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 generation per capita in major cities, towns and rural areas 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 waste generation per capita in cities, towns and rural areas (kg per capita per year),
WT is the total waste generation (tonne),
P_C, P_T and P_R are cities, towns and rural population (thousands) accordingly.

The amounts of waste disposed to 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 by waste generation per capita.

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 of landfill gas recovery (in million m^3) and of gas composition were provided by the corresponding regional waste management centres responsible for landfill supervision. CH_4 recovery in Gg was recalculated using equation:

$$Q = V \cdot n \cdot \frac{M_{CH4}}{MV},$$

where:
Q is the amount of recovered CH_4, Gg,
V is the volume of collected landfill gas, million m^3,
n is CH_4 fraction in recovered landfill gas,
M_{CH4} is CH_4 molecular weight (= 16 g),
MV is CH_4 molecular volume (= 22,4 litre).

Data of CH_4 recovery from landfills are provided in Table 8-11.

Table 8-11. Methane recovery from landfills, Gg

	Kaunas	Utena	Vilnius	Klaipėda	Marijampolė	Total
CH_4 fraction in recovered landfill gas	51%	55%	50%	47%	60%	
2008	0,33	0,04	NO	NO	NO	0,37

[121] Meeting at the Ministry of Environment with the Head of Waste Division Ingrida Kavaliauskienė and senior specialist Ingrida Rimaitytė, September 25, 2009

2009	1,02	0,11	NO	NO	NO	1,13
2010	0,87	0,20	0,50	0,07	0,01	1,65

8.2.2 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 CH_4 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, CH_4 emissions from solid waste disposal sites were estimated using IPCC waste model based on the first order decay method provided in the *2006 IPCC Guidelines*.

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:

$$DDOC_m = DDOC_m(0) \cdot e^{-kt}$$

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).

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).

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
Sewage sludge	0,05 (IPCC 2006, v. 5, p. 2.15)

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)

8.2.3 Uncertainties and Time-Series Consistency

Uncertainties

Default values of uncertainties of input parameters were used for Tier 1 uncertainty analysis (IPCC 2000, page 5.12, Table 5.2).

Bearing in mind that some data from waste disposal are not reliable, especially in the beginning of the period, it was assumed that uncertainty in establishing activity data was about 30%, i.e. minimum value provided in IPCC 2000 multiplied by three.

Uncertainties of separate input parameters for Tier 1 uncertainty analysis were taken as average values of uncertainties provided in IPCC 2000, p. 5.12 (Table 8-12).

Table 8-12. Uncertainties of separate input parameters

Parameter	IPCC 2000, Table 5,2	Assumed average uncertainty
Degradable organic carbon	-50%, +20%	35%
Fraction of degradable organic carbon dissimilated	-30%, +0%	15%
Methane correction factor:		
MCF = 1	-10%, +0%	5%
MCF = 0,4	-30%, +30%	30%
MCF = 0,6	-50%, +60%	55%
Methane fraction in landfill gas	-0%, +20%	10%
Methane generation rate constant	-40%, +300%	170%

Uncertainty of implied emission factor for three separate MCF values was established using IPCC 2000, equation 6.4 (p. 6.12):

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \dots + U_n^2},$$

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 8-12 are provided in Table 8-13.

Table 8-13. Overall uncertainties of implied emission factors

Methane correction factor	Uncertainties of implied emission factor
MCF = 1	174%
MCF = 0,4	176%
MCF = 0,8	182%

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 over the period 1990-2010 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.

8.2.4 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(QA) and Quality Control(QC) Plan[122].

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.

[122] 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.
In addition, verification of methane emissions from solid waste disposal on land was performed by comparing per capita emission data with neighboring countries: Latvia, Estonia, Poland, and Denmark. The results are shown in Table 8-14.

Table 8-14. Comparison of GHG emissions from solid waste disposal on land (tonne CO_2 eq. per capita)

Year	Lithuania* 2010	Denmark* 2009	Latvia 2009	Estonia* 2009	Poland* 2009
1990	0,245	0,215	0,148	0,382	0,167
1991	0,251	0,220	0,158	0,375	0,169
1992	0,256	0,222	0,167	0,373	0,171
1993	0,261	0,224	0,178	0,391	0,172
1994	0,264	0,217	0,186	0,397	0,173
1995	0,266	0,210	0,194	0,376	0,174
1996	0,269	0,209	0,201	0,382	0,176
1997	0,272	0,199	0,208	0,430	0,179
1998	0,274	0,192	0,216	0,466	0,184
1999	0,276	0,198	0,225	0,473	0,188
2000	0,280	0,199	0,235	0,500	0,193
2001	0,290	0,202	0,244	0,497	0,187
2002	0,295	0,195	0,247	0,472	0,185
2003	0,299	0,202	0,235	0,456	0,183
2004	0,295	0,187	0,230	0,449	0,183
2005	0,292	0,187	0,236	0,416	0,184
2006	0,290	0,198	0,243	0,403	0,181
2007	0,288	0,194	0,254	0,385	0,180
2008	0,286	0,192	0,261	0,383	0,170
2009	0,287	0,187	0,262	0,349	0,168

*Including emissions from sewage sludge disposed in landfills

Established methane emissions per capita from solid waste disposal on land in Lithuania are higher than in Denmark, Latvia and Poland but lower than in Estonia.

Methane emissions in Latvia are slightly lower than calculated in Lithuania which, at least partially, could be explained by the fact that sewage sludge disposed of in landfills was included in methane emission calculations in Lithuania.

In the very beginning of nineties Lithuanian per capita emissions from solid waste disposal on land were very close to Danish data but later Danish emissions decreased due to significant (53%) increase of methane recovery causing the difference to rise to approximately 35% in 2009.

In general, established per capita methane emissions from solid waste disposal on land in Lithuania are only slightly higher (about 9% on average) than the mean vales for the reviewed countries. Bearing this in mind, it could be concluded that correspondence of emission data is quite good.

8.2.5 Source specific recalculations

CH_4 emissions were recalculated including data of sewage sludge disposal on land and additionally obtained data of disposal of biodegradable waste of industrial and commercial origin during 1990-2000.

Impact of recalculations of CH_4 emission (Gg) from solid waste disposal on land is shown in Table 8-15.

Table 8-15. 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	752,9	907,0	154,1	20,5%
1991	770,9	928,8	157,9	20,5%
1992	786,5	947,9	161,5	20,5%
1993	798,0	960,4	162,4	20,4%
1994	806,1	964,7	158,6	19,7%
1995	811,8	964,1	152,3	18,8%
1996	816,9	967,7	150,8	18,5%
1997	821,6	971,6	150,0	18,3%
1998	826,1	974,1	148,0	17,9%
1999	830,5	972,6	142,1	17,1%
2000	833,8	979,5	145,8	17,5%
2001	840,3	1010,1	169,8	20,2%
2002	841,8	1022,4	180,5	21,4%
2003	847,3	1032,6	185,3	21,9%
2004	832,3	1014,8	182,5	21,9%
2005	827,8	996,5	168,7	20,4%
2006	827,5	982,6	155,1	18,7%
2007	829,3	972,6	143,3	17,3%
2008	887,2	961,8	74,6	8,4%
2009	891,6	959,7	68,1	7, 6%

8.2.6 Planned improvements

The study to improve knowledge and understanding about sewage sludge treatment and disposal including sewage sludge application to agriculture and composting will be conducted in 2012. Procurement tender for this study was announced in April 2012. Study results are to be ready in August 2012.

8.3 Wastewater Handling (CRF 6.B)

8.3.1 Source category description

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 not connected to centralised sewer networks is shown in Table 8-16.

Table 8-16. Fraction of population having no connection to sewerage networks

Year	Fraction, %
2001	46,7
2002	46,1
2003	43,6
2004	42,3
2005	41,7
2006	39,0
2007	39,0
2008	42,4
2009	41,4
2010	40,5

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[123] 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

[123] Lithuanian Water Suppliers Association. Certificate on municipal wastewater treatment plant capacity assessment, 2011.03.04.

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.

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 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 8-17 both parameters are determined 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 8-17. 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 8-18.

Table 8-18. Evaluated CH_4 emissions from wastewater (Gg)

Year	Wastewater treatment	Septic tanks	Total	CH_4 recovery (from sludge)
1990	0,22	8,10	8,31	NO
1991	0,18	8,11	8,29	NO
1992	0,13	8,10	8,23	NO
1993	0,12	8,06	8,18	NO
1994	0,10	8,01	8,11	NO
1995	0,10	7,95	8,05	NO
1996	0,10	7,89	7,99	NO
1997	0,11	7,83	7,94	NO
1998	0,12	7,77	7,90	NO
1999	0,09	7,72	7,81	0,28
2000	0,11	7,66	7,77	1,01
2001	0,11	7,12	7,23	1,02
2002	0,09	7,00	7,09	1,02
2003	0,11	6,60	6,71	1,09
2004	0,12	6,37	6,49	1,13
2005	0,11	6,23	6,35	1,36
2006	0,13	5,79	5,92	1,48
2007	0,13	5,77	5,91	1,57
2008	0,13	6,23	6,36	1,68
2009	0,12	6,06	6,18	2,12
2010	0,13	5,83	5,95	2, 84

Methane recovery

Anaerobic digestion installations with CH_4 recovery are operated by four water supply companies. Data of CH_4 recovery was provided by listed companies (Table 8-19).

Table 8-19. CH_4 recovery, million Nm^3

Year	Aukštaitijos vandenys	Kauno vandenys	Utenos vandenys	Klaipėdos vanduo	Total
1999	NO	NO	0,55	NO	0,55
2000	NO	1,46	0,64	NO	2,10
2001	NO	1,55	0,58	NO	2,13
2002	NO	1,55	0,58	NO	2,12
2003	NO	1,71	0,57	NO	2,28
2004	NO	1,83	0,53	NO	2,36
2005	NO	2,33	0,52	NO	2,85
2006	NO	2,42	0,67	NO	3,10
2007	0,45	2,20	0,65	NO	3,30
2008	0,97	1,86	0,71	NO	3,53

2009	0,81	2,82	0,62	0,23	4,48
2010	0,80	2,87	0,57	1,85	6, 10

CH_4 recovery in Gg was calculated using equation provided in Section 8.2.1.6 and data of CH_4 content in recovered biogas provided by the companies (Table 8-20). During the period 1999-2010 the amount of recovered CH_4 increased from 0,28 to 2,84 Gg.

Table 8-20. CH_4 recovery, Gg

	Aukštaitijos vandenys	**Kauno vandenys**	**Utenos vandenys**	**Klaipėdos vanduo**	**Total**
CH_4 content	65,0%	66,0%	70,0%	62,5%	
1999	NO	NO	0,28	NO	0,28
2000	NO	0,69	0,32	NO	1,01
2001	NO	0,73	0,29	NO	1,02
2002	NO	0,73	0,29	NO	1,02
2003	NO	0,81	0,28	NO	1,09
2004	NO	0,86	0,27	NO	1,13
2005	NO	1,10	0,26	NO	1,36
2006	NO	1,14	0,34	NO	1,48
2007	0,21	1,04	0,32	NO	1,57
2008	0,45	0,87	0,35	NO	1,68
2009	0,38	1,33	0,31	0,10	2,12
2010	0,37	1,35	0,29	0,83	2, 84

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.
Discharges of degradable organic matter in Lithuania in 1990-2010 are shown in Table 8-21.

Table 8-21. Discharge of degradable organic matter, Gg BOD

Year	Discharge of degradable organic matter, Gg BOD
1990	120,0
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

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[124] 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.

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.

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 8-22.

Table 8-22. 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.

[124] Denmar k's National Inventory Report 2011. Emission Inventories 1990-2009 NERI Technical Report no. 827, 2011, p. 490

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[125].

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.

8.3.5 Source specific recalculations

As sewage sludge was included in solid waste disposal on land category. CH_4 emissions from wastewater handling were recalculated taking into account only methane generation in sewers and wastewater treatment facilities when anaerobic conditions develop.

Impact of recalculations on CH_4 emissions (Gg) from wastewater handling is shown in Table 8-23.

Table 8-23. Impact of recalculations on CH_4 emissions (Gg CO_2 eq.) from wastewater handling

Year	Previous submission	This submission	Difference	
			Gg	%
1990	774,9	174,6	-600,3	-77,5
1991	676,4	174,1	-502,2	-74,3
1992	524,7	172,8	-351,9	-67,1
1993	503,1	171,9	-331,2	-65,8
1994	461,1	170,4	-290,7	-63,0
1995	445,4	169,0	-276,4	-62,1
1996	450,1	167,8	-282,3	-62,7
1997	482,2	166,8	-315,4	-65,4
1998	507,3	165,8	-341,5	-67,3
1999	406,9	163,9	-242,9	-59,7
2000	459,5	163,2	-296,3	-64,5
2001	463,3	151,9	-311,5	-67,2

[125] National Greenhouse Gas Emission Inventory of the Republic of Lithuania. Quality Assurance and Quality control Plan 2011-2012. Vilnius, 2011.

2002	395,1	148,8	-246,3	-62,3
2003	446,7	140,9	-305,9	-68,5
2004	476,0	136,3	-339,7	-71,4
2005	452,5	133,3	-319,2	-70,5
2006	474,0	124,3	-349,7	-73,8
2007	497,3	124,0	-373,3	-75,1
2008	487,9	133,6	-354,3	-72,6
2009	475,1	129,8	-345,3	-72,7

In addition, CH_4 recovery from anaerobic digestion installations operated by water supply companies was recalculated based on updated information obtained from water supply companies ("Aukštaitijos vandenys" provided data of CH_4 recovery for the first time). Impact of recalculations is shown in Table 8-24.

Table 8-24. Impact of recalculations on CH_4 recovery data, Gg

Year	Previous submission	This submission	Difference	
			Gg	%
1999	0,23	0,28	0,05	16,4
2000	0,86	1,01	0,15	14,5
2001	0,87	1,02	0,15	14,7
2002	0,87	1,02	0,15	14,4
2003	0,93	1,09	0,16	14,5
2004	0,97	1,13	0,16	14,1
2005	1,17	1,36	0,19	13,8
2006	1,27	1,48	0,21	14,0
2007	1,17	1,57	0,40	25,4
2008	1,05	1,68	0,63	37,4
2009	1,75	2,12	0,37	17, 4

8.3.6 Planned Improvements

In order to improve precision and reliability of data on GHG emissions from wastewater management, more accurate and reliable information on wastewater and sludge treatment systems is needed. Study on research of methane emissions from wastewater and sludge will be conducted in 2012. Collection and analysis of data of status and conditions of wastewater and sludge management systems will be implemented during the study. Procurement tender for this study was announced in April 2012. Study results are to be ready in August 2012.

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[126] (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 8-25).

Table 8-25. 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	0,25
2006	29,6	0,25
2007	29,9	0,25
2008	30,2	0,25
2009	30,5	0,26
2010	30,7	0, 26

8.3.7.2 Methodological issues

The emissions of N_2O from human sewage were calculated according to Revised 1995 IPCC Guidelines (p. 6.28) methodology (equation 15):

$N_2O\ emission = Protein \times Frac_{NPR} \times NR_{PEOPLE} \times EF_6$,

[126] 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

New data on evaluated protein consumption in 2007 were obtained from the Health Education and Ilness Prevention Centre. As a result, recalculated N_2O emissions from 2003 have slightly increased (Table 8-26).

Table 8-26. Impact of recalculations on N_2O emissions (Gg CO_2 eq.) from human sewage

Year	Previous submission	This submission	Difference	
			Gg	%
2003	76,9	77,5	0,6	0,7
2004	76,7	77,8	1,1	1,5
2005	76,4	78,1	1,7	2,2
2006	76,1	78,4	2,2	2,9
2007	75,9	78,7	2,8	3,7
2008	75,7	79,0	3,3	4,4
2009	75,4	79,3	3,8	5,1

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 facility 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, during 2010 waste was incinerated only for testing purposes.

Evaluated CO_2 emissions from waste incineration are provided in Table 8-27.

Table 8-27. CO_2 emissions from waste incineration, (Gg)

Year	Hazardous	Clinical Health care	Sewage sludge	Municipal	Total
1990	3,99	0,01	0,00	0,00	3,99
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

Evaluated N_2O emissions from waste incineration are provided in Table 8-28.

Table 8-28. 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

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.

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.

Activity data of incinerated amounts of waste were obtained from Environment Protection Agency (EPA) waste database (Table 8-29). Data collection and validation procedures are described in chapter 1.2.1.1.

Table 8-29. Amounts of incinerated waste 1990-2010, (Gg)

Year	Hazardous	Clinical Health care	Sewage sludge	Municipal	Total
1990	2,43	0,01	0,01	0,00	2,45
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

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 8-30):

Table 8-30. Default data for estimation of CO_2 emissions from waste incineration (GPG 2000, p. 5.29)

	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[127].

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.

[127] National Greenhouse Gas Emission Inventory of the Republic of Lithuania. Quality Assurance and Quality control Plan 2011-2012. Vilnius, 2011.

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

Emissions from sewage sludge were recalculated assuming that fossil carbon content in sewage sludge is 0%. Recalculation resulted in slight reduction of emissions during 1990-1994 (Table 8-31).

Table 8-31. Impact of recalculations on CO_2 emissions from waste incineration, (Gg)

Year	Previous submission	This submission	Difference	
			Gg	%
1990	4,00	3,99	-0,01	-0,1%
1991	4,33	4,33	-0,01	-0,1%
1992	1,34	1,21	-0,13	-10,0%
1993	3,71	3,59	-0,13	-3,4%
1994	1,13	1,11	-0,02	-1,8%

8.4.6 Planned improvements

No improvements are planned for the next submission.

9 OTHER (CRF 7)

Not applicable.

10 RECALCULATIONS AND IMPROVEMENTS

List of improvements made in response to ERT recommendations in the 2011 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	RECALCULATIONS	REFERENCE
Total (Net Emissions)			
1. Energy			
A. Fuel Combustion (Sectoral Approach)			
1. Energy Industries			
2. Manufacturing Industries and Construction			
3. Transport	√	√	CH_4 and N_2O from 1A3b; see NIRChapter 3.4.2
4. Other Sectors	√	√	CH_4 from 1A4B, see NIR Chapter 3.5
5. Other			
B. Fugitive Emissions from Fuels			
1. Solid Fuels			
2. Oil and Natural Gas			
2. Industrial Processes			
A. Mineral Products	√	√	CO2 emission from asphalt roofing calculated for the first time (see NIR Chapter 4.2.5.). CO2 emission from Mineral wool production recalculated using country specific EF(see Chapter 4.2.6.2.).
B. Chemical Industry			
C. Metal Production			
D. Other Production			
E. Production of Halocarbons and SF6			
F. Consumption of Halocarbons and SF6	√	√	HFC from 2F1, see NIR Chapter 4.7.1
G. Other			
3. Solvent and Other Product Use			
4. Agriculture			
A. Enteric Fermentation	√	√	CH_4 from 4.A, see NIR Chapter 6.2
B. Manure Management	√	√	CH_4, N_2O from 4.B. see NIR Chapter 6.3
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			
A. Forest Land	√	√	CO_2, CH4, N2O from 5A, see NIR Chapter 7.2
B. Cropland	√	√	Emissions from Cropland reported for the first time, see NIR Chapter 7.3
C. Grassland	√	√	Emissions from Grassland reported for the first time, see NIR Chapter 7.4
D. Wetlands			
E. Settlements			
F. Other Land			
G. Other			
6. Waste			
A. Solid Waste Disposal on Land	√	√	CH_4 from 6A, see NIR Chapter 8.2
B. Waste-water Handling	√	√	CH_4 from 6B, see NIR Chapter 8.3

C. Waste Incineration			
D. Other			
7. Other (as specified in Summary 1.A)			
Memo Items:			
International Bunkers	√	√	GHG from 1C1; see NIR Chapter 3.2.2
Aviation			
Marine			
Multilateral Operations			
CO2 Emissions from Biomass			

NIR Chapter	DESCRIPTION		REFERENCE
Chapter 1.2 Institutional arrangements	√		see NIR Chapter 1.2.
Chapter 1.6 QA/QC plan	√		see NIR Chapter 1.6

10.1 Source specific recalculations

Energy sector

Recalculations of CO_2 emission factors for jet kerosene, gas/diesel oil and residual fuel oil were reviewed and corrected. In this submission country specific emission factors based on research protocols of AB "ORLEN Lietuva" Quality Research Center have been used.

Activity data of peat consumption were corrected for the period 2006-2008 based on information provided by Lithuanian Statistics.

Emissions, previously calculated using Corinair EFs were recalculated using IPCC 1996 and IPCC 2006 defaults: CO_2 (wood/wood waste and other solid biomass, biogas, lignite), N_2O (LPG, biogas, not liquefied petroleum gas), CH_4 (residual fuel oil, gasoil, shale oil).

Coal used for non-energy use was reallocated for feedstock and non-energy use category. These reallocations done for period 1999-2005 according to the coking coal use.

The estimates of aviation gasoline consumption were linearly interpolated for the period 1996-1999 and trend extrapolation of GHG from jet kerosene for 1990-2000 years was evaluated.

The emissions from *Road Transportation* have been recalculated for the entire time-series, using software COPERT IV version 9,0 (October, 2011). Changes with respect to the 2009 report year include recalculation of CH_4 and N_2O at new Tier 3 method.

Activity data of gasoil consumption in Commercial/institutional sector for the period 2005-2009 was corrected, as in the last submission gasoil consumption in fishing sector has not been taken into account.

In Other Industries sector (CRF 1.A.2.f) activity data for 2008 and 2009 was corrected taking into consideration updated information provided by Lithuanian Statistics.

In oil and natural gas category (CRF 1.B.2) following recalculations has been done: number of drilling, testing and servicing wells was corrected. The Lithuanian Geological Survey provided updated data for period 2000-2009 therefore these new data has been taken into consideration in 2012 submission.

Emissions from the natural gas transportation in pipelines (CRF 1.A.3.e) for the 1990-2000 period were estimated for the first time in this submission.

Industrial processes sector

Asphalt roofing

Emissions from asphalt roofing were calculated for the first time in the Lithuanian inventory, Emissions were estimated for the whole reporting period.

Mineral wool Production

Source-specific recalculations were done for the whole time series based on more precise activity data and plant specific CO_2 emission factor provided by the producer UAB Paroc:

- total production of mineral wool (1998-2010);
- data on dolomite consumption (1997-2010);
- plant specific CO_2 emission factor for dolomite (2008-2010).

Nitric acid production

Recalculation was made for the entire time series (1990-2010) using plant and production unit specific emission factors and unit specific activity data.

Other production

Data on emissions from pulp and paper production are reported for the first time in Lithuanian inventory.

Data on NMVOC emissions from food and drink production were recalculated for the whole reporting period using statistical data on total annual production. Activity data in previous submission was based on PRODCOM classification and provided double counting for some of the products. CO_2 emissions from food and drink production are reported for the first time in Lithuanian inventory.

Consumption of Halocarbons and SF_6

Emissions from the mobile air conditioning were recalculated using updated calculation method to account for the age of air conditioning units. The whole time series is covered in the current submission.

Emissions from the domestic refrigeration were recalculated using updated calculation method to account for the age of refrigeration units and refilling of the lost charge. Emissions were recalculated for the whole time series.

Gap in reporting on potential emissions was filled. In this submission potential emissions cover Domestic Refrigeration, Commercial Refrigeration, Transport refrigeration, Industrial Refrigeration and Mobile Air-Conditioning.

Emission of HFC-365mfc, HFC-134a, HFC 245fa and HFC227ea from foam blowing was estimated for the period 2005-2010 based on newly collected activity data. In previous submission emission of F-gases from foam blowing was estimated based on emission rate from a cluster of countries.

HFC227ea emissions from fire extinguishers were estimated for the period 2000-2010. Estimates are based on 2009-2010 activity data collected by Environmental Protection Agency.

Agriculture sector

In this submission, the number of animals was updated and corrected for the following animal categories and years:

- Dairy cattle (1997-1998, 2007-2009);
- Non-dairy cattle (1997-1998, 2007-2009);
- Sheep (2004-2009);
- Swine (1997-1998);
- Poultry (2009).

Enteric fermentation

Following the recommendation of ERT in 2011, in order to increase consistency of used methodologies for calculation of emission from enteric fermentation, the following recalculations have been made:

- disaggregated into sub-categories non-dairy cattle population data was collected and gross energy (GE) intake was recalculated for entire time-series for each subcategory of the non-dairy cattle (Table 6-27), therefore emission was calculated by Tier 2 method for all time series.
- Emission from dairy cattle for years 1990-1998 was recalculated due to updated milk fat data.
- Emission from swine was recalculated disaggregating swine population by sub-categories, therefore emission was calculated by Tier 2 method for all time series in this submission. The calculation of GE intake for every sub-category of swine led to reduction of emission factors.

In addition, emission for all time-series from sheep was recalculated using Tier 2 method: sheep population was divided into subcategories and GE intake was estimated for each sheep subcategory. The calculation of GE intake for every subcategory of sheep resulted in increase of emission factors.

Manure management CH_4

Following the recommendation of ERT in 2011, in order to ensure consistency of methodologies used to estimate CH_4 emission from manure management, the following recalculations have been made:

- Non-dairy cattle population data was disaggregated into sub-categories and gross energy (GE) intake was recalculated for entire time-series for each subcategory of the non-dairy cattle. Due to the use of the disaggregated population data of non-dairy cattle sub-categories, the percentage of AWMS (Animal waste management system) for non-dairy cattle was also recalculated.
- CH_4 emission from dairy cattle recalculations for 1997-2009 period are related to milk fat data updates used for GE intake estimates.
- Swine population data was disaggregated into sub-categories for the period 1990-2009. The calculation of gross energy (GE) intake for each sub-category of swine led to a reduction of emission factors. In addition, biogas recovery data for years 2004-2010 was updated. Treated liquid manure in biogas reduces emission of CH_4.

CH_4 emission from sheep was recalculated due to animal number data corrections and updates.

Manure management N_2O
Following ERT recommendation in 2011, N-excretion for dairy, non-dairy cattle and swine was recalculated for entire time series using Tier 2 method and updated data on animal herd structure and protein consumption (Table 6-46). N excretion for beef cattle was calculated as a function of milk production – output, for other non-dairy cattle – as a function of weight gain – output. N excretions for swine were calculated in detail as a function of weight gain – output.

Agricultural soils
Recalculation of N-excretion for dairy cattle, non-dairy cattle and swine caused certain changes in evaluated N_2O emissions from manure application on agricultural soils.
Recalculation of emission from synthetic fertilizers use is related to update and correction of activity data for the years 2003, 2004, 2006 and 2008.

Waste sector

As sewage sludge was included in solid waste disposal on land category, methane emissions from wastewater handling were recalculated taking into account only methane generation in sewers and wastewater treatment facilities when anaerobic conditions develop.

In addition, methane recovery in anaerobic digestion installations operated by water supply companies was recalculated based on updated information obtained from water supply companies.

New data on evaluated protein consumption in 2007 were obtained from the Health Education and Illness Prevention Centre. As a result, recalculated N2O emissions from 2003 have slightly increased.

Emissions from sewage sludge incineration were recalculated assuming that fossil carbon content in sewage sludge is 0%. Recalculation resulted in slight reduction of emissions in 1990-1994.

LULUCF

Recently implemented studies (Study-1 and Study-2) provided accurate data on forest and other land use areas on which basis all recalculations were made in this submission. In addition, GHG emissions estimates from biomass burning (wildfires) in Forest land were improved.

Emissions and removals from the Cropland (changes in carbon stocks in living biomass and changes in carbon stocks in soils) and Grassland (changes in carbon stocks in living biomass and changes in carbon stocks in soils) categories were estimated for the first time in this submission.

KP - LULUCF

In the previous submission afforestation and reforestation area was accounted together without differentiation into natural and human induced. In this submission area of afforested and reforested areas is divided, only human induced afforestation and reforestation is accounted. Natural afforestation and reforestation is included in Forest management area. Deforested areas in the previous submission were modelled based on expert assumptions, thus *Study-1* in this submission provided precise data about deforested areas since 1990.

In addition, emissions from biomass burning were estimated separately for Forest management area and Afforestation/Reforestation area in this submission. Following ERT recommendation, EF (biomass consumption value for fire) used to estimate emission from wildfires was correctd in this submission as well.

10.2 Planned improvements

Energy sector

The following improvements are foreseen:

- A study on the revision of the emission factors used for energy sector will be implemented during 2012. Procurement tender for this study was announced in March 2012. Study results are to be ready in August 2012.
- Civil aviation emission recalculations using Tier 2 methodology based on detailed activity data on Take-off/Landing cycle with more detailed information on aircraft types (EMEP/EEA, 2009).
- Refine activity data for LPG fuel cars evaluates emissions at the Tier 3 level improving time series consistency (Road transportation emissions).
- Investigate a possibility for implementation of Tier 2 approach in year 2013 in the calculation of emissions from Railways.

Industrial processes sector

Mineral industry
It is planned to calculate emissions from the Road paving with asphalt.

Consumption of Halocarbons and SF_6
To improve F-gases estimates, a study to determine the quantity of fluorinated gases (HFCs, PFCs and SF_6) use in Lithuania during 1990-2011 was initiated in 2012. It is expected that this study will cover all remaining reporting gaps, improved methods for emissions calculations and recommendations how to enhance F-gases data collection system will be developed. Procurement procedure for this study was started in April 2012. Study results are to be ready in August 2012.

Agriculture sector

In 2012 a Study on experimental research and evaluation of country specific methane producing capacity (B_0) in Lithuania manure management system was initiated. Additionally, collection of more accurate data on manure storage systems used in the Lithuanian agriculture will be done in the scope of this study. The study results will allow to improve methane and nitrous oxide emission estimates from manure management. Procurement tender for this study was announced in March 2012. Study results are to be ready in August 2012.

LULUCF

Starting 2012, inventory of all permanent NFI sample plots, for the purpose of improved estimation of carbon stock change in different land use categories will start.

Forest land

In 2012 Lithuania will finish the third cycle (second re-measurement of permanent plots) of NFI inventory and will have possibility to revise in this submission provided activity data related to deadwood volume. In addition, sector-specific quality control procedures and improvements of uncertainty estimates are planned for the next submission.

Cropland, Grassland

Country specific values for reference carbon stocks is planned to be used for calculations and more detailed stratification of management systems will be involved.

Other improvements

Additional studies and information research is planned to improve reporting of Settlements and Other land areas that are under NA, NO reported in this submission.

Waste sector

In order to improve precision and reliability of data on GHG emissions from wastewater management, more accurate and reliable information on wastewater and sludge treatment systems is needed. Study on research of methane emissions from wastewater and sludge will be conducted in 2012. Collection and analysis of data of status and conditions of wastewater and sludge management systems will be implemented during the study. Procurement tender for this study was announced in April 2012. Study results are to be ready in August 2012.

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* (GPG) 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 in GPG for LULUCF 2003).

Net removals from Article 3.3 activities were -161,35 Gg CO_2 in 2010. Afforestation (A) and Reforestation (R) resulted in a net removal of -196,64 Gg CO_2 eq. (Table11-7) and deforestation (D) a net emission of 35,29Gg CO_2 eq. (Table 11-8). The area subjected to AR was 25,88 thous. ha 2010. In the end of 2010, the area deforested since 1 January 1990 was 1,03 thous. ha (Table 11-2).

Net removals from Article 3.4 activity (FM) were -12068.06 Gg CO_2 eq. (Table 11-12). The area subjected to FM was 2140,13 thous. ha in the end of the commitment period (Table 11-3).

Lithuania has elected commitment period accounting for LULUCF for the first commitment period.

11.1.1 Definition of forest and any other criteria

Forest land is defined according to Law on Forests 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 for including land areas into forest land areas (Table 11-1). 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 11-1. 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 11-2. Forest land area 1990-2010, thous. ha

Years	Forest land
1990	2063,0
1991	2069,8
1992	2075,7
1993	2080,9
1994	2083,7
1995	2086,1
1996	2091,3
1997	2094,9
1998	2098,9
1999	2101,7
2000	2106,9
2001	2110,1
2002	2114,1
2003	2119,3
2004	2127,3
2005	2135,7
2006	2142,9
2007	2151,2
2008	2157,2
2009	2159,6
2010	2166,0

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 11-3.

Table 11-3. Area of afforestation, reforestation and deforestation, thous. ha

Year	Afforestation	Reforestation	Total A/R	Deforestation
1990	1,36	0,04	1,41	-
1991	0,85	0,07	0,92	-
1992	0,51	0,04	0,55	-
1993	0,37	0,06	0,43	0,19
1994	0,25	0,04	0,29	0,10
1995	0,34	0,08	0,41	0,01
1996	0,32	0,12	0,44	0,05
1997	0,42	0,14	0,54	0,04
1998	0,60	0,20	0,80	0,02
1999	0,83	0,20	1,02	0,04
2000	1,15	0,21	1,36	0,02
2001	0,75	0,13	0,88	0,12
2002	1,33	0,09	1,39	-
2003	1,37	0,09	1,45	-
2004	1,69	0,03	1,72	-
2005	1,64	0,05	1,69	0,05

2006	1,80	0,06	1,86	-
2007	2,02	0,08	2,11	0,29
2008	1,17	0,04	1,21	0,01
2009	0,82	0,09	0,91	0,02
2010	4,35	0,11	4,45	0,07
Total (1990-2010)	**23,91**	**1,96**	**25,88**	**1,03**

11.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

In the first commitment period 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. This was done taking into account importance of forests to Lithuania and available precise accounting data of forest resources. Since 1922 regular information on Lithuanian forest resources by SFI data is available. Lithuania essentially has improved quality of data about forest resources since 2002, when NFI permanent sample plots net completely covered all Lithuania's territory. Thus, since 2009 every deforestation case, which is under very strict regulation and control by the Forest Law, is fixed in special database as well as afforestation and reforestation.

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 (on the 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 definition of afforestation (A), reforestation (R) and deforestation (D) is in accordance with the GPG (IPCC 2003).

ARD definitions presented in GPG for LULUCF (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, wetlands. Separation of afforestation and reforestation areas required more efforts in studying of archive data of SFI and aerial photography up to the 1940s (*Study-1*). 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.

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). All afforested land (human induced and natural) is fixed during Standwise Forest Inventory (SFI) and legitimized registering data 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. Forest land areas and their changes that were identified (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 the areas, where the forest land has been registered at least once) during 1990-2011 years.

The main data sources were used:

- Data from National forest inventory (NFI), that 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, maps S 1:10 000;
- Orthophoto maps (S 1:10 000);
- National Paying Agency data of declarations on afforested areas (2010-2011);
- Topographical maps (1973-1990), S 1:50 000;
- Archive cartographical (S 1:10 000) material backwards to 1946-1949;
- 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.1were identified and distinguished;
- GIS layers of afforested, reforested and deforested (ARD) areas and areas remaining under forest management were prepared;
- report, showing considered land unit changes prepared;
- proposals elaborated 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 and the Kyoto Protocol requirements.

The definition of Forest Management is in accordance with the GPG (IPCC 2003). Forest land area reported for Forest management 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.

Table 11-4. Area of Forest management*, thous. ha

Year	Total area	Organic soils		
		Not drained	Drained	Total
1990	2061,6	160,9	163,0	323,9
1991	2067,4	161,4	163,5	325,0
1992	2072,9	161,9	164,0	325,9
1993	2077,6	162,3	164,4	326,7
1994	2080,1	162,5	164,6	327,1
1995	2082,1	162,7	164,8	327,5
1996	2086,9	163,1	165,2	328,3
1997	2089,9	163,4	165,5	328,9
1998	2093,1	163,7	165,8	329,5
1999	2094,9	163,9	166,0	330,0
2000	2099,1	164,3	166,4	330,8
2001	2101,4	164,6	166,7	331,3
2002	2104,0	164,9	167,0	331,9
2003	2107,8	165,3	167,4	332,7
2004	2114,1	165,9	168,1	334,0
2005	2120,7	166,6	168,7	335,3
2006	2126,1	167,1	169,3	336,4
2007	2132,0	167,8	169,9	337,7
2008	2136,7	168,3	170,4	338,7
2009	2138,2	168,5	170,6	339,1
2010	2140,1	168,9	171,2	340,1

**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 only Forest management under Article 3.4 activities, therefore there is no hierarchy among Article 3.4 activities.

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.

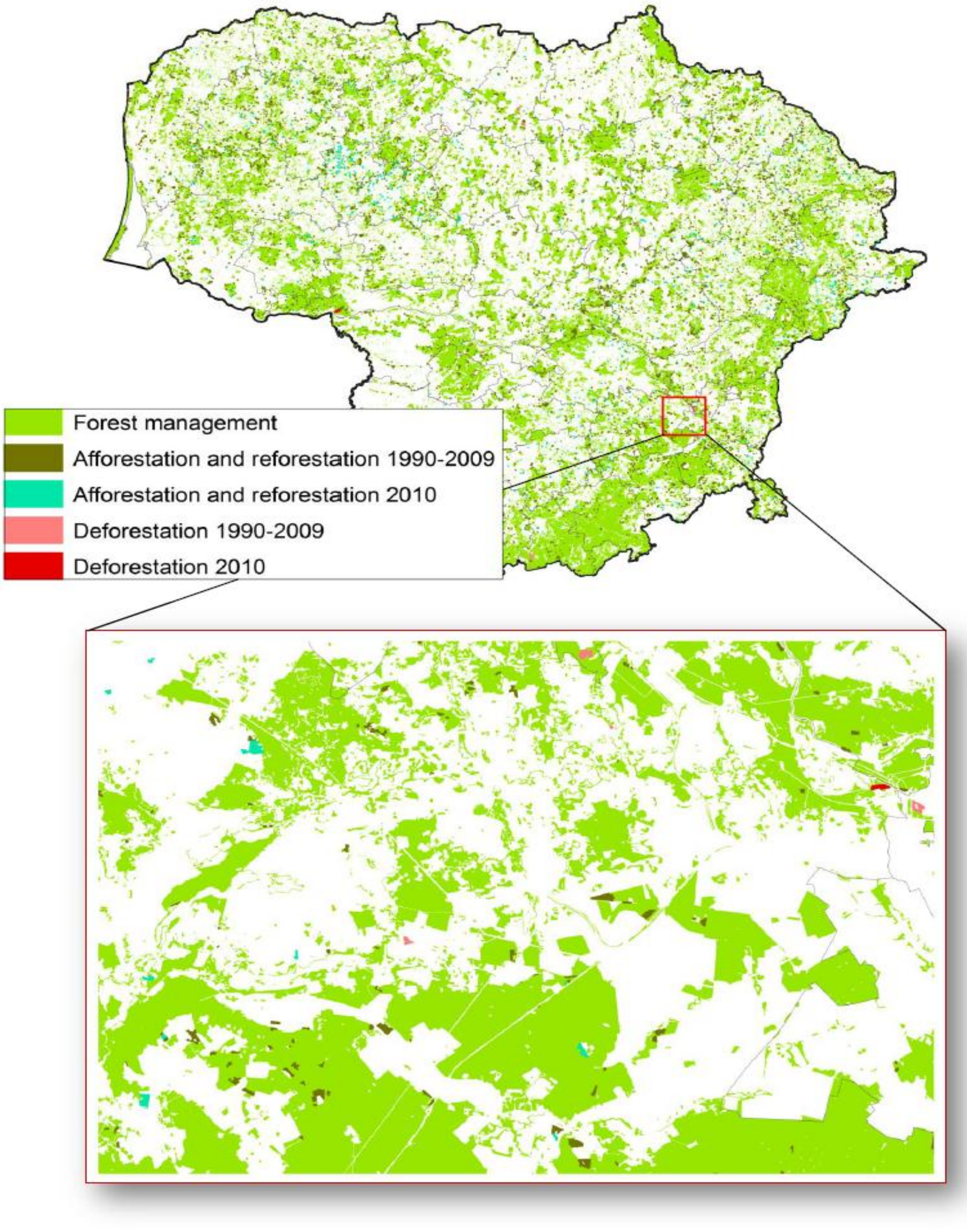


Figure 11-1. Afforestation, reforestation and deforestation activities 1990-2010

Codes that were used in *Study-1* for identification of activities on forest land are presented in Table 11-5.

Table 11-5. Codes to identify Article 3.3 and 3.4 activities

Codes used	Descriptions
FM	*Forest management*
A1	*Afforestation with human inducement*

A2	*Natural afforestation (included in Forest management)*
R1	*Reforestation with human inducement*
R2	*Natural reforestation (included in Forest management)*
D	*Deforestation*

To achieve the annual wall-to-wall mapping of forest land areas and to detect the changes several types of source material were used, like State forest cadastre, National paying agency information about agricultural land, non-agricultural and abandoned land afforestation, Lithuanian forest resource database at a scale 1:50 000, all available orthophotos for the country developed during the period being analysed, satellite maps from CORINE IMAGE, http://earthexplorer.usgs.gov/, 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), are 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 grown forests, as according to national regulations naturally grown 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 solve that: 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 done 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 currently available, but missing 50 years ago (according to the database developed and referring to the 1950s).

Extra solution to identify afforestation and reforestation was to use stand attribute coming from stand register and stating the forest compartment to be first time inventoried during the last stand-wise forest inventory. However, such approach faced some limitations 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 base, 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 stand-wise 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 some facts on newly established forests. Data from National paying agency were acquired to represent the borders of afforestation, 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 accounted for in the State Forest Cadastre was taken into the account. Recently non-forest land types, identified as forest stands during the previous forest inventories were candidates to be assigned to the deforestation category. Next, there were some records in the State Forest Cadastre attributed to officially registered 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 National forest inventory to be around 95%. Thus, the differences between the 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 checked 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).

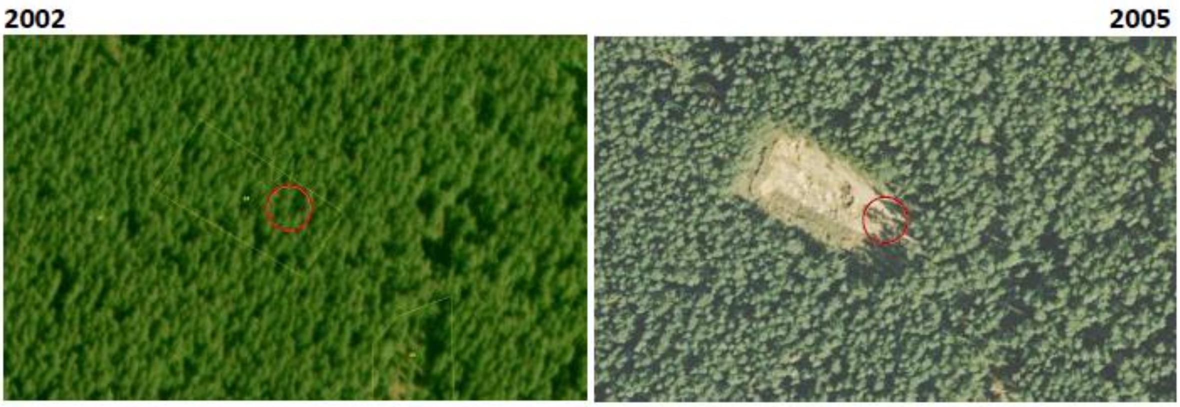


Figure 11-2. Identification of deforestation (D) case using two consecutive orthophotos

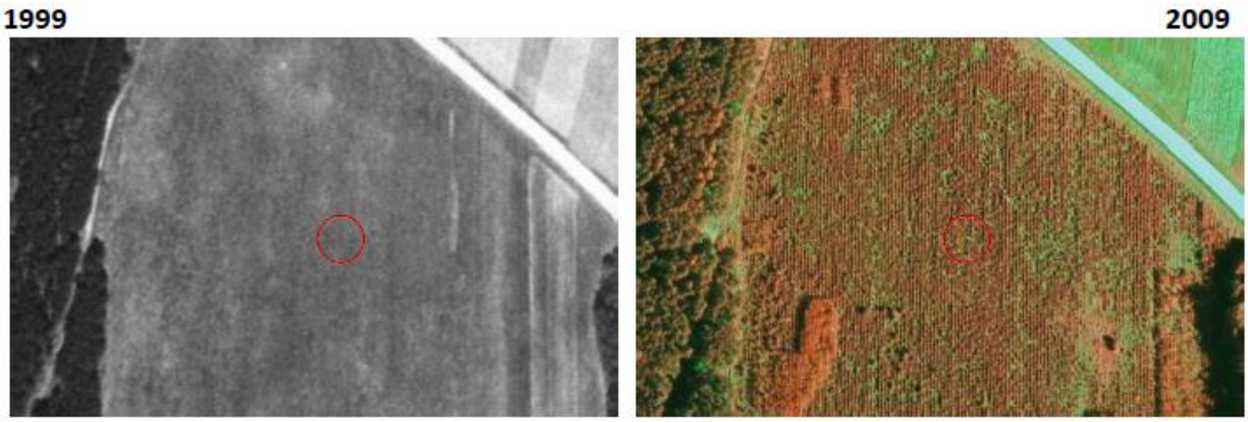


Figure 11-3. Identification of human induced afforestation (A1) based on two consecutive orthophotos

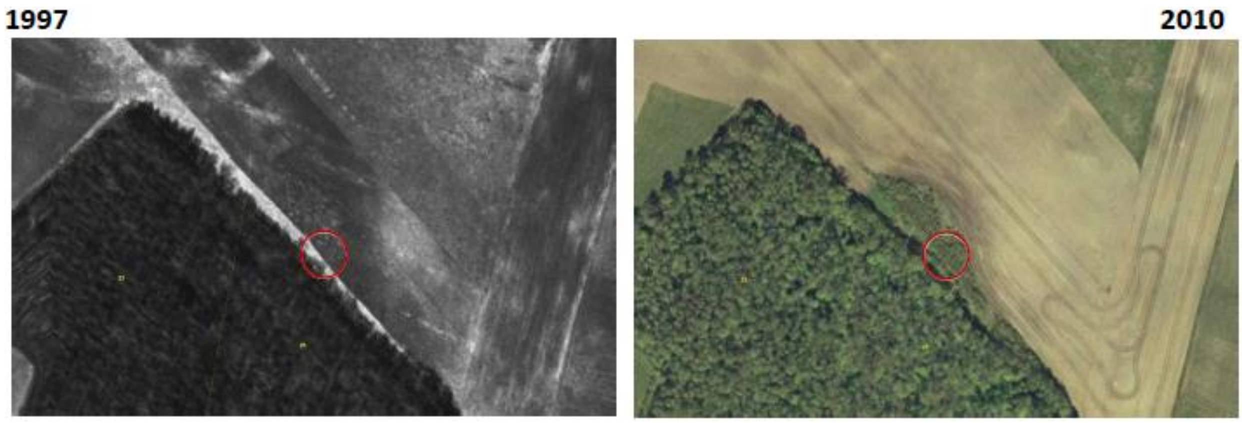


Figure 11-4. Identification of natural afforestation (A2) case using two consecutive orthophotos

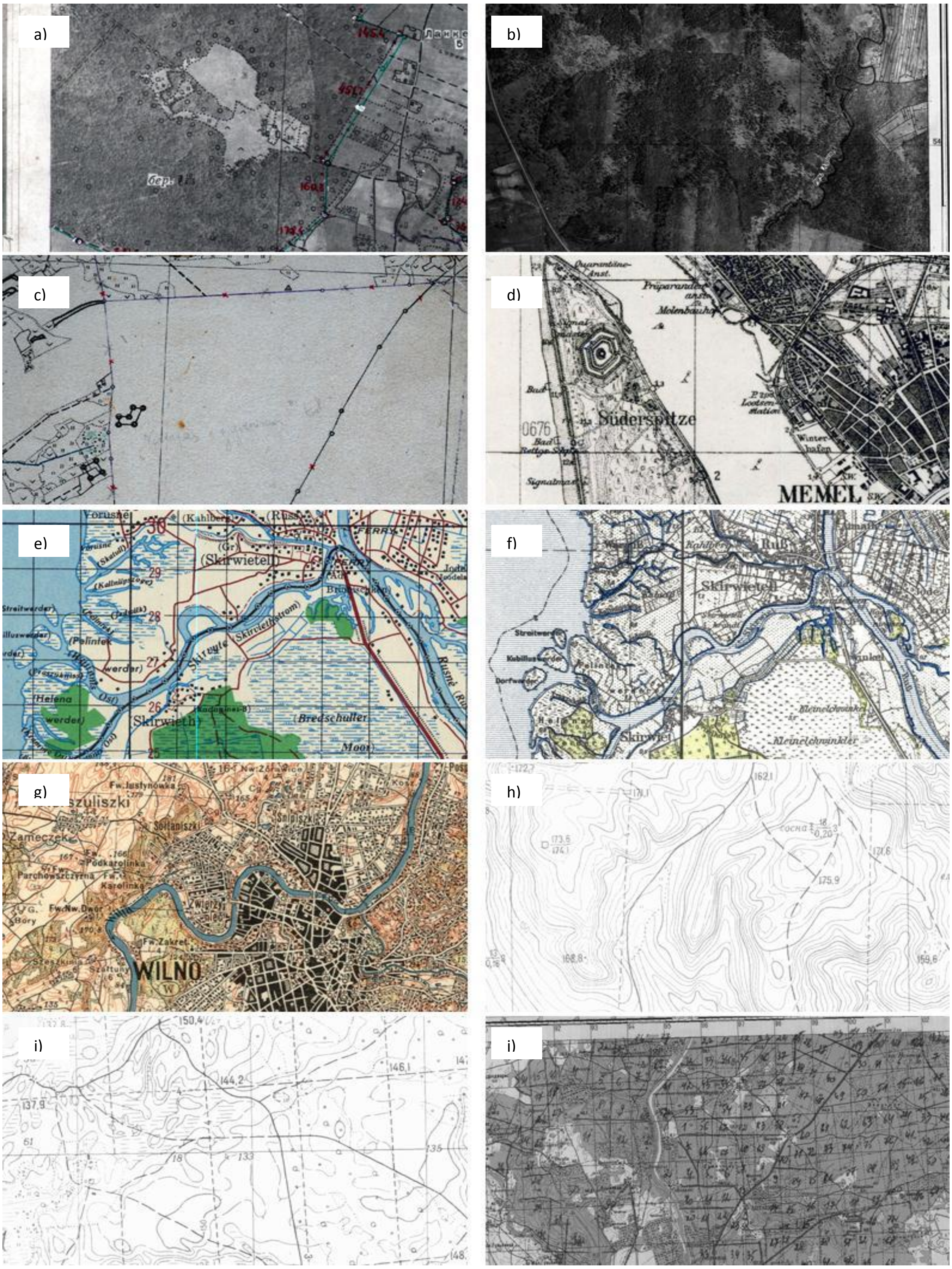


Figure 11-5. Examples of archive cartographical data used for *Study-1:*

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 units of land 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 11-6 represents total Afforestation and Reforestation area tendencies between LSCF (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 prove that there is no inconsistency among them. In this case NFI data could be used for quality assurance. 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 total forest land.

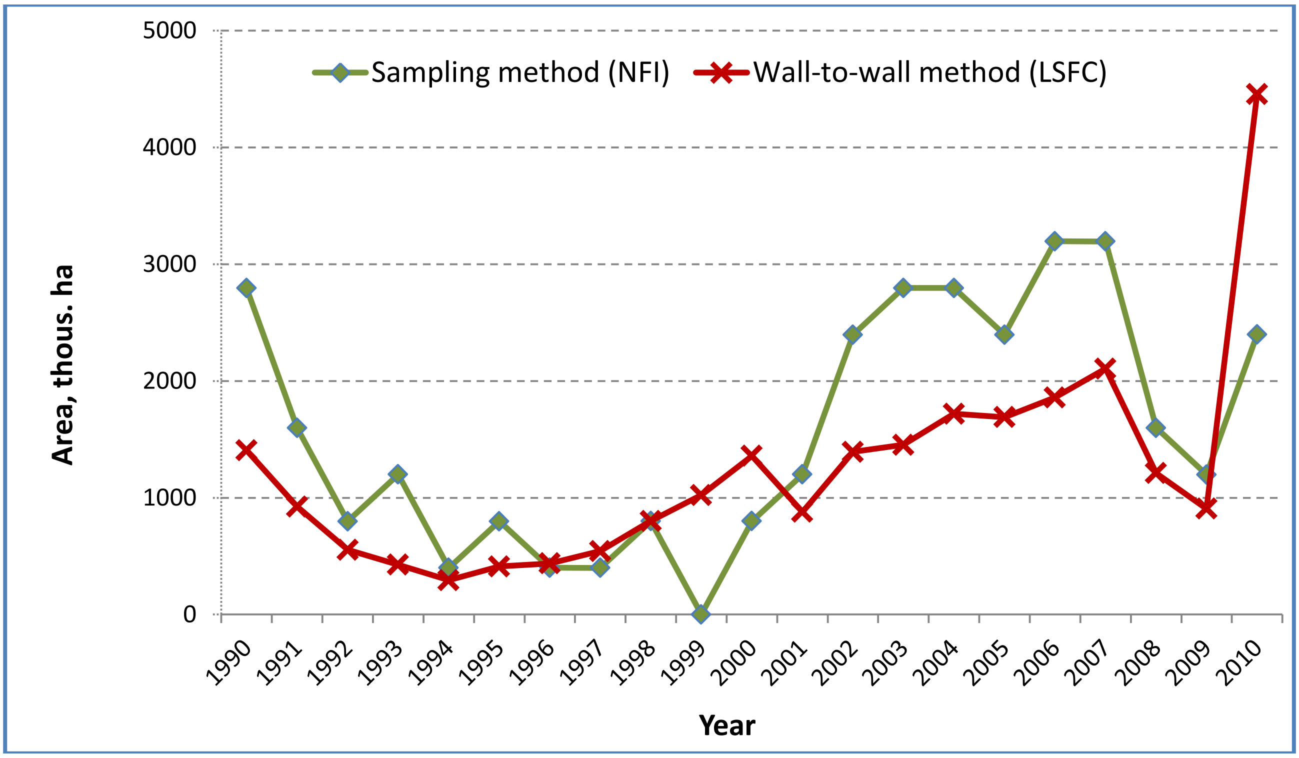


Figure 11-6. Wall-to-wall method quality assurance using NFI data

Drop down in afforestation and reforestation area in 2008-2009 was caused by accounting shortcomings. Precise data base of afforested and reforested areas was created in 2009, and some of the areas afforested in 2007-2009 due to unknown exact date of establishment were included in 2010 accounting, therefore such a high increase in area in 2010 and decrease in 2008-2009 is reflected in the figure above.

Table 11-6 presents areas and changes in areas between previous and current inventory years.

Table 11-6. Land transition matrix for 2010, 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**	21,43	0,00						21,43
	D		0,97						0,97
Article 3.4 activities	**FM**		0,07	2138,13					2138,20
	CM	NA	NA		NA	NA	NA		NA
	GLM	NA	NA		NA	NA	NA		NA
	REV	NA			NA	NA	NA		NA
Other [128]		4,45	0,00	2,00	NA	NA	NA	4362,95	4369,40
Total area at the end of the current inventory year		25,88	1,04	2140,13	NA	NA	NA	4362,95	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

The total forest land area estimated using NFI data, but for comparison LSFC maps (S 1:10 000) and database were used.

NFI data is 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.

Starting this submission LSFC will be the main data provider for Afforested, Reforested and Deforested areas and their geographical borders. This was endorsed by Amendment of the Government Resolution No 1255 on State Forest Cadastre (No 570), adopted on 23.05.2012.

Lithuanian State Forest Cadastre (LSFC) database (Figure 11-7):

- 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,

[128] "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.

- up to date,
- real time.

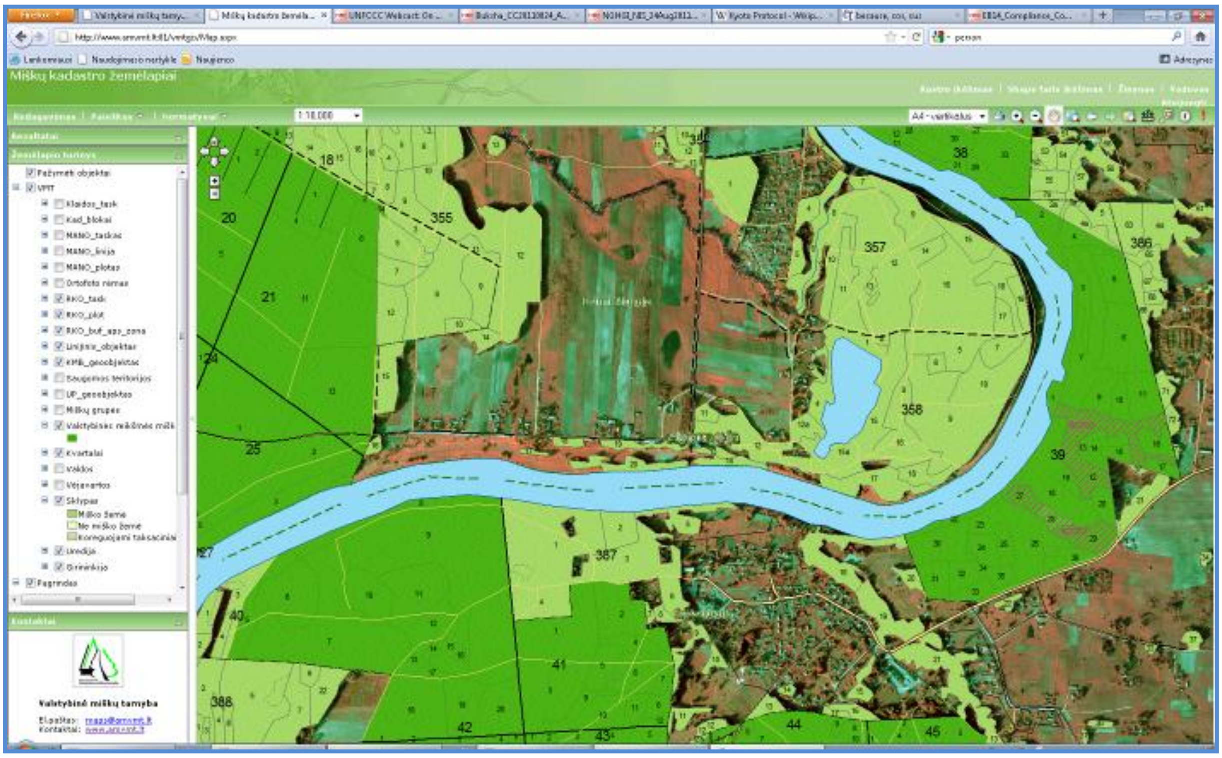


Figure 11-7. Sight of LSFC database

The main object of Lithuanian NFI is forest land area including all forestry related activities taking place on it. Art. 4 of the Forest Law indicate that State Forest Inventory is carried out by sampling method. It is dedicated for the strategic planning of the forest sector and for control of its efficiency at the national level and is executed by the State Forest Service.

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 started in 1998. The systematic grid of the NFI of Lithuania covers all land classes (Figure 11-8) including inland waters.

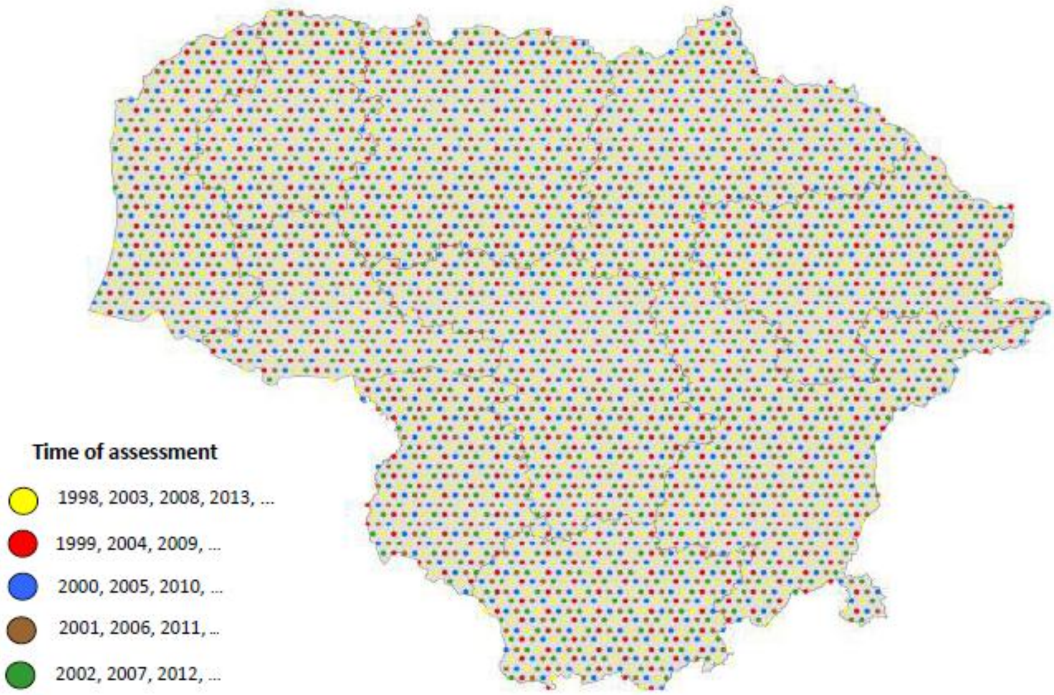


Figure 11-8. Distribution of NFI plots on Lithuania's territory

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.

The aim of establishment of permanent plots is to estimate reliably (by direct measurements) growing stock volume, gross increment, mortality and cut 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

Methods for estimating carbon stock changes in forests are the same used for the UNFCCC LULUCF reporting (chapter 7.2.2).

Carbon stock changes in living biomass

Lithuania has chosen Method 2 which also called as the stock change method:

$$\Delta C_{LB} = (C_{t2} - C_{t1})/(t2 - t1) \textit{ and } C = (AGB + BGB) \times CF \qquad (11.1)$$

where:
C – total carbon stock in living biomass
ΔC_{LB} - annual change in carbon stock in living biomass (includes above- and below-ground biomass) in total forest land. t C yr^{-1};
C_{t2} – total carbon in biomass calculated at time t2. t C
C_{t1} – total carbon in biomass calculated at time t1. t C
AGB – above-ground biomass, t d. m.
BGB – below-ground biomass, t d. m.
CF – carbon fraction of dry matter (default = 0.5), t C $(tonne\ d.m.)^{-1}$

Carbon stock changes in dead wood, litter and soil

Biomass of dead trees stems is calculated by using stock change method and employing equation 3.2.12 from IPCC Good Practice Guidance for LULUCF.
The average value of carbon stock in litter was accepted as 24 t per ha. It was calculated for Forest land using values according to cold temperate dry and moist regions from Table 3.2.1 of IPCC GPG for LULUC (Lithuanian Country Report on Global Forest Resources Assessment 2005. 2010).
It was assumed that carbon inputs and losses in mineral soil balance is equal one to another and the net changes are close to zero.

Carbon stock change in drained organic forest soils was calculated using equation 3.2.15 of the IPCC Good Practice Guidance for LULUCF:

$$\Delta C_{FOS} = A_{Drainage} \times EF_{Drainage} \qquad (11.2)$$

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 Good Practice Guidance for LULUFC (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 ground forest biomass as well as dead wood and litter – organic matter was removed entirely as a result of conversion.

Biomass burning

Data on areas affected by forest fires is provided by the Directorate General of State Forests (Table 11-7). 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.

The uniform system of state fire prevention measures, comprising monitoring, preventive and fire control measures, is established and maintained in forests irrespective of the forest ownership type. Data on forest fires is presented from every forest enterprise to the Directorate General of State Forests every year.

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 merged with *Study-1* GIS layer of afforested and reforested areas, to receive complete information for GHG emissions calculations.

Table 11-7. 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	0,02	NA	NA	110,47	0,92
2009	3,06	0,03	NA	NA	312,24	2,60
2010	2,17	0,02	NA	NA	19,33	0,16

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).

N_2O emissions from drainage of soils

N_2O emissions from drained organic soils were calculated employing equation 3A.2.1 (Appendix 3A.2, IPCC GPG 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 GPG 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

According to information received from Directorate General of State Forests there were no fertilization or liming of forest land in Lithuania since 1990 to 2010.
Fertilization and liming of forest land is possible using biofuel ashes, but there are only few studies done in Lithuania, evaluating impact of application of ashes on forest land, and there is no clear evidence of efficiency of such application[129].
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

According to the data collection principles used by State Forest Service, windbreaks and windfalls removals are included in round wood or fuel wood removals. 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.

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

The carbon stock changes in the soil and in the forest litter of Forest management is not expected to occur and hence following the GPG LULUCF (IPCC, 2003) Tier 1 approach. The carbon stock changes in forest litter are related only with changes in area of Forest management.

Based on NFI 1998-2010 data changes of dead wood are not significant in the Afforestation and Reforestation lands. For estimation of carbon stock change of dead wood it was assumed to be zero and reported as 'NA'. Lithuania has assumed that carbon stock changes in forest litter and soils (except drained organic soils) of Afforestation and Reforestation lands are negligible and therefore reported 'NA'.

[129] Ozolinčius R., Armolaitis K., Mikšys V., Varnagirytė-Kabašinskienė I. 2010. Recommendations for compensating wood ash fertilization (2nd revised edition).

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 Changes in data and methods since the previous submission (recalculations)

Considering results from *Study-1*, recalculations were made and the impact of recalculations to earlier (04.11.2011) submitted data is depicted in the tables below. In the previous submission afforestation and reforestation area was accounted together without differentiation into natural and human induced. In this submission area of afforested and reforested areas is divided, only human induced afforestation and reforestation is accounted. Natural afforestation and reforestation is included in Forest management area. Deforested areas in the previous submission were modelled based on expert assumptions, thus *Study-1* in this submission provided precise data about deforested areas since 1990.

In addition, emissions from biomass burning were estimated separately for Forest management area and Afforestation/ Reforestation area in this submission. Following ERT recommendation, EF (biomass consumption value for fire) used to estimate emission from wildfires was correctd in this submission as well.

Table 11-8. Impact of recalculations on Afforestation/ Reforestation/ Deforestation area, thous. ha

Year	Afforestation and Reforestation*			Deforestation		
	Previous submission (human induced and natural expansion)	This submission (only human induced)	Difference	Previous submission	This submission	Difference
1990	10,70	1,41	-9,29	0,90	-	-0,90
1991	5,13	0,92	-4,92	0,43	-	-0,43
1992	5,13	0,55	-4,58	0,43	-	-0,43
1993	5,13	0,43	-4,70	0,43	0,19	-0,24
1994	5,13	0,29	-4,84	0,43	0,10	-0,33
1995	5,13	0,41	-4,72	0,43	0,01	-0,33
1996	5,13	0,44	-4,69	0,43	0,05	-0,38
1997	5,13	0,54	-4,59	0,43	0,04	-0,39
1998	15,29	0,80	-14,49	1,29	0,02	-1,27
1999	15,29	1,02	-14,27	1,29	0,04	-1,25
2000	15,29	1,36	-13,93	1,29	0,02	-1,27
2001	15,29	0,88	-14,41	1,29	0,12	-1,17
2002	12,02	1,39	-10,63	1,02	-	-1,02
2003	26,22	1,45	-24,77	2,22	-	-2,22
2004	24,03	1,72	-22,31	2,03	-	-2,03
2005	32,77	1,69	-31,08	2,77	0,05	-2,72
2006	16,38	1,86	-14,52	1,38	-	-1,38
2007	7,65	2,11	-5,54	0,65	0,29	-0,36
2008	7,65	1,21	-6,44	0,65	0,01	-0,64
2009	10,92	0,91	-10,01	0,92	0,02	-0,90

2010	10,92	4,45	-6,47	0,92	0,07	-0,85
Total (1990-2010)	**256,36**	**25,88**	**-230,51**	**21,66**	**1,03**	**-20,63**

*In previous submission Lithuania used official forest statistic data on AR which included all non-forest land converted to forest land by human inducement and natural afforestation. In this submission AR defined only as human induced and natural afforestation areas are included in FM.

After changes in definitions Afforestation and Reforestation defined only as human induced activity without natural forest expansion. That caused significant differences between results of previous and this submission (Table 11-9; Table 11-10).

Table 11-9. Impact of recalculations on emissions/ removals of CO_2 from Afforestation/ Reforestation

Year	Total carbon stock change, Gg			Emission/ removals of CO_2, Gg		
	Previous submission	This submission	Difference	Previous submission	This submission	Difference
2008	68,74	21,05	-47,69	-252,05	-77,19	174,86
2009	103,14	22,85	-80,29	-378,18	-83,80	294,38
2010	102,20	53,63	-48,57	-374,73	-196,64	178,09

Table 11-10. Impact of recalculations on emissions/ removals of CO_2 from Deforestation

Year	Total carbon stock change, Gg			Emission/ removals of CO_2, Gg		
	Previous submission	This submission	Difference	Previous submission	This submission	Difference
2008	-109,53	-1,63	-107,90	401,61	5,99	-395,62
2009	-156,64	-2,94	-153,70	574,35	10,83	-563,52
2010	-156,79	-9,63	-147,16	574,90	35,29	-539,61

11.3.1.5 Uncertainty estimates

Standard error for the total forest land area is 1%. Standard error for land converted to forest is 25%. Standard error of gross volume increment is 1,4% for total forest land.

Table 11-11. Uncertainty assessment values

Indicator	Unit	Uncertainty	Method used
Growing stock volume	m^3/ha	0,9%	sampling
	m^3	1,4%	sampling
Gross volume increment	m^3/ha	0,8%	sampling
	m^3	1,4%	sampling
Dead trees volume	m^3/ha	2,3%	sampling
	m^3	2,5%	sampling
Forest land	ha	1%	sampling
Forest Management area	ha	1%	sampling
Land converted to Forest land	ha	25%	sampling

Afforestation, Reforestation & Deforestation	ha	S 1:10000	wall-to-wall

Area of afforestation, reforestation and deforestation meets requirements at the scale 1:10 000. Objects are identified clearly within 7 m from their actual position.

11.3.1.6 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 2008-2010 may change in the final report at the end of the commitment period.

11.3.1.7 The year of the onset of an activity, if after 2008

Not relevant for Lithuania.

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.

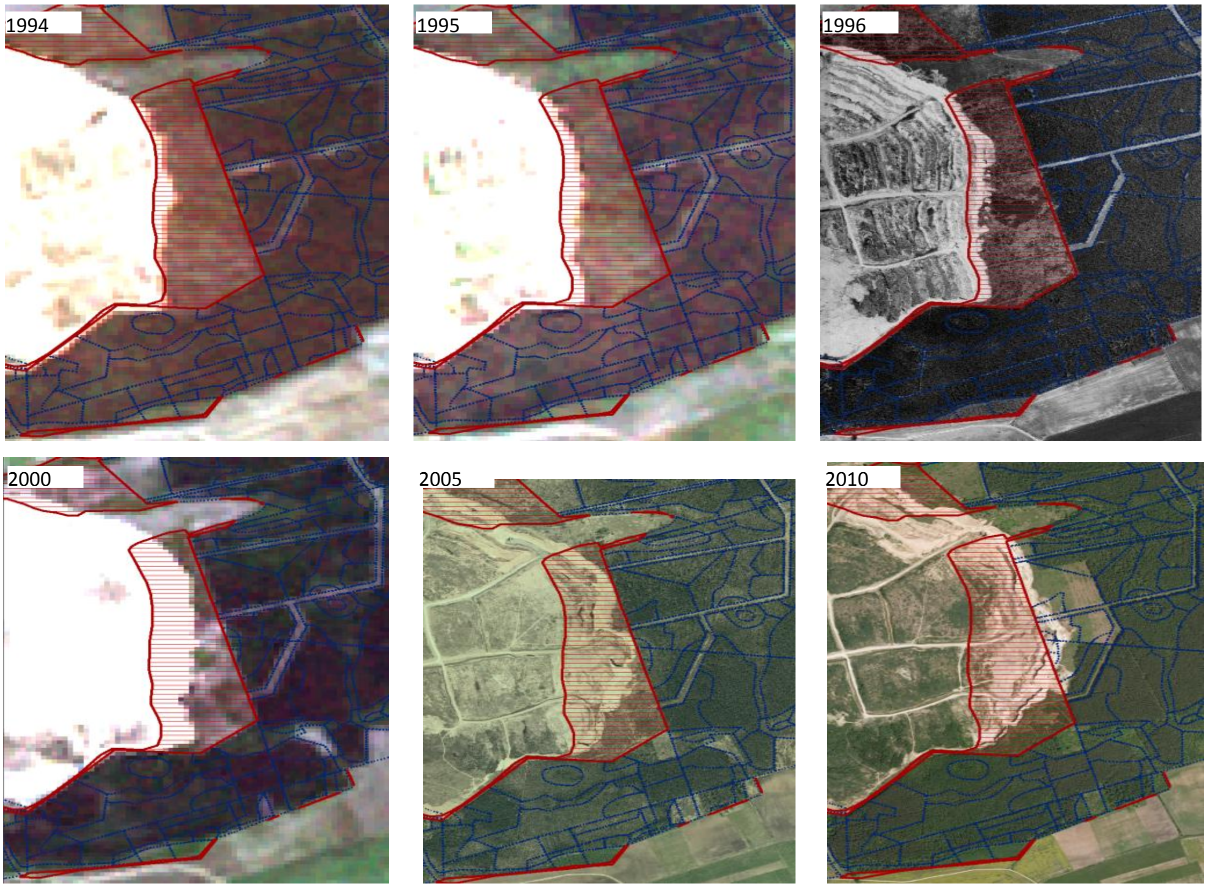
Reported Afforestation and Reforestation activities are defined only as human-induced activities without natural forest expansion. Forest Law regulates afforestation process in agricultural lands and other lands (swamps, peatlands, other land) too. Afforestation of these lands could be done by artificial 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 1990-2010 estimated as the result of the *Study-1*. Special methodology and descriptive codes (Table 11-5) 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 (1990-2010).

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. 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 Image land cover database (Figure 11-9).



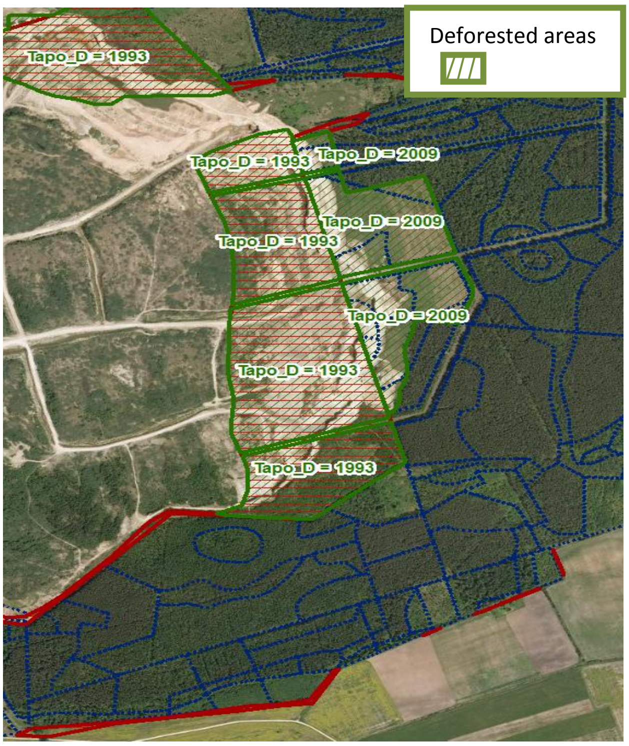


Figure 11-9. Procedure of identification of deforested areas 1994 – 2010

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 2010 – 19331 ha.

11.4.4 Emissions and removals under Article 3.3

Afforestation and Reforestation activities were a net sink of -77,19 Gg CO_2 in 2008, -83,80 Gg CO_2 in 2009 and -196,64 Gg CO_2 in 2010. (Table 11-12). 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 (NA). Accurate data for forest litter and mineral soils is not available . The Deforestation activities were a net source of 5,99 Gg CO_2 in 2008, 10,83 Gg CO_2 in 2009 and 35,29 Gg CO_2 in 2010 (Table 11-13).

Table 11-12. 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	17,54	3,51	NA	NA	NA	NA	21,05	-77,19
2009	19,04	3,81	NA	NA	NA	NA	22,85	-83,80
2010	44,68	8,95	NA	NA	NA	NA	53,63	-196,64

Table 11-13. 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	Miner al soil	Organic soil		
2008	-0,75	-0,17	-0,02	-0,17	-0,42	-0,10	-1,63	5,99
2009	-1,37	-0,31	-0,04	-0,31	-0,74	-0,17	-2,94	10,83
2010	-4,49	-1,03	-0,14	-0,99	-2,41	-0,57	-9,63	35,29

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*.

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 be identified only 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 11-14.

Table 11-14. Net removals and emissions from Forest management in 2008 - 2010 (Gg)

	2008	2009	2010
Net CO_2 removals	-8170,07	-11231,36	-12091,22
CH_4 and N_2O emission	0,08	0,11	0,07
Total (CO_2 eq.)	-8146,72	-11207,37	-12068,06

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 GPG (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 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 11-15.

Table 11-15. 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_2012_1_10-35-48 2-4-2012.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 2011 to and from other Parties of the Kyoto Protocol.

12.2 Summary of information reported in the SEF tables

At the beginning of the 2011 there were 202 353 017 AAUs in the Lithuania's national holding accounts. 3 963 710 AAUs, 512 342 ERUs and 771 357 CERs were in entity holding accounts. In the retirement account were 9 880 407 AAUs, 461 637 ERUs and 1 550 891 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 1 643 504 ERUs converted from AAUs.

5 563 062 AAUs, 183 378 ERUs and 648 014 CERs were surrendered by Lithuania's operators and retired to Lithuania's national retirement account.

At the end of 2011 160 163 624 AAUs and 41 993 ERUs were left in National holding account. 6 036 077 AAUs, 755 932 CERs and 2 502 312 ERUs 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

No discrepancies and notifications occurred in 2011.

12.4 Publicly accessible information

The information required to be publicly accessible by the decision 13/CMP/1 is available in the user interface of the Lithuania's ETR – https://etr.am.lt/crweb/. It is also accessible via Registry management office web page on www.laaif.lt. According to the Article 10 of the Commission Regulation No. 2216/2004, all 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 the transaction, held in the registries and the Community independent transaction log 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 (2010), which is calculated below:

5 x 20,809,736,94 = 104,048,685 tonnes CO_2 eq.

13 INFORMATION ON CHANGES IN NATIONAL SYSTEM

Governmental Resolution No 683 on establishment of permanent GHG inventory preparation working group was amended in 2012. By this amendment, Lithuanian Research Centre for Agriculture and Forestry was designated to be responsible for GHG emissions and removals estimates in LULUCF sector (except forestry), replacing State Land Fund. State Land Fund remains to be responsible for the collection of data on land use changes.

The other institutional changes were related to strengthening of institutional capacities in the responsible institutions:

- Permanent staff of State Forest Service (SFS) is complemented by 6 officials: 2 specialists were employed to work on data collection and GHG emission 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 reporting).
- In the beginning of 2012 Climate change division for GHG inventory was established within the Environment Protection Agency, which is responsible for GHG inventory compilation, QA/QC etc. 5 officials were employed within Climate change division.

In response to Saturday paper 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.

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.

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, in November 2011 Lithuania developed "Action plan to improve LULUCF reporting" which was approved by the ERT 2011 and endorsed by the Order of the Minister of Environment and Minister of Agriculture on Approval of Action plan to improve LULUCF reporting of Lithuania (adopted on 16-12-2011, No D1-987/3D-927). Already implemented measures pursuant to the Action Plan to improve LULUCF reporting of Lithuania are listed below.

- Legal acts, improving the legislative basis to ensure mandatory registration of areas specific to the activities under Article 3 paragraph 3 and 4 of the Kyoto Protocol adopted:
  - *Order of the Minister of Environment on Approval of Harmonised Principles for LULUCF reporting (adopted on 12-01-2012, No D1-27);*
  - *Amendment of the Order of the Minister of Environment No D1-570 on National forest inventory by sampling method (adopted on 24-01-2012, No D1-59);*
  - *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 03-04-2012, 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 08-05-2012, No D1-*409/3D-331*);*
  - *Amendment of the Government Resolution No 1255 on State Forest Cadastre (adopted on 23-05-2012).*

- Annual land plots identification is being strengthened through the results of 2 studies:
  - *"Forest land changes in Lithuania during 1990-2011"* and
  - *"Changes of areas of cropland, grassland, wetlands, settlements and other land in Lithuania during 1990-2011".*

The studies are already implemented and results incorporated in this NIR submission in Chapter 7 and Chapter 11. The studies are described in Chapters 7.1.1 and 7.1.2.

Norway Grants partnership project "Cooperation on GHG inventory" between Lithuania and Norway under the programme No25 „Capacity-building and institutional cooperation between beneficiary state and Norwegian public institutions, local and regional authorities" based on the Memorandum of Understanding of the implementation of the Norwegian financial mechanism for the period 2009-2014 between the Kingdom of Norway and the Republic of Lithuania, which is in force of 6 April 2011 (p. 10 part C paragraph 3, found on http://www.eeagrants.org/id/2453.0) is scheduled to begin in 2012. The partner of this programme will be Norwegian Climate and Pollution Agency (Klif), which is 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. Project will be implemented during the years 2012-2013 and the budget allocated for this project amounts to 772 500 Eur. Expected outcomes of the project are described in the Chapter 1.2 of the NIR.

A number of studies to improve GHG inventory estimates were initiated in 2012:

- 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 which accurately reflect the carbon content and other physical properties of fossil fuel consumed in country is required. Procurement tender was announced in March 2012. Study results are to be ready in August 2012.

- 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 is needed in order to complement GHG inventory and collect more detailed information on F-gases use in Lithuania during 1990-2010. Procurement procedure for this study was started in April 2012. Study results are to be ready in August 2012.

- Study on research and evaluation of methane producing capacity in the Lithuanian manure management systems. Procurement tender was announced in March 2012. Study results are to be ready in August 2012.

- Study on research and analyses of methane emissions from wastewater and sludge. The study is required as data is not sufficient for the proper calculation of GHG emissions in waste sector. Procurement tender was announced in April 2012. Study results are to be ready in August 2012.

14 INFORMATION ON CHANGES IN THE NATIONAL GREENHOUSE GAS REGISTRY

General description and background information on the National GHG Registry has been included in the Lithuania's Initial Report, submitted to the UNFCCC. Lithuanian GHG Registry has been completely operational since 2005. The UNFCCC Secretariat completed the live connection between the UNFCCC International Transaction Log (ITL) and the Lithuanian Registry on the 6th of October, 2008. The whole process was synchronized between ITL, the European Union Community Independent Transaction Log (CITL) and 26 EU greenhouse gas emissions trading registries in 2008. There was a migration of registry data from GRETA (UK) to Community Registry (EC) software in October 2009, followed by the successfully performed EU ETS and Annex H of Data Exchange Standards for Registry Systems under the Kyoto Protocol (Technical specifications) tests. Implementation of the 4-eye transaction verification mechanism in 2011 resulted in Community Registry's version update from 3.2 to 3.3.

15/CMP.1 annex II.E paragraph 32 (a) Change of name or contact.

The change of registry administrators occurred in 2011: Registry administrator Diana Vedlugaitė (contact information diana@laaif.lt; sdregistras@laaif.lt; 0037052169799) was replaced by Chief Specialist (Registry Administrator) Justė Akmenskytė (contact information: juste@laaif.lt, sdregistras@laaif.lt 0037052169799).

15/CMP.1 annex II.E paragraph 32 (b) Change of cooperation arrangement.

Lithuania is not cooperating in maintaining national registry with other parties.
No change of cooperation arrangement occurred during 2011.

15/CMP.1 annex II.E paragraph 32 (c) Change to database or the capacity of National Registry.

There was no change to Database and Application Backup plan including Application Logging Documentation since the previous report.
There was no change to Disaster Recovery plan since the previous report.

15/CMP.1 annex II.E paragraph 32 (d) Change of conformance to technical standards.

There was no change of conformance to technical standards since the previous report.

15/CMP.1 annex II.E paragraph 32 (e) Change of discrepancies procedures.

No change of discrepancies procedures occurred during 2011.

15/CMP.1 annex II.E paragraph 32 (f) Change of Security.

In April 2011 4-eye transaction verification mechanism was implemented as a countermeasure against phishing and session hijacking. Addition of the 4-eye verification mechanism means that for each internal and external transfer of units a confirmation of the national Registry administrator is required. The administrator approves transactions only after receiving a signed and faxed request from the sending account's representatives. In order to check whether a particular account

representative is actually attempting to transfer the units, the national administrator contacts the person via phone (only the numbers recorded in the GHG Registry are used for validation).
During the same year, in order to secure the communication between the Registry and CITL, the SSL certificate was installed onto the Registry system.
Other measures required by the European Commission were also implemented in order to eliminate the vulnerabilities within the Registry.

15/CMP.1 annex II.E paragraph 32 (g) Change of list of publicly accessible information.

No change to the list of publicly available information occurred during 2011.

15/CMP.1 annex II.E paragraph 32 (h) Change of Internet address.

Due to the installation of the SSL certificate, the Registry Internet address changed to: https://etr.am.lt/crweb/.

15/CMP.1 annex II.E paragraph 32 (i) Change of data integrity measure.

No change of data integrity measures occurred during 2011.

15/CMP.1 annex II.E paragraph 32 (j) Change of test results.

There were no changes related to test procedures during 2011.

There were no other changes in National Registry according to 15/CMP.1 annex II.E paragraph 32 (a) to (j) during the reported year.

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

Lithuania is striving under the Kyoto protocol to implement its commitments in such a way as to minimize adverse social, environmental and economic impacts on developing countries.

During the international negotiations on the post-2012 climate change regime EU and its member states' committed to provide EUR 7,2 billion cumulatively over the period 2010 – 2012 to fast start finance, in order to promote the implementation of climate change measures in developing countries, In this context Lithuania has started the implementation of its **Fast Start Financing** (FSF) commitment to provide 3 million EUR during 2010-2012. USD 26 711,44 were allocated to the Energy Sector Management Assistance Programme (ESMAP) under the World Bank in 2010. The program addresses the challenges posed by energy security, poverty reduction and climate change through its core functions as a think thank and knowledge clearing house, but also through operational leveraging. ESMAP assists low- and middle-income countries to promote environmentally sustainable energy solutions for poverty reduction and economic growth. ESMAP offers pre-investment activities such as analytical and advisory activities, studies, pilot projects, conferences, trainings and workshops, but not investments themselves. A priori the potential of investments are analysed, while ex post best practices are gathered, evaluations are undertaken and knowledge is transferred.

In accordance with the provisions of the Law on Financial instruments for climate change management, adopted on 7 July 2009 by the Parliament of the Republic of Lithuania, a **Special Programme for Climate Change** (SPCC) was established. The aim of this programme is to rise additional funding for the climate change management measures. One of the areas where the funds of the SPCC shall be used is the implementation, in the territory of the Republic of Lithuania and third countries, of measures of adaptation to climate change and mitigation of climate change effects as stipulated under legal acts of the European Union, the Convention on Climate Change, the Kyoto Protocol and other international agreements, 0,29 mill. EUR will be allocated in 2012 in accordance with the provisions of the Order of the MoE on the use of funds from Special Programme for Climate Change (SPCC).

In the frame of **Official Development Assistance** (ODA) Lithuania has started implementation of the following bilateral assistance projects in 2011:

- Adaptation to climate change project in Moldova (EUR 8 696);
- Climate change mitigation project and climate change awareness raising project in Georgia (EUR 25 435);
- Climate change mitigation project in Ukraine (via contribution to E5P) (EUR 28 962).

Additional measures

Carbon market in our view is one of the most efficient ways to mobilize resources for funding of developing countries. The following measures were implemented in order to increase the private financing generated via carbon market:

Lithuania established guidelines for the approval of CDM projects in 2010;

Lithuania approved the guidelines on the use of CER/ERU for compliance under EU emission trading scheme in 2010.

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ANNEX I. Key source category analysis

Key category 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	6281,40	12,8%	13%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	5981,61	12,2%	25%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	3667,08	7,5%	33%
4.A. Enteric Fermentation, cattle, CH_4	3139,43	6,4%	39%
1.AA.3.B Road transportation gasoline, CO_2	3053,06	6,2%	45%
1.AA.4.A Commercial/Institutional, CO_2	2892,87	5,9%	51%
1.AA.4.B Residential, CO_2	2382,83	4,9%	56%
1.AA.3.B Road transportation diesel, CO_2	2133,93	4,4%	60%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	2110,76	4,3%	65%
4.D.3. Indirect Emissions, N_2O	1878,54	3,8%	68%
1.AA.3.E Off-road vehicles and machinery, CO_2	1765,49	3,6%	72%
2.A.1. Cement Production, CO_2	1668,07	3,4%	75%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1495,34	3,1%	79%
4.D.1. Direct Soil Emissions synthetic N fertilizer, N_2O	1341,59	2,7%	81%
2.B.1. Ammonia Production, CO_2	1190,53	2,4%	84%
2.B.2. Nitric Acid Production, N_2O	928,99	1,9%	86%
6.A. Solid Waste Disposal on Land, CH_4	907,03	1,9%	87%
4.B. Manure Management, N_2O	873,50	1,8%	89%
4.D.1. Direct Soil Emissions manure fertilizers, N_2O	667,64	1,4%	91%
4.B. Manure Management swine, CH_4	637,65	1,3%	92%
4.D.2. Pasture, Range and Paddock Manure, N_2O	485,56	1,0%	93%
4.B. Manure Management, cattle, CH_4	424,59	0,9%	94%
1.AA.4.C Agriculture/Forestry/Fisheries, CO2	418,71	0,9%	95%
1.AA.3.C Railways, CO_2	349,94	0,7%	95%
4.D.1. Direct Soil Emissions Crop residues, N_2O	283,95	0,6%	96%
1.AA.3 Transport, N_2O	249,19	0,5%	96%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	228,06	0,5%	97%
2.A.2. Lime Production, CO_2	216,42	0,4%	97%
1.AA.1 Energy industries solid fuel, CO_2	193,42	0,4%	98%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	177,15	0,4%	98%
6.B. Waste-water Handling, CH_4	174,60	0,4%	98%
1.B. Fugitive Emissions from Fuels, CH_4	149,38	0,3%	99%
3. Solvent and Other Product Use, CO_2	100,50	0,2%	99%
1.AA.3.E Natural gas transportation in pipelines, CO_2	88,08	0,2%	99%
6.B. Waste-water Handling, N_2O	79,91	0,2%	99%
1.AA.4 Other sectors, biomass, CH_4	68,58	0,1%	99%
1.AA.3.B Road transportation LPG, CO_2	60,19	0,1%	100%

1.AA.3 Transport, CH_4	37,75	0,1%	100%
1.AA.4 Other sectors, N_2O	30,53	0,1%	100%
1.AA.1 Energy industries, N_2O	23,41	0,0%	100%
2.C.1.2 Pig iron, CO_2	21,41	0,0%	100%
1.AA.3.D Navigation, CO_2	15,45	0,0%	100%
2.A.7 Glass Production, CO_2	13,25	0,0%	100%
1.AA.2 Manufacturing and construction, N_2O	11,09	0,0%	100%
1.AA.3.A Civil aviation, CO_2	9,01	0,0%	100%
1.AA.1 Energy industries, CH_4	8,38	0,0%	100%
1.AA.2 Manufacturing and construction, CH_4	7,41	0,0%	100%
2.A.7 Mineral wool production, CO_2	6,28	0,0%	100%
2.A.4. Soda Ash Production and Use, CO_2	4,99	0,0%	100%
2.F Consumption of Halocarbons and SF_6, HFC, 1995	4,67	0,0%	100%
2.A.3. Limestone and Dolomite Use, CO_2	4,48	0,0%	100%
6.C. Waste Incineration, CO_2	3,99	0,0%	100%
2.B.5.5 Methanol, CH_4	3,83	0,0%	100%
4.B. Manure Management other, CH_4	2,63	0,0%	100%
4.A. Enteric Fermentation others, CH_4	1,37	0,0%	100%
1.B. Fugitive Emissions from Fuels, CO_2	1,05	0,0%	100%
6.C. Waste Incineration, N_2O	0,17	0,0%	100%
2.F Consumption of Halocarbons and SF_6, SF_6, 1995	0,05	0,0%	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,00	0,0%	100%
1.AA.5 Other, CH_4	0,00	0,0%	100%
1.AA.5 Other, CO_2	0,00	0,0%	100%
1.AA.5 Other, N_2O	0,00	0,0%	100%

Key category 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	6950,77	12,2%	12%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	6281,40	11,0%	23%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	5981,61	10,5%	34%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	3667,08	6,4%	40%
4.A. Enteric Fermentation, cattle, CH_4	3139,43	5,5%	46%
1.AA.3.B Road transportation gasoline, CO_2	3053,06	5,3%	51%
1.AA.4.A Commercial/Institutional, CO_2	2892,87	5,1%	56%
1.AA.4.B Residential, CO_2	2382,83	4,2%	60%
1.AA.3.B Road transportation diesel, CO_2	2133,93	3,7%	64%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	2110,76	3,7%	68%
4.D.3. Indirect Emissions, N_2O	1878,54	3,3%	71%
1.AA.3.E Off-road vehicles and machinery, CO_2	1765,49	3,1%	74%
2.A.1. Cement Production, CO_2	1668,07	2,9%	77%

1.AA.1.B Petroleum refining, liquid fuel, CO_2	1495,34	2,6%	80%
4.D.1. Direct Soil Emissions synthetic N fertilizer, N_2O	1341,59	2,4%	82%
2.B.1. Ammonia Production, CO_2	1190,53	2,1%	84%
2.B.2. Nitric Acid Production, N_2O	928,99	1,6%	86%
6.A. Solid Waste Disposal on Land, CH4	907,03	1,6%	87%
4.B. Manure Management, N_2O	873,50	1,5%	89%
4.D.1. Direct Soil Emissions manure fertilizers, N_2O	667,64	1,2%	90%
4.B. Manure Management swine, CH_4	637,65	1,1%	91%
4.D.2. Pasture, Range and Paddock Manure, N_2O	485,56	0,9%	92%
5.C. Grassland, CO_2	461,51	0,8%	93%
4.B. Manure Management, cattle, CH_4	424,59	0,7%	93%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	418,71	0,7%	94%
5.B. Cropland, CO_2	354,81	0,6%	95%
1.AA.3.C Railways, CO_2	349,94	0,6%	95%
4.D.1. Direct Soil Emissions Crop residues, N_2O	283,95	0,5%	96%
5.A.2. Land converted to Forest Land, CO_2	256,72	0,4%	96%
1.AA.3 Transport, N_2O	249,19	0,4%	97%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	228,06	0,4%	97%
2.A.2. Lime Production, CO_2	216,42	0,4%	98%
1.AA.1 Energy industries solid fuel, CO_2	193,42	0,3%	98%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	177,15	0,3%	98%
6.B. Waste-water Handling, CH_4	174,60	0,3%	99%
1.B. Fugitive Emissions from Fuels, CH_4	149,38	0,3%	99%
3. Solvent and Other Product Use, CO_2	100,50	0,2%	99%
1.AA.3.E Natural gas transportation in pipelines, CO_2	88,08	0,2%	99%
6.B. Waste-water Handling, N_2O	79,91	0,1%	99%
5.D. Wetlands, CO_2	72,73	0,1%	99%
1.AA.4 Other sectors, biomass, CH_4	68,58	0,1%	99%
1.AA.3.B Road transportation LPG, CO_2	60,19	0,1%	100%
1.AA.3 Transport, CH_4	37,75	0,1%	100%
1.AA.4 Other sectors, N_2O	30,53	0,1%	100%
1.AA.1 Energy industries, N_2O	23,41	0,0%	100%
5.A.1. Forest Land remaining Forest Land, N_2O	22,04	0,0%	100%
2.C.1.2 Pig iron, CO_2	21,41	0,0%	100%
1.AA.3.D Navigation, CO_2	15,45	0,0%	100%
2.A.7 Glass Production, CO_2	13,25	0,0%	100%
1.AA.2 Manufacturing and construction, N_2O	11,09	0,0%	100%
1.AA.3.A Civil aviation, CO_2	9,01	0,0%	100%
1.AA.1 Energy industries, CH_4	8,38	0,0%	100%
1.AA.2 Manufacturing and construction, CH_4	7,41	0,0%	100%
2.A.7 Mineral wool production, CO_2	6,28	0,0%	100%
2.A.4. Soda Ash Production and Use, CO_2	4,99	0,0%	100%
2.F Consumption of Halocarbons and SF_6, HFC, 1995	4,67	0,0%	100%
2.A.3. Limestone and Dolomite Use, CO_2	4,48	0,0%	100%
6.C. Waste Incineration, CO_2	3,99	0,0%	100%

2.B.5.5 Methanol, CH_4	3,83	0,0%	100%
4.B. Manure Management other, CH_4	2,63	0,0%	100%
4.A. Enteric Fermentation others, CH_4	1,37	0,0%	100%
1.B. Fugitive Emissions from Fuels, CO_2	1,05	0,0%	100%
5.A.1. Forest Land remaining Forest Land, CH_4	0,37	0,0%	100%
6.C. Waste Incineration, N_2O	0,17	0,0%	100%
2.F Consumption of Halocarbons and SF_6, SF_6, 1995	0,05	0,0%	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,00	0,0%	100%
1.AA.5 Other, CH_4	0,00	0,0%	100%
1.AA.5 Other, CO_2	0,00	0,0%	100%
1.AA.5 Other, N_2O	0,00	0,0%	100%
5.E Settlements, CO_2	0,00	0,0%	100%

Key category analysis excluding LULUCF: 2010

Key Category	GHG emissions, Gg CO_2 eq.	Level assessment	Cumulative total
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	3310,78	16,1%	16%
1.AA.3.B Road transportation diesel, CO_2	2678,42	13,0%	29%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1568,75	7,6%	37%
2.B.1. Ammonia Production, CO_2	1150,30	5,6%	42%
4.A. Enteric Fermentation, cattle, CH_4	1142,05	5,5%	48%
6.A. Solid Waste Disposal on Land, CH_4	954,42	4,6%	52%
4.D.3. Indirect Emissions, N_2O	952,25	4,6%	57%
1.AA.3.B Road transportation gasoline, CO_2	904,54	4,4%	61%
4.D.1. Direct Soil Emissions synthetic N fertilizer, N_2O	815,48	4,0%	65%
1.AA.4.B Residential, CO_2	733,91	3,6%	69%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	682,86	3,3%	72%
2.B.2. Nitric Acid Production, N_2O	578,04	2,8%	75%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	494,60	2,4%	77%
1.AA.3.B Road transportation LPG, CO_2	494,18	2,4%	80%
1.AA.4.A Commercial/Institutional, CO_2	377,52	1,8%	82%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	340,81	1,7%	83%
2.A.1. Cement Production, CO_2	289,05	1,4%	85%
4.B. Manure Management, N_2O	287,91	1,4%	86%
1.B. Fugitive Emissions from Fuels, CH_4	260,98	1,3%	87%
4.D.1. Direct Soil Emissions manure fertilizers, N_2O	251,87	1,2%	89%
4.B. Manure Management swine, CH_4	225,65	1,1%	90%
4.B. Manure Management, cattle, CH_4	221,36	1,1%	91%
4.D.1. Direct Soil Emissions Crop residues, N_2O	214,41	1,0%	92%
4.D.2. Pasture, Range and Paddock Manure, N_2O	203,85	1,0%	93%
1.AA.3.C Railways, CO_2	185,14	0,9%	94%
2.F Consumption of Halocarbons and SF_6, HFC, 1995	172,28	0,8%	94%

1.AA.4 Other sectors, biomass, CH_4	161,85	0,8%	95%
1.AA.3.E Off-road vehicles and machinery, CO_2	156,65	0,8%	96%
6.B. Waste-water Handling, CH_4	125,01	0,6%	97%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	105,03	0,5%	97%
3. Solvent and Other Product Use, CO_2	89,25	0,4%	98%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	86,59	0,4%	98%
6.B. Waste-water Handling, N_2O	79,79	0,4%	98%
1.AA.3.E Natural gas transportation in pipelines, CO_2	58,49	0,3%	99%
1.AA.3 Transport, N_2O	55,03	0,3%	99%
1.AA.4 Other sectors, N_2O	34,67	0,2%	99%
1.AA.1 Energy industries solid fuel, CO_2	27,54	0,1%	99%
1.AA.1 Energy industries, N_2O	20,55	0,1%	99%
2.A.2. Lime Production, CO_2	18,64	0,1%	99%
1.AA.3.D Navigation, CO_2	17,13	0,1%	100%
1.AA.5 Other, CO_2	15,89	0,1%	100%
1.AA.3 Transport, CH_4	13,93	0,1%	100%
2.F Consumption of Halocarbons and SF_6, SF_6, 1995	10,70	0,1%	100%
1.B. Fugitive Emissions from Fuels, CO_2	9,48	0,0%	100%
1.AA.1 Energy industries, CH_4	9,14	0,0%	100%
2.A.7 Mineral wool production, CO_2	8,32	0,0%	100%
1.AA.2 Manufacturing and construction, N_2O	5,90	0,0%	100%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	4,84	0,0%	100%
2.A.7 Glass Production, CO_2	4,16	0,0%	100%
2.C.1.2 Pig iron, CO_2	4,11	0,0%	100%
1.AA.2 Manufacturing and construction, CH_4	4,00	0,0%	100%
4.B. Manure Management other, CH_4	2,70	0,0%	100%
6.C. Waste Incineration, CO_2	1,93	0,0%	100%
4.A. Enteric Fermentation others, CH_4	1,66	0,0%	100%
1.AA.3.A Civil aviation, CO_2	1,62	0,0%	100%
2.A.4. Soda Ash Production and Use, CO_2	0,45	0,0%	100%
1.AA.5 Other, N_2O	0,15	0,0%	100%
6.C. Waste Incineration, N_2O	0,11	0,0%	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,03	0,0%	100%
2.A.3. Limestone and Dolomite Use, CO_2	0,03	0,0%	100%
1.AA.5 Other, CH_4	0,01	0,0%	100%
2.B.5.5 Methanol, CH_4	0,00	0,0%	100%

Key category analysis including LULUCF: 2010

Key Category	GHG emissions, Gg CO_2 eq.	Level assessment	Cumulative total
5.A.1. Forest Land remaining Forest Land, CO_2	11873,87	35,4%	35%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	3310,78	9,9%	45%

1.AA.3.B Road transportation diesel, CO_2	2678,42	8,0%	53%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1568,75	4,7%	58%
2.B.1. Ammonia Production, CO_2	1150,30	3,4%	61%
4.A. Enteric Fermentation, cattle, CH_4	1142,05	3,4%	65%
6.A. Solid Waste Disposal on Land, CH_4	954,42	2,8%	68%
4.D.3. Indirect Emissions, N_2O	952,25	2,8%	70%
1.AA.3.B Road transportation gasoline, CO_2	904,54	2,7%	73%
4.D.1. Direct Soil Emissions synthetic N fertilizer, N_2O	815,48	2,4%	76%
1.AA.4.B Residential, CO_2	733,91	2,2%	78%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	682,86	2,0%	80%
2.B.2. Nitric Acid Production, N_2O	578,04	1,7%	81%
5.C. Grassland, CO_2	535,50	1,6%	83%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	494,60	1,5%	85%
1.AA.3.B Road transportation LPG, CO_2	494,18	1,5%	86%
5.A.2. Land converted to Forest Land, CO_2	429,76	1,3%	87%
1.AA.4.A Commercial/Institutional, CO_2	377,52	1,1%	88%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	340,81	1,0%	89%
2.A.1. Cement Production, CO_2	289,05	0,9%	90%
4.B. Manure Management, N_2O	287,91	0,9%	91%
1.B. Fugitive Emissions from Fuels, CH_4	260,98	0,8%	92%
4.D.1. Direct Soil Emissions manure fertilizers, N_2O	251,87	0,8%	93%
4.B. Manure Management swine, CH_4	225,65	0,7%	93%
4.B. Manure Management, cattle, CH_4	221,36	0,7%	94%
4.D.1. Direct Soil Emissions Crop residues, N_2O	214,41	0,6%	95%
4.D.2. Pasture, Range and Paddock Manure, N_2O	203,85	0,6%	95%
1.AA.3.C Railways, CO_2	185,14	0,6%	96%
2.F Consumption of Halocarbons and SF_6, HFC, 1995	172,28	0,5%	96%
1.AA.4 Other sectors, biomass, CH_4	161,85	0,5%	97%
1.AA.3.E Off-road vehicles and machinery, CO_2	156,65	0,5%	97%
6.B. Waste-water Handling, CH_4	125,01	0,4%	98%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	105,03	0,3%	98%
3. Solvent and Other Product Use, CO_2	89,25	0,3%	98%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	86,59	0,3%	98%
6.B. Waste-water Handling, N_2O	79,79	0,2%	99%
1.AA.3.E Natural gas transportation in pipelines, CO_2	58,49	0,2%	99%
5.D. Wetlands, CO_2	56,47	0,2%	99%
1.AA.3 Transport, N_2O	55,03	0,2%	99%
1.AA.4 Other sectors, N_2O	34,67	0,1%	99%
5.B. Cropland, CO_2	30,28	0,1%	99%
1.AA.1 Energy industries solid fuel, CO_2	27,54	0,1%	99%
5.A.1. Forest Land remaining Forest Land, N_2O	23,10	0,1%	100%
1.AA.1 Energy industries, N_2O	20,55	0,1%	100%
2.A.2. Lime Production, CO_2	18,64	0,1%	100%
1.AA.3.D Navigation, CO_2	17,13	0,1%	100%
1.AA.5 Other, CO_2	15,89	0,0%	100%

1.AA.3 Transport, CH_4	13,93	0,0%	100%
2.F Consumption of Halocarbons and SF_6, SF_6, 1995	10,70	0,0%	100%
1.B. Fugitive Emissions from Fuels, CO_2	9,48	0,0%	100%
1.AA.1 Energy industries, CH_4	9,14	0,0%	100%
2.A.7 Mineral wool production, CO_2	8,32	0,0%	100%
1.AA.2 Manufacturing and construction, N_2O	5,90	0,0%	100%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	4,84	0,0%	100%
2.A.7 Glass Production, CO_2	4,16	0,0%	100%
2.C.1.2 Pig iron, CO_2	4,11	0,0%	100%
1.AA.2 Manufacturing and construction, CH_4	4,00	0,0%	100%
4.B. Manure Management other, CH_4	2,70	0,0%	100%
6.C. Waste Incineration, CO_2	1,93	0,0%	100%
4.A. Enteric Fermentation others, CH_4	1,66	0,0%	100%
1.AA.3.A Civil aviation, CO_2	1,62	0,0%	100%
2.A.4. Soda Ash Production and Use, CO_2	0,45	0,0%	100%
1.AA.5 Other, N_2O	0,15	0,0%	100%
6.C. Waste Incineration, N_2O	0,11	0,0%	100%
5.A.1. Forest Land remaining Forest Land, CH_4	0,06	0,0%	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,03	0,0%	100%
2.A.3. Limestone and Dolomite Use, CO_2	0,03	0,0%	100%
1.AA.5 Other, CH_4	0,01	0,0%	100%
2.B.5.5 Methanol, CH_4	0,00	0,0%	100%
5.E Settlements, CO_2	0,00	0,0%	100%
5.F Other land, CO_2	0,00	0,0%	100%

Trend assessment excluding LULUCF: 1990 – 2010

Key Category	GHG emissions, Gg CO_2 eq.		Level assessment 2010	Trend assessment		Cumulative total
	1990	2010				
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	6281,40	494,60	2,46%	25,99%	16,84%	17%
1.AA.3.B Road transportation diesel, CO_2	2133,93	2678,42	13,30%	17,60%	11,41%	28%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	3667,08	86,59	0,43%	17,30%	11,21%	39%
1.AA.4.A Commercial/Institutional, CO_2	2892,87	377,52	1,88%	10,39%	6,74%	46%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1495,34	1568,75	7,79%	9,09%	5,89%	52%
1.AA.3.E Off-road vehicles and machinery, CO_2	1765,49	156,65	0,78%	7,12%	4,61%	57%
2.B.1. Ammonia Production, CO_2	1190,53	1150,30	5,71%	6,20%	4,02%	61%
1.AA.3.B Road transportation gasoline, CO_2	3053,06	904,54	4,49%	5,64%	3,66%	64%
6.A. Solid Waste Disposal on Land, CH_4	907,03	954,42	4,74%	5,54%	3,59%	68%
2.A.1. Cement Production, CO_2	1668,07	289,05	1,44%	5,24%	3,40%	71%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	5981,61	3310,78	16,45%	5,15%	3,34%	75%
1.AA.3.B Road transportation LPG, CO_2	60,19	494,18	2,45%	4,90%	3,18%	78%
1.AA.4.B Residential, CO_2	2382,83	733,91	3,65%	4,11%	2,66%	81%
4.A. Enteric Fermentation, cattle, CH_4	3139,43	1142,05	5,67%	3,57%	2,31%	83%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	2110,76	682,86	3,39%	3,29%	2,13%	85%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	177,15	340,81	1,69%	2,71%	1,75%	87%
1.B. Fugitive Emissions from Fuels, CH_4	149,38	260,98	1,30%	2,01%	1,30%	88%
4.D.1. Direct Soil Emissions synthetic N fertilizer, N_2O	1341,59	815,48	4,05%	1,92%	1,25%	89%
2.F Consumption of Halocarbons and SF_6, HFC, 1995	4,67	172,28	0,86%	1,79%	1,16%	90%
2.B.2. Nitric Acid Production, N_2O	928,99	578,04	2,87%	1,47%	0,95%	91%
1.AA.4 Other sectors, biomass, CH_4	68,58	161,85	0,80%	1,36%	0,88%	92%
4.B. Manure Management, N_2O	873,50	287,91	1,43%	1,31%	0,85%	93%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	228,06	4,84	0,02%	1,08%	0,70%	94%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	418,71	105,03	0,52%	0,97%	0,63%	94%
2.A.2. Lime Production, CO_2	216,42	18,64	0,09%	0,88%	0,57%	95%

4.D.1. Direct Soil Emissions Crop residues, N_2O	283,95	214,41	1,07%	0,85%	0,55%	96%
4.B. Manure Management swine, CH_4	637,65	225,65	1,12%	0,79%	0,51%	96%
4.D.3. Indirect Emissions, N_2O	1878,54	952,25	4,73%	0,70%	0,45%	97%
1.AA.1 Energy industries solid fuel, CO_2	193,42	27,54	0,14%	0,67%	0,43%	97%
4.D.1. Direct Soil Emissions manure fertilizers, N_2O	667,64	251,87	1,25%	0,66%	0,43%	97%
1.AA.3 Transport, N_2O	249,19	55,03	0,27%	0,66%	0,43%	98%
6.B. Waste-water Handling, CH_4	174,60	125,01	0,62%	0,45%	0,29%	98%
6.B. Waste-water Handling, N_2O	79,91	79,79	0,40%	0,44%	0,29%	98%
3. Solvent and Other Product Use, CO_2	100,50	89,25	0,44%	0,44%	0,29%	99%
4.D.2. Pasture, Range and Paddock Manure, N_2O	485,56	203,85	1,01%	0,27%	0,17%	99%
4.B. Manure Management, cattle, CH_4	424,59	221,36	1,10%	0,22%	0,14%	99%
1.AA.4 Other sectors, N_2O	30,53	34,67	0,17%	0,21%	0,14%	99%
1.AA.3.C Railways, CO_2	349,94	185,14	0,92%	0,21%	0,14%	99%
1.AA.3.E Natural gas transportation in pipelines, CO_2	88,08	58,49	0,29%	0,18%	0,12%	99%
1.AA.5 Other, CO_2	0,00	15,89	0,08%	0,17%	0,11%	100%
2.F Consumption of Halocarbons and SF_6, SF_6, 1995	0,05	10,70	0,05%	0,11%	0,07%	100%
1.AA.3.D Navigation, CO_2	15,45	17,13	0,09%	0,10%	0,07%	100%
1.AA.1 Energy industries, N_2O	23,41	20,55	0,10%	0,10%	0,06%	100%
1.B. Fugitive Emissions from Fuels, CO_2	1,05	9,48	0,05%	0,09%	0,06%	100%
2.C.1.2 Pig iron, CO_2	21,41	4,11	0,02%	0,06%	0,04%	100%
2.A.7 Mineral wool production, CO_2	6,28	8,32	0,04%	0,06%	0,04%	100%
1.AA.1 Energy industries, CH_4	8,38	9,14	0,05%	0,05%	0,04%	100%
1.AA.3 Transport, CH_4	37,75	13,93	0,07%	0,04%	0,03%	100%
1.AA.3.A Civil aviation, CO_2	9,01	1,62	0,01%	0,03%	0,02%	100%
2.A.7 Glass Production, CO_2	13,25	4,16	0,02%	0,02%	0,01%	100%
2.A.3. Limestone and Dolomite Use, CO_2	4,48	0,03	0,00%	0,02%	0,01%	100%
2.A.4. Soda Ash Production and Use, CO_2	4,99	0,45	0,00%	0,02%	0,01%	100%
4.B. Manure Management other, CH_4	2,63	2,70	0,01%	0,02%	0,01%	100%
4.A. Enteric Fermentation others, CH_4	1,37	1,66	0,01%	0,01%	0,01%	100%
1.AA.2 Manufacturing and construction, N_2O	11,09	5,90	0,03%	0,01%	0,00%	100%
1.AA.2 Manufacturing and construction, CH_4	7,41	4,00	0,02%	0,01%	0,00%	100%

1.AA.5 Other, N_2O	0,00	0,15	0,00%	0,00%	0,00%	100%
6.C. Waste Incineration, CO_2	3,99	1,93	0,01%	0,00%	0,00%	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,00	0,03	0,00%	0,00%	0,00%	100%
6.C. Waste Incineration, N_2O	0,17	0,11	0,00%	0,00%	0,00%	100%
1.AA.5 Other, $CH_{4,}$	0,00	0,01	0,00%	0,00%	0,00%	100%
2.B.5.5 Methanol, CH_4	3,83	0,00	0,00%	0,00%	0,00%	100%

Trend assessment including LULUCF: 1990 - 2010

Key Category	GHG emissions, Gg CO_2 eq.		Level assessment 2010	Trend assessment		Cumulative total
	1990	2010				
5.A.1. Forest Land remaining Forest Land, CO_2	6950,77	11873,87	35,36%	45,66%	33,33%	33%
1.AA.1.A Public electricity and heat production, liquid fuel, CO_2	6281,40	494,60	1,47%	15,94%	11,64%	45%
1.AA.2 Manufacturing and construction, liquid fuels, CO_2	3667,08	86,59	0,26%	10,44%	7,62%	53%
1.AA.3.B Road transportation diesel, CO_2	2133,93	2678,42	7,98%	8,61%	6,29%	59%
1.AA.4.A Commercial/Institutional, CO_2	2892,87	377,52	1,12%	6,51%	4,75%	64%
1.AA.3.E Off-road vehicles and machinery, CO_2	1765,49	156,65	0,47%	4,38%	3,20%	67%
1.AA.1.B Petroleum refining, liquid fuel, CO_2	1495,34	1568,75	4,67%	4,31%	3,15%	70%
1.AA.3.B Road transportation gasoline, CO_2	3053,06	904,54	2,69%	4,04%	2,95%	73%
2.A.1. Cement Production, CO_2	1668,07	289,05	0,86%	3,35%	2,45%	75%
1.AA.4.B Residential, CO_2	2382,83	733,91	2,19%	3,00%	2,19%	78%
4.A. Enteric Fermentation, cattle, CH_4	3139,43	1142,05	3,40%	2,97%	2,17%	80%
2.B.1. Ammonia Production, CO_2	1190,53	1150,30	3,43%	2,88%	2,10%	82%
6.A. Solid Waste Disposal on Land, CH_4	907,03	954,42	2,84%	2,63%	1,92%	84%
1.AA.3.B Road transportation LPG, CO_2	60,19	494,18	1,47%	2,58%	1,89%	86%
1.AA.2 Manufacturing and construction, gaseous fuels, CO_2	2110,76	682,86	2,03%	2,47%	1,80%	87%
5.A.2. Land converted to Forest Land, CO_2	256,72	429,76	1,28%	1,64%	1,20%	89%
5.C. Grassland, CO_2	461,51	535,50	1,59%	1,62%	1,18%	90%
1.AA.2 Manufacturing and construction, solid fuels, CO_2	177,15	340,81	1,02%	1,38%	1,01%	91%

1.B. Fugitive Emissions from Fuels, CH_4	149,38	260,98	0,78%	1,01%	0,74%	92%
4.B. Manure Management, N_2O	873,50	287,91	0,86%	0,99%	0,72%	92%
2.F Consumption of Halocarbons and SF_6, HFC, 1995	4,67	172,28	0,51%	0,95%	0,69%	93%
5.B. Cropland, CO_2	354,81	30,28	0,09%	0,89%	0,65%	94%
1.AA.4 Other sectors, biomass, CH_4	68,58	161,85	0,48%	0,70%	0,51%	94%
1.AA.1.A Public electricity and heat production, gaseous fuel, CO_2	5981,61	3310,78	9,86%	0,69%	0,50%	95%
1.AA.4.C Agriculture/Forestry/Fisheries, CO_2	418,71	105,03	0,31%	0,66%	0,48%	95%
2.A.7 Bricks and Tiles (decarbonizing), CO_2	228,06	4,84	0,01%	0,65%	0,48%	96%
4.B. Manure Management swine, CH_4	637,65	225,65	0,67%	0,64%	0,47%	96%
4.D.1. Direct Soil Emissions manure fertilizers, N_2O	667,64	251,87	0,75%	0,58%	0,42%	96%
4.D.1. Direct Soil Emissions synthetic N fertilizer, N_2O	1341,59	815,48	2,43%	0,56%	0,41%	97%
2.A.2. Lime Production, CO_2	216,42	18,64	0,06%	0,54%	0,39%	97%
2.B.2. Nitric Acid Production, N_2O	928,99	578,04	1,72%	0,46%	0,34%	98%
1.AA.3 Transport, N_2O	249,19	55,03	0,16%	0,43%	0,32%	98%
1.AA.1 Energy industries solid fuel, CO_2	193,42	27,54	0,08%	0,42%	0,31%	98%
4.D.1. Direct Soil Emissions Crop residues, N_2O	283,95	214,41	0,64%	0,35%	0,26%	99%
4.D.2. Pasture, Range and Paddock Manure, N_2O	485,56	203,85	0,61%	0,31%	0,22%	99%
4.D.3. Indirect Emissions, N_2O	1878,54	952,25	2,84%	0,27%	0,20%	99%
6.B. Waste-water Handling, N_2O	79,91	79,79	0,24%	0,21%	0,15%	99%
3. Solvent and Other Product Use, CO_2	100,50	89,25	0,27%	0,20%	0,15%	99%
6.B. Waste-water Handling, CH_4	174,60	125,01	0,37%	0,18%	0,13%	99%
1.AA.4 Other sectors, N_2O	30,53	34,67	0,10%	0,10%	0,08%	99%
5.D. Wetlands, CO_2	72,73	56,47	0,17%	0,10%	0,07%	100%
1.AA.5 Other, CO_2	0,00	15,89	0,05%	0,09%	0,06%	100%
1.AA.3.E Natural gas transportation in pipelines, CO_2	88,08	58,49	0,17%	0,06%	0,05%	100%
5.A.1. Forest Land remaining Forest Land, N_2O	22,04	23,10	0,07%	0,06%	0,05%	100%
2.F Consumption of Halocarbons and SF_6, SF_6, 1995	0,05	10,70	0,03%	0,06%	0,04%	100%
1.B. Fugitive Emissions from Fuels, CO_2	1,05	9,48	0,03%	0,05%	0,04%	100%
1.AA.3.D Navigation, CO_2	15,45	17,13	0,05%	0,05%	0,04%	100%
1.AA.1 Energy industries, N_2O	23,41	20,55	0,06%	0,05%	0,03%	100%

2.C.1.2 Pig iron, CO_2	21,41	4,11	0,01%	0,04%	0,03%	100%
1.AA.3 Transport, CH_4	37,75	13,93	0,04%	0,03%	0,03%	100%
2.A.7 Mineral wool production, CO_2	6,28	8,32	0,02%	0,03%	0,02%	100%
4.B. Manure Management, cattle, CH_4	424,59	221,36	0,66%	0,03%	0,02%	100%
1.AA.1 Energy industries, CH_4	8,38	9,14	0,03%	0,03%	0,02%	100%
1.AA.3.A Civil aviation, CO_2	9,01	1,62	0,00%	0,02%	0,01%	100%
2.A.7 Glass Production, CO_2	13,25	4,16	0,01%	0,02%	0,01%	100%
2.A.3. Limestone and Dolomite Use, CO_2	4,48	0,03	0,00%	0,01%	0,01%	100%
2.A.4. Soda Ash Production and Use, CO_2	4,99	0,45	0,00%	0,01%	0,01%	100%
1.AA.3.C Railways, CO_2	349,94	185,14	0,55%	0,01%	0,01%	100%
4.B. Manure Management other, CH_4	2,63	2,70	0,01%	0,01%	0,01%	100%
4.A. Enteric Fermentation others, CH_4	1,37	1,66	0,00%	0,01%	0,00%	100%
6.C. Waste Incineration, CO_2	3,99	1,93	0,01%	0,00%	0,00%	100%
1.AA.5 Other, N_2O	0,00	0,15	0,00%	0,00%	0,00%	100%
5.A.1. Forest Land remaining Forest Land, CH_4	0,37	0,06	0,00%	0,00%	0,00%	100%
1.AA.2 Manufacturing and construction, CH_4	7,41	4,00	0,01%	0,00%	0,00%	100%
1.B. Fugitive Emissions from Fuels, N_2O	0,00	0,03	0,00%	0,00%	0,00%	100%
6.C. Waste Incineration, N_2O	0,17	0,11	0,00%	0,00%	0,00%	100%
1.AA.2 Manufacturing and construction, N_2O	11,09	5,90	0,02%	0,00%	0,00%	100%
1.AA.5 Other, CH_4	0,00	0,01	0,00%	0,00%	0,00%	100%
2.B.5.5 Methanol, CH_4	3,83	0,00	0,00%	0,00%	0,00%	100%
5.E Settlements, $CO_{2,}$ base year 1993	5301,21	0,00	0,00%	0,00%	0,00%	100%
5.F Other land, $CO_{2,}$ base year 1993	629,49	0,00	0,00%	0,00%	0,00%	100%

ANNEX II. Tier I Uncertainty evaluation

1. Uncertainty evaluation excluding LULUCF

IPCC Source category	Gas	Base year (1990) emissions*	Emissions in 2010	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2010	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: liquid fuel	CO_2	7.786,07	2.073,85	2	5	5,4	0,54	-0,024	0,042	-0,12	0,12	0,17
1A1 Energy Industries: solid fuel	CO_2	193,42	27,54	2	7	7,3	0,01	-0,001	0,001	-0,01	0,00	0,01
1A1 Energy Industries: gaseous fuel	CO_2	5.981,61	3.314,48	2	5	5,4	0,86	0,016	0,067	0,08	0,19	0,21
1A1 Energy Industries: biomass	CO_2			50	5	50,2	0,00	0,000	0,000	0,00	0,00	0,00
1A2 Manufacturing Industries	CO_2	5.954,99	1.110,26	2	7	7,3	0,39	-0,028	0,022	-0,20	0,06	0,21
1A3 Civil aviation	CO_2	9,01	1,62	10	2	10,2	0,00	0,000	0,000	0,00	0,00	0,00
1A3 Railways	CO_2	349,94	185,14	5	5	7,1	0,06	0,001	0,004	0,00	0,03	0,03
1A3 Navigation	CO_2	15,45	17,13	3	3	4,2	0,00	0,000	0,000	0,00	0,00	0,00
1A3 Mobile combustion: road transport	CO_2	5.247,18	4.077,13	2	2	2,8	0,55	0,038	0,082	0,08	0,23	0,25

1A3 Mobile combustion: other transport	CO_2	1853,58	215,14	5	5	7,1	0,07	-0,011	0,004	-0,06	0,03	0,06
1A4 Commercial/ Institutional	CO_2	2.892,87	377,52	5	5	7,1	0,13	-0,017	0,008	-0,08	0,05	0,10
1A4 Residential	CO_2	2.382,83	733,91	5	5	7,1	0,25	-0,005	0,015	-0,03	0,10	0,11
1B Fugitive Emissions from Fuels	CO_2	1,05	9,48	5	50	50,2	0,02	0,000	0,000	0,01	0,00	0,01
1A4 Agriculture/ Forestry/Fishing	CO_2	418,71	105,03	5	5	7,1	0,04	-0,001	0,002	-0,01	0,02	0,02
1A5 Other	CO_2		15,89	7	7	9,9	0,01	0,000	0,000	0,00	0,00	0,00
2A1 Cement Production	CO_2	1.668,07	289,05	2	5	5,4	0,07	-0,008	0,006	-0,04	0,02	0,04
2A2 Lime Production	CO_2	216,42	18,64	5	5	7,1	0,01	-0,001	0,000	-0,01	0,00	0,01
2A3 Limestone and dolomite use	CO_2	4,48	0,03	10	5	11,2	0,00	0,000	0,000	0,00	0,00	0,00
2A4 Soda ash use	CO_2	4,99	0,45	10	5	11,2	0,00	0,000	0,000	0,00	0,00	0,00
2A5 Asphalt roofing	CO_2	0,02	0,02	5	25	25,5	0,00	0,000	0,000	0,00	0,00	0,00
2A71 production	CO_2	13,25	4,16	7	5	8,6	0,00	0,000	0,000	0,00	0,00	0,00
2A72 Mineral wool production	CO_2	6,28	8,32	7	5	8,6	0,00	0,000	0,000	0,00	0,00	0,00
2A7.3 Bricks and tiles	CO_2	228,06	4,84	7	5	8,6	0,00	-0,002	0,000	-0,01	0,00	0,01
2B1 Ammonia production	CO_2	1.190,53	1.150,30	2	10	10,2	0,56	0,013	0,023	0,13	0,07	0,15
2.D.2 Food and drink	CO_2	9,32	8,25	5	5	7,1	0,00	0,000	0,000	0,00	0,00	0,00

2C12 Pig iron production	CO_2	21,41	4,11	4	10	10,8	0,00	0,000	0,000	0,00	0,00	0,00
3 Solvent and other product use	CO_2	100,50	89,25	30	20	36,1	0,15	0,001	0,002	0,02	0,08	0,08
6C Waste incineration	CO_2	3,99	1,93	30	30	42,4	0,00	0,000	0,000	0,00	0,00	0,00
Total	CO_2	**36.554,04**	**13.843,46**				**1,39**					**0,48**
1A1, 1A2 Energy: stationary combustion	CH_4	15,79	13,14	2	50	50,0	0,03	0,000	0,000	0,01	0,00	0,01
1A3 Civil aviation	CH_4	0,01	0,01	10	100	100,5	0,00	0,000	0,000	0,00	0,00	0,00
1A3 Energy: mobile combustion	CH_4	37,74	13,92	5	40	40,3	0,03	0,000	0,000	0,00	0,00	0,00
1A4 Energy: other sectors	CH_4	183,53	179,84	5	50	50,2	0,43	0,002	0,004	0,10	0,03	0,11
1A5 Other	CH_4		0,01	5	100	100,1	0,00	0,000	0,000	0,00	0,00	0,00
2B55 Methanol production	CH_4	3,83		5	30	30,4	0,00	0,000	0,000	0,00	0,00	0,00
1B Fugitive Emissions	CH_4	149,38	260,98	5	50	50,2	0,63	0,004	0,005	0,20	0,04	0,20
4A Enteric Fermentation	CH_4	3.238,89	1.194,95	5	30	30,4	1,75	-0,003	0,024	-0,10	0,17	0,20
4B Manure Management	CH_4	1.094,98	466,79	20	30	36,1	0,81	0,000	0,009	0,00	0,27	0,27
6A Solid Waste	CH_4	907,03	954,42	30	129	132,4	6,07	0,012	0,019	1,49	0,82	1,70
6B Wastewater Handling	CH_4	174,60	125,01	30	65	71,6	0,43	0,001	0,003	0,07	0,11	0,13
Total	CH_4	**5.805,78**	**3.209,06**				**6,43**					**1,76**
1A1, 1A2, 1A4 Energy: stationary combustion	N_2O	65,03	61,12	2	50	50,0	0,15	0,001	0,001	0,03	0,00	0,03
1A3 Civil aviation	N_2O	0,08	0,01	10	150	150,3	0,00	0,000	0,000	0,00	0,00	0,00

1A3 Energy: mobile combustion	N_2O	249,10	55,02	5	50	50,2	0,13	-0,001	0,001	-0,05	0,01	0,05
1A5 Other	N_2O		0,15	5	150	150,1	0,00	0,000	0,000	0,00	0,00	0,00
2B2 Nitric Acid Production	N_2O	928,99	578,04	2	10	10,2	0,28	0,004	0,012	0,04	0,03	0,05
3 Solvent and other product use	N_2O	97,11	3,37	30	20	36,1	0,01	-0,001	0,000	-0,02	0,00	0,02
4B Manure Management	N_2O	873,50	287,91	20	50	53,9	0,75	-0,002	0,006	-0,08	0,16	0,18
4D1 Direct Soil Emissions	N_2O	2.414,97	1.352,59	20	100	102,0	6,63	0,007	0,027	0,68	0,77	1,03
4D2 Pasture Range and Paddock	N_2O	485,56	203,85	20	100	102,0	1,00	0,000	0,004	0,00	0,12	0,12
4D3 Indirect Soil Emissions	N_2O	1.878,54	952,25	20	100	102,0	4,67	0,003	0,019	0,33	0,54	0,64
6B Wastewater Handling	N_2O	79,91	79,79	30	50	58,3	0,22	0,001	0,002	0,05	0,07	0,08
6C Waste incineration	N_2O	0,17	0,11	30	100	104,4	0,00	0,000	0,000	0,00	0,00	0,00
Total	N_2O	**7.072,96**	**3.574,20**				**8,21**					**1,23**
2F Consumption of halocarbons and SF_6		4,71	182,98	10	50	51,0	0,45	0,004	0,004	0,18	0,05	0,19
Total emissions		**49.437,49**	**20.809,71**				**10,53**					**2,21**

2. Uncertainty evaluation including LULUCF

IPCC Source category	Gas	Base year (1990) emissions* Gg CO_2 eq	Emissions in 2010 Gg CO_2 eq	Activity data uncertainty %	Emission factor uncertainty %	Combined uncertainty %	Combined uncertainty as % of total national emissions in 2010 %	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: liquid fuel	CO_2	7.786,07	2.073,85	2	5	5,4	1,25	0,011	0,048	0,05	0,14	0,15
1A1 Energy Industries: solid fuel	CO_2	193,42	27,54	2	7	7,3	0,02	0,000	0,001	0,00	0,00	0,00
1A1 Energy Industries: gaseous fuel	CO_2	5.981,61	3.314,48	2	5	5,4	2,00	0,048	0,077	0,24	0,22	0,32
1A1 Energy Industries: biomass	CO_2			50	5	50,2	0,00	0,000	0,000	0,00	0,00	0,00
1A2 Manufacturing Industries	CO_2	5.954,99	1.110,26	2	7	7,3	0,91	-0,003	0,026	-0,02	0,07	0,08
1.A.3 Civil aviation	CO_2	9,01	1,62	10	2	10,2	0,00	0,000	0,000	0,00	0,00	0,00
1.A.3 Railways	CO_2	349,94	185,14	5	5	7,1	0,15	0,003	0,004	0,01	0,03	0,03
1.A.3 Navigation	CO_2	15,45	17,13	3	3	4,2	0,01	0,000	0,000	0,00	0,00	0,00
1A3 Mobile combustion: road transport	CO_2	5.247,18	4.077,13	5	5	7,1	3,23	0,069	0,095	0,35	0,67	0,75
1A3 Mobile combustion: other transport	CO_2	1853,58	215,14	5	5	7,1	0,17	-0,004	0,005	-0,02	0,04	0,04
1A4 Commercial/Institutional	CO_2	2.892,87	377,52	5	5	7,1	0,30	-0,005	0,009	-0,03	0,06	0,07
1A4 Residential	CO_2	2.382,83	733,91	5	5	7,1	0,58	0,006	0,017	0,03	0,12	0,12

1A5 Other	CO_2		15,89	7	7	9,9	0,02	0,000	0,000	0,00	0,00	0,00
1.B. Fugitive Emissions from Fuels	CO_2	1,05	9,48	5	5	7,1	0,01	0,000	0,000	0,00	0,00	0,00
1A4 Agriculture/Forestry/Fishing	CO_2	418,71	105,03	5	5	7,1	0,08	0,000	0,002	0,00	0,02	0,02
2A1 Cement Production	CO_2	1.668,07	289,05	2	5	5,4	0,17	-0,001	0,007	-0,01	0,02	0,02
2A2 Lime Production	CO_2	216,42	18,64	5	5	7,1	0,01	-0,001	0,000	0,00	0,00	0,00
2A3 Limestone and dolomite use	CO_2	4,48	0,03	10	5	11,2	0,00	0,000	0,000	0,00	0,00	0,00
2A4 Soda ash use	CO_2	4,99	0,45	10	5	11,2	0,00	0,000	0,000	0,00	0,00	0,00
2.A.5 Asphalt roofing	CO_2	0,02	0,02	5	25	25,5	0,00	0,000	0,000	0,00	0,00	0,00
2A7.1Glass production	CO_2	13,25	4,16	7	5	8,6	0,00	0,000	0,000	0,00	0,00	0,00
2A7.2 Mineral wool production	CO_2	6,28	8,32	7	5	8,6	0,01	0,000	0,000	0,00	0,00	0,00
2A7.3 Bricks and tiles	CO_2	228,06	4,84	5	5	7,1	0,00	-0,001	0,000	0,00	0,00	0,00
2B1 Ammonia production	CO_2	1.190,53	1.150,30	2	10	10,2	1,32	0,021	0,027	0,21	0,08	0,22
2.D.2 Food and drink	CO_2	9,32	8,25	5	5	7,1	0,01	0,000	0,000	0,00	0,00	0,00
2.C.1.2 Cast iron production	CO_2	21,41	4,11	5	10	11,2	0,01	0,000	0,000	0,00	0,00	0,00
3 Solvent and other product use	CO_2	100,50	89,25	30	20	36,1	0,36	0,002	0,002	0,03	0,09	0,09
5.A.1. Forest Land remaining Forest Land	CO_2	-6950,77	-11873,87	1	5	5,1	-6,79	-0,242	-0,275	-1,21	-0,39	1,27
5.A.2. Land converted to Forest Land	CO_2	-256,72	-429,76	25	10	26,9	-1,30	-0,009	-0,010	-0,09	-0,35	0,36
5.B. Cropland	CO_2	354,81	-30,28	1	90	90,0	-0,31	-0,002	-0,001	-0,22	0,00	0,22

5.C. Grassland	CO_2	461,51	535,50	1	90	90,0	5,41	0,010	0,012	0,92	0,02	0,92
5.D. Wetlands	CO_2	72,73	56,47	80	20	82,5	0,52	0,001	0,001	0,02	0,15	0,15
6C Waste incineration	CO_2	3,99	1,93	30	30	42,4	0,01	0,000	0,000	0,00	0,00	0,00
Total	CO_2	**30.235,60**	**2.101,52**				**9,83**					**1,86**
1A1, 1A2 Energy: stationary combustion	CH_4	15,79	13,14	2	50	50,0	0,07	0,000	0,000	0,01	0,00	0,01
1.A.3 Civil aviation	CH_4	0,01	0,01	10	100	100,5	0,00	0,000	0,000	0,00	0,00	0,00
1A3 Energy: mobile combustion	CH_4	37,74	13,92	5	40	40,3	0,06	0,000	0,000	0,01	0,00	0,01
1A4 Energy: other sectors	CH_4	183,53	179,84	5	50	50,2	1,01	0,003	0,004	0,16	0,03	0,17
1.A.5 Other	CH_4		0,01	7	50	50,5	0,00	0,000	0,000	0,00	0,00	0,00
2.B.5.5 Methanol production	CH_4	3,83		5	30	30,4	0,00	0,000	0,000	0,00	0,00	0,00
1B Fugitive Emissions	CH_4	149,38	260,98	5	15	15,8	0,46	0,005	0,006	0,08	0,04	0,09
4A Enteric Fermentation	CH_4	3.238,89	1.194,95	2	30	30,1	4,03	0,012	0,028	0,37	0,08	0,37
4B Manure Management	CH_4	1.094,98	466,79	20	20	28,3	1,48	0,006	0,011	0,11	0,31	0,33
5.A.1. Forest Land remaining Forest Land	CH_4	0,37	0,06	1	70	70,0	0,00	0,000	0,000	0,00	0,00	0,00
5.B. Cropland	CH_4	0,07	0,04	1	70	70,0	0,00	0,000	0,000	0,00	0,00	0,00
5.C. Grassland		1,78	0,93	1	70	70,0	0,01	0,000	0,000	0,00	0,00	0,00
6A Solid Waste	CH_4	907,03	954,42	30	129	132,4	14,18	0,018	0,022	2,29	0,94	2,48
6B Wastewater Handling	CH_4	174,60	125,01	30	65	71,6	1,00	0,002	0,003	0,13	0,12	0,18
Total	CH_4	**5.808,01**	**3.210,10**				**14,90**					**2,54**

1A1, 1A2, 1A4 Energy: stationary combustion	N_2O	65,03	61,12	2	50	50,0	0,34	0,001	0,001	0,06	0,00	0,06
1.A.3 Civil aviation	N_2O	0,08	0,01	10	150	150,3	0,00	0,000	0,000	0,00	0,00	0,00
1A3 Energy: mobile combustion	N_2O	249,10	55,02	5	50	50,2	0,31	0,000	0,001	0,00	0,01	0,01
1A5 Other	N_2O		0,15	7	50	50,5	0,00	0,000	0,000	0,00	0,00	0,00
2B2 Nitric Acid Production	N_2O	928,99	578,04	2	25	25,1	1,63	0,009	0,013	0,22	0,04	0,23
3 Solvent and other product use	N_2O	97,11	3,37	30	20	36,1	0,01	0,000	0,000	-0,01	0,00	0,01
4B Manure Management	N_2O	873,50	287,91	20	50	53,9	1,74	0,002	0,007	0,12	0,19	0,23
4D1 Direct Soil Emissions	N_2O	2.414,97	1.352,59	20	100	102,0	15,48	0,020	0,031	1,98	0,89	2,17
4D2 Pasture Range and Paddock	N_2O	485,56	203,85	20	100	102,0	2,33	0,002	0,005	0,24	0,13	0,27
4D3 Indirect Soil Emissions	N_2O	1.878,54	952,25	20	100	102,0	10,90	0,013	0,022	1,31	0,62	1,45
5.A.1. Forest Land remaining Forest Land	N_2O	22,04	23,10	1	70	70,0	0,18	0,000	0,001	0,03	0,00	0,03
5.B. Cropland	N_2O	0,17	1,98	1	70	70,0	0,02	0,000	0,000	0,00	0,00	0,00
5.C. Grassland	N_2O	2,40	1,25	1	70	70,0	0,01	0,000	0,000	0,00	0,00	0,00
6B Wastewater Handling	N_2O	79,91	79,79	30	50	58,3	0,52	0,001	0,002	0,07	0,08	0,11
6C Waste incineration	N_2O	0,17	0,11	30	100	104,4	0,00	0,000	0,000	0,00	0,00	0,00
Total	N_2O	**7.097,57**	**3.600,54**				**19,23**					**2,64**
2.F Consumption of halocarbons and SF6		4,71	182,98	5	50	50,2	1,03	0,004	0,004	0,21	0,03	0,21
Total emissions		**43.141,17**	**8.912,15**				**26,26**					**4,12**

* 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	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	502	5358	13491	20081	18504	16307	12872	9217	7718	6595	5465	4918	4909
Biofuel blended	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Import	396707	131189	199709	272070	261120	299997	372149	380035	349532	203786	390555	358659	385276
Export	,,	335	13254	14957	5288	12305	8212	6312	4907	6649	5512	4831	4736
Changes in stocks	4563	-4730	-1169	1955	1534	-1167	-7472	9169	-10033	-890	4826	904	-1081
Gross inland consumption	401772	131482	198777	279149	275870	302832	369337	392109	342310	202842	395334	359650	384368
Statistical difference	,,	-42	,,	-44	,,	,,	,,	,,	,,	,,	,,	,,	,,
Transformed in power, heat and other plants:	401772	131440	198777	279101	275870	302815	369309	392101	342307	202835	395334	359631	384357
- in heat plants	84	167	99	72	49	38	,,	,,	,,	,,	,,	,,	,,
- in other industries	401688	131273	198678	279029	275821	302777	369309	392101	342307	202835	395334	359631	384357
Consumed in energy sector, total:	,,	,,	,,	,,	,,	,,	5	3	3	3	,,	,,	,,
- in refineries	,,	,,	,,	,,	,,	,,	5	3	3	3	,,	,,	,,
Distribution and transmission losses	,,	,,	,,	4	,,	17	23	5	,,	4	,,	19	11

Table 2. Balance of motor gasoline, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	87988	37709	68838	84279	77453	85113	105530	112699	98505	72271	123381	119393	123626
Biofuel blended	,,	,,	,,	,,	,,	,,	3	35	219	471	714	655	445
Import	220	14328	736	1068	36	65	146	1115	3836	376	303	405	2616
Export	42104	23601	50765	69672	61362	68707	90618	95698	89376	54162	104168	105355	114237
Changes in stocks	-2725	-1758	-2012	739	-322	-517	111	-3193	2700	275	-1087	982	506
Gross inland consumption	43379	26678	16797	16414	15805	15954	15172	14958	15884	19231	19143	16080	12956
Statistical difference	,,	,,	,,	,,	132	,,	,,	,,	,,	,,	,,	,,	,,
Consumed in energy sector, total:	,,	,,	15	9	10	5	3	4	3	,,	,,	,,	,,
- in peat mining enterprises	,,	,,	,,	,,	5	3	2	1	1	,,	,,	,,	,,
- in electricity, gas, steam and air conditioning enterprises	,,	,,	15	9	5	2	1	3	2	,,	,,	,,	,,
Distribution and transmission losses	308	176	68	51	46	130	45	61	71	33	29	27	22
Final consumption:	43071	26502	16714	16354	15881	15819	15124	14893	15810	19198	19114	16053	12934
- in industry	44	88	48	15	16	28	21	31	30	21	28	18	15
- in construction	439	176	101	53	42	42	45	69	56	47	50	34	28
- in transport	41840	25887	16337	16169	15710	15662	14973	14721	15652	19058	18965	15948	12841
- in agriculture	440	307	170	91	93	78	70	53	59	62	52	41	43
- in commercial / public services	308	44	58	26	20	9	15	19	13	10	19	12	7

Table 3. Balance of aviation gasoline, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Import	,,	,,	14	22	22	22	22	20	20	22	23	17	18
Gross inland consumption	,,	,,	14	22	22	22	22	20	20	22	23	18	18
Final consumption:	,,	,,	14	22	22	22	22	20	20	22	23	18	18
- in transport	,,	,,	14	22	22	22	22	20	20	22	23	18	18

Table 4. Balance of gasoline type jet fuel, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	,,	,,	,,	,,	,,	,,	,,	,,	,,	-36	-14	,,	,,
Biofuel blended	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Import	,,	,,	65	917	637	379	972	3	22	,,	,,	,,	,,
Export	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	5	,,
Changes in stocks	,,	,,	-65	36	-3	17	16	,,	-22	10	9	5	,,
Gross inland consumption	,,	,,	,,	953	634	396	988	3	,,	,,	,,	,,	,,
Final consumption:	,,	,,	,,	953	634	396	988	3	,,	,,	,,	,,	,,
- in transport				953	634	396	988	3					

Table 5. Balance of kerosene type jet fuel, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	28125	9088	18566	19886	21183	18163	23874	24705	23467	6495	20850	9668	10352
Import	387	948	846	198	443	704	,,	,,	584	669	,,	5	837
Export	22956	8442	16673	21130	20879	17951	23507	21406	22091	4669	17443	8090	9062
Changes in stocks	86	129	-1651	1529	-116	57	287	-1185	419	502	-11	117	115
Gross inland consumption	5642	1723	1088	483	631	973	654	2114	2379	2997	3396	1700	2242
Distribution and transmission losses	,,	,,	,,	,,	,,	7	13	14	14	4	12	4	5
Final consumption:	5642	1723	1088	483	631	966	641	2100	2365	2993	3384	1696	2237
- in industry	,,	,,	2	5	5	5	,,	,,	,,	,,	,,	,,	,,
- in transport	5642	1723	1078	478	626	961	641	2100	2365	2993	3384	1696	2237
- in households	,,	,,	3	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,

Table 6. Balance of transport diesel, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	107712	42490	56232	88234	86164	99692	120024	127985	103670	78465	135302	134283	150168
Biofuel blended	,,	,,	,,	,,	,,	,,	,,	119	589	1748	2127	1597	1478
Import	8923	10198	1670	3020	2127	754	4376	2840	3113	11877	7336	5127	7882
Export	49416	27364	28516	61774	59932	70619	93286	92877	69973	43895	94200	103262	116251
International marine bunkers	,,	,,	942	894	935	,,	,,	,,	,,	,,	,,	,,	,,
Changes in stocks	-1997	850	-4819	-1048	1226	-1391	1142	-2586	724	-1773	-2979	661	31
Gross inland consumption	65222	26174	23625	27538	28650	28436	32285	35481	38123	46422	47586	38406	43308
Statistical difference	,,	213	853	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Transformed in power, heat and other plants:	7521	1742	36	16	15	7	,,	,,	,,	,,	,,	,,	,,
- in heat plants	7521	1742	36	16	15	7	,,	,,	,,	,,	,,	,,	,,
Consumed in energy sector, total:	128	43	136	152	176	153	125	194	174	127	140	167	144
- in peat mining enterprises	128	43	60	56	89	86	83	125	110	93	110	131	109
- in crude oil extraction enterprises	,,	,,	22	46	32	29	27	49	44	24	20	25	23
- in refineries	,,	,,	5	11	11	8	,,	,,	2	2	,,	,,	,,
- in electricity, gas, steam and air conditioning enterprises	,,	,,	49	39	44	30	15	20	18	8	10	11	12
Non-energy use	,,	,,	6	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Distribution and transmission losses	297	128	55	24	24	58	58	122	89	74	80	69	73
Final consumption:	57276	24474	24245	27346	28435	28218	32102	35165	37860	46221	47366	38170	43091
- in industry	2124	1827	510	471	321	331	381	499	453	378	263	196	190
- in construction	2507	935	613	534	565	547	495	589	601	615	670	367	382
- in transport	34289	14489	21476	24894	25976	25882	29721	32515	35362	43721	44808	36197	41030
- in agriculture	14277	4207	1327	1253	1384	1385	1335	1362	1325	1429	1487	1354	1444
- in fishing	,,	,,	,,	,,	,,	,,	,,	14	7	4	4	7	5
- in commercial / public services	2889	2804	319	194	189	73	170	186	112	74	134	52	40
- in households	1190	212	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,

Table 7. Balance of heating and other gasoil, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	,,	,,	,,	,,	43	356	609	2125	1824	1033	1155	932	1130
Biofuel blended	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	3	2
Import	,,	717	,,	,,	37	905	899	915	818	660	585	617	854
Export	,,	,,	,,	,,	,,	,,	,,	985	1075	192	108	9	,,
International marine bunkers	,,	,,	,,	,,	12	746	859	770	637	617	617	693	756
Changes in stocks	,,	-717	65	23	-16	-22	-51	-225	-17	-48	-45	28	-7
Gross inland consumption	,,	,,	65	23	52	493	598	1060	913	836	970	878	1223
Transformed in power, heat and other plants:	,,	,,	22	8	14	67	44	102	26	33	30	33	55
- in heat plants	,,	,,	22	8	14	67	44	102	26	33	30	33	55

Distribution and transmission losses	,,	,,	,,	,,	,,	,,	,,	,,	8	,,	,,	,,	,,
Final consumption:	,,	,,	43	15	38	426	554	958	879	803	940	845	1163
- in industry	,,	,,	7	6	13	98	127	405	240	198	233	188	220
- in construction	,,	,,	7		5	15	30	25	22	31	33	26	47
- in transport	,,	,,	,,	,,	,,	175	230	226	247	235	251	214	235
- in agriculture	,,	,,	23	5	8	43	118	137	122	153	174	167	230
- in fishing	,,	,,	,,	,,	,,	,,	,,	59	157	108	101	79	73
- in commercial and public services	,,	,,	6	4	12	68	38	55	53	58	77	57	69
- in households	,,	,,	,,	,,	,,	27	11	51	38	20	71	111	289

Table 8. Balance of liquefied petroleum gases (LPG), TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	12006	7636	11026	19565	19104	17662	21146	21046	18812	13254	18439	12679	12720
Biofuel blended	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Import	2208	1056	3972	2436	1858	3433	3319	3110	4182	5621	3725	4008	5024
Export	7038	4646	5793	13196	11286	10171	12460	11596	10235	6928	11363	7183	8114
International marine bunkers	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Changes in stocks	46	230	-420	42	222	-159	21	163	-59	-44	-74	231	-111
Gross inland consumption	7222	4276	8785	8847	9898	10765	12026	12723	12700	11903	10727	9735	9519
Statistical difference	,,	,,	,,	41	,,	,,	,,	,,	,,	,,	,,	,,	,,
Transformed in power, heat and other plants:	46	,,	51	58	60	78	94	92	101	80	78	88	90
- in power plants	,,	,,	,,	,,	,,	,,	,,	2	,,	,,	,,	1	3
- in heat plants	46	,,	51	58	60	78	94	90	101	80	78	87	87
Consumed in energy sector, total:	552	138	36	5	6	5	18	4	2	3	,,	,,	,,
- in refineries	552	138	22	,,	,,	,,	6	,,	,,	2	,,	,,	,,
- in electricity, gas, steam and air conditioning enterprises	,,	,,	14	5	6	5	12	4	2	1	,,	,,	,,
Distribution and transmission losses	322	92	103	39	42	39	42	47	47	38	32	39	26
Final consumption:	6302	4046	8595	8786	9790	10643	11872	12580	12550	11782	10617	9608	9403
- in industry	,,	,,	201	179	169	158	176	229	292	324	292	250	273
- in construction	92	46	74	64	79	82	95	77	93	94	133	98	122
- in transport	920	1058	5032	5272	6378	7332	8857	9593	9810	9708	8615	7681	7554
- in agriculture	230	46	19	13	15	29	37	38	41	43	43	46	41
- in fishing	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
- in commercial /public services	460	92	62	36	19	26	22	23	22	22	16	8	6
- in households	4600	2804	3207	3222	3130	3016	2685	2620	2292	1591	1518	1525	1407

Table 9. Balance of fuel oil – high sulphur (>1%), TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	133867	33356	40780	39422	53574	49329	55283	66969	71994	77669	55489	77691	66771
Biofuel blended	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Import	293464	47887	12594	4110	2704	3743	3919	5343	5056	4860	3748	3059	6288
Export	277769	8148	10915	16608	25555	29685	39133	53824	56627	66524	44361	68981	56675
International marine bunkers	3894	5780	1999	2857	3031	3290	3330	3564	4712	4471	3622	2878	4017
Changes in stocks	-8951	-11159	7237	-4689	-51	2991	-1155	-662	-1824	2202	-24	3526	1110
Gross inland consumption	136717	56156	47797	19378	27641	23088	15584	14262	13887	13736	11230	12417	13477
Statistical difference	,,	40	40	5592	,,	120	,,	,,	,,	,,	,,	,,	,,
Transformed in power, heat and other plants:	70406	39377	35023	14650	16485	13918	8928	6698	5536	6668	3439	3941	6168
- in power plants	44837	20712	20830	7260	7566	7482	5157	4461	3837	5202	2066	3370	5586
- in heat plants	25569	18665	14193	7390	8919	6436	3771	2237	1699	1466	1373	571	582
Consumed in energy sector, total:	8068	3693	4878	4899	6115	6096	5159	5815	6716	5746	7474	8158	7165
- in refineries	8068	3693	4878	4899	6115	6096	5159	5815	6716	5746	7474	8158	7165
Distribution and transmission losses	361	,,	,,	,,	,,	,,	,,	,,	38	3	2	4	,,
Final consumption:	57882	13126	7836	5421	5041	3194	1497	1749	1597	1319	315	314	144
- in industry	43993	11520	6876	5202	4849	3007	1308	1620	1486	1238	241	245	140
- in construction	1044	201	80	11	22	34	17	13	17	14	9	9	,,
- in transport	,,	,,	,,	3	3	,,	4	3	4	10	6	4	4
- in agriculture	1084	201	280	114	97	95	94	78	80	50	44	35	
- in fishing	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
- in commercial / public services	11641	1204	600	91	70	58	74	35	10	7	15	21	,,
- in households	120	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,

Table 10. Balance of fuel oil – low sulphur (<1%), TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	,,	,,	,,	,,	,,	,,	43	,,	,,	,,	-221	21	170
Import			1407	1199	950	1052	991	1191	1105	1634	1821	1123	2779
Export	,,	,,	,,	,,	,,	,,	43	23	,,	2	,,	6	40
International marine bunkers	,,	,,	29	187	317	456	269	451	573	705	227	575	2224
Changes in stocks	,,	,,	56	71	58	-29	-144	-60	23	-266	-535	331	-218
Gross inland consumption	,,	,,	1434	1083	691	567	578	657	555	661	838	894	467
Transformed in power, heat and other plants:	,,	,,	755	778	465	247	293	328	468	296	560	664	215
- in power plants	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	292	377	18
- in heat plants	,,	,,	755	778	465	247	293	328	468	296	268	286	197
Final consumption:	,,	,,	679	305	226	320	285	329	87	360	278	231	252
- in industry	,,	,,	363	166	67	124	188	220	40	241	162	153	147
- in construction	,,	,,	47	44	59	76	66	93	38	87	100	54	75
- in transport	,,	,,	,,	,,	,,	,,	,,	,,	4	3	4	7	,,
- in agriculture	,,	,,	15	21	9	3	3	2	2	13	5	4	5

- in fishing	,,	,,	,,	,,	,,	,,	,,	9	,,	,,	,,	,,	,,
- in commercial / public services	,,	,,	254	74	91	117	28	5	3	16	7	13	25

Table 11. Balance of refinery gas (not liquefied), TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	11032	5318	8253	10973	12028	12922	14936	15250	12884	9409	14029	13418	14127
Biofuel blended	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Gross inland consumption	11032	5318	8253	10973	12028	12922	14936	15250	12884	9409	14029	13418	14127
Transformed in power, heat and other plants:	,,	,,	,,	,,	,,	,,	,,	,,	,,	71	92	88	109
- in heat plants	,,	,,	,,	,,	,,	,,	,,	,,	,,	71	92	88	109
Consumed in energy sector, total:	11032	5318	8253	10973	12028	12922	14936	15250	12884	9338	13937	13330	14018
- in refineries	11032	5318	8253	10973	12028	12922	14936	15250	12884	9338	13937	13330	14018

Table 12. Balance of bitumen, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	9534	1108	3117	2646	3989	4344	5578	6804	6421	3957	5829	4576	4938
Biofuel blended	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Import	40	791	474	626	1176	897	1424	1150	1836	3965	3321	828	1814
Export	1662	356	839	738	1588	1174	1800	2587	2746	1729	2884	2359	2896
Changes in stocks	40	39	71	-50	-218	185	-64	28	-35	-155	176	110	-165
Gross inland consumption	7952	1582	2823	2484	3359	4252	5138	5395	5476	6038	6442	3155	3691
Non-energy use	7952	1582	2823	2484	3359	4252	5138	5395	5476	6038	6442	3155	3691

Table 13. Balance of lubricants, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	,,	,,	1226	659	792	849	816	847	931	1093	1218	1257	1504
Import	413	620	602	834	1085	910	955	1121	1296	1252	1175	1150	1709
Export	,,	,,	924	483	580	691	718	843	1113	1352	1444	1711	2350
International marine bunkers	,,	,,	,,	,,	,,	,,	,,	,,	12	,,	,,	,,	,,
Changes in stocks	,,	,,	129	4	-168	36	92	-14	-53	16	39	58	-17
Gross inland consumption	413	620	1033	1014	1129	1104	1145	1111	1049	1009	988	754	846
Statistical difference	,,	,,	-84	,,	42	,,	,,	,,	,,	,,	,,	,,	,,
Non-energy use	413	620	949	1014	1171	1104	1145	1111	1049	1009	988	754	846

Table 14. Balance of petroleum coke, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	1962	1393	2740	3422	3039	3144	3831	3940	3345	3199	4113	3892	3856
Biofuel blended	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Import	,,	,,	,,	,,	,,	,,	32	1100	,,	,,	1006	,,	9
Changes in stocks	,,	,,	,,	,,	,,	,,	-15	-1054	325	793	-788	685	102
Gross inland consumption	1962	1393	2740	3422	3039	3144	3848	3986	3670	3992	4331	4577	3967
Consumed in energy sector,	1962	1393	2740	3422	3039	3144	3831	3940	3345	3199	4113	3892	3856

total:													
- in refineries	1962	1393	2740	3422	3039	3144	3831	3940	3345	3199	4113	3892	3856
Final consumption:	„	„	„	„	„	„	17	46	325	793	218	685	111
- in industry	„	„	„	„	„	„	17	46	325	793	218	685	111

Table 15. Balance of refinery feedstock, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	2524	8513	418	493	615	1124	850	1827	1108	34	370	126	0
Import	1304	17209	13934	9761	5740	3623	1274	3568	13464	44038	13120	12327	12171
Changes in stocks	-3744	-8470	213	3584	667	-379	-189	-1121	-1335	663	152	670	614
Gross inland consumption	84	17252	14565	13838	7022	4368	1935	4274	13237	44735	13642	13123	12785
Statistical difference	„	-43	„	„	-126	„	„	„	„	„	„	„	„
Transformed in power, heat and other plants:	84	17209	14565	13838	6896	4368	1935	4274	13237	44735	13642	13123	12785
- in other industries	84	17209	14565	13838	6896	4368	1935	4274	13237	44735	13642	13123	12785

Table 16. Balance of naphtha, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	„	„	„	4103	6190	5379	3935	3477	2436	2071	1890	2031	„
Biofuel blended	„	„	„	„	„	„	„	„	„	„	„	„	„
Import	„	„	„	„	„	„	„	„	„	„	„	„	„
Export	„	„	„	4103	6190	5379	3935	3257	2656	2071	1890	2031	„
Changes in stocks	„	„	„	„	„	„	„	-220	220	„	„	„	„

Table 17. Balance of orimulsion, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Import	„	729	1383	1308	664	1661	1727	1681	1655	„	„	„	„
Changes in stocks	„	„	-734	-81	787	-1074	-194	700	-461	1508	40	„	„
Gross inland consumption	„	729	649	1227	1451	587	1533	2381	1194	1508	40	„	„
Transformed in power, heat and other plants:	„	729	649	1227	1451	587	1533	2381	1194	1508	40	„	„
- in power plants	„	729	649	1227	1451	587	1533	2381	1194	1508	40	„	„

Table 18. Balance of shale oil, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	„	„	„	„	„	„	-4	„	„	„	„	„	„
Import	„	„	„	„	„	„	55	73	90	81	172	103	19
Export	„	„	„	„	„	„	„	„	„	„	77	36	18
Changes in stocks	„	„	„	„	„	„	1	-7	-2	-7	-9	-7	31
Gross inland consumption	„	„	„	„	„	„	52	66	88	73	86	60	32
Transformed in power, heat and	„	„	„	„	„	„	16	9	29	18	8	9	10

other plants:													
- in heat plants	„	„	„	„	„	„	16	9	29	18	8	9	10
Consumed in energy sector, total:	„	„	„	„	„	„	„	„	„	„	7	„	„
- in electricity, gas, steam and air conditioning enterprises	„	„	„	„	„	„	„	„	„	„	7	„	„
Final consumption:	„	„	„	„	„	„	36	57	59	55	71	51	22
- in industry	„	„	„	„	„	„	5	13	40	22	27	„	„
- in agriculture	„	„	„	„	„	„	20	23	„	4	8	15	4
- in commercial / public services	„	„	„	„	„	„	11	21	19	29	36	36	18
- in households	„	„	„	„	„	„	„	„	„	„	„	„	„

Table 19. Balance of hard coal, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Import	31752	6506	3261	2656	5589	7401	6642	7374	9891	9089	9611	5402	8027
Export	„	50	„	„	„	„	12	41	78	201	216	424	888
Changes in stocks	980	2889	13	245	-299	-596	-26	-186	127	641	-1254	1116	525
Gross inland consumption	32732	9345	3274	2901	5290	6805	6604	7147	9940	9529	8141	6094	7664
Transformed in power, heat and other plants:	1834	452	291	323	274	302	287	282	277	246	206	139	166
- in heat plants	1834	452	291	323	274	302	287	282	277	246	206	139	166
Non-energy use	„	25	8	10	6	5	2	3	„	„	„	„	„
Distribution and transmission losses	„	25	12	11	24	26	9	7	19	13	8	11	9
Final consumption:	30898	8843	2957	2557	4986	6472	6306	6855	9644	9270	7927	5944	7489
- in industry	1583	703	142	110	1970	3207	3240	3385	4900	5100	4511	2373	3094
- in construction	226	25	14	13	14	25	14	20	26	19	12	5	6
- in transport	„	„	„	„	„	„	„	„	„	„	„	„	„
- in agriculture	1557	50	15	14	15	39	30	40	55	21	17	15	15
- in commercial / public services	12359	6632	2065	1668	2010	2035	1960	2251	3056	2271	1602	1957	2107
- in households	15173	1433	721	752	977	1166	1062	1159	1607	1859	1785	1594	2267

Table 20. Balance of coke, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	„	„	„	„	„	„	„	„	„	„	„	„	„
Biofuel blended	„	„	„	„	„	„	„	„	„	„	„	„	„
Import			445	327	415	417	447	440	786	712	456	294	466
Changes in stocks	„	„	-52	57	-38	7	-42	96	-69	-2	31	27	7
Gross inland consumption	„	„	393	384	377	419	405	536	717	710	487	321	473
Non-energy use	„	„	47	80	60	52	46	2	„	„	„	„	„
Distribution and transmission losses	„	„	„	„	15	7	„	„	„	„	„	„	„
Final consumption:	„	„	346	304	302	360	359	534	717	710	487	321	473
- in industry	„	„	346	304	302	360	359	534	717	710	487	321	473

Table 21. Balance of lignite/brown coal, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Import	,,	,,	15	9	4	3	17	40	36	,,	1	,,	14
Changes in stocks	,,	,,	1	14	5	,,	3	2	4	3	,,	,,	-6
Gross inland consumption	,,	,,	16	23	9	3	20	42	40	3	1	,,	8
Final consumption:	,,	,,	16	23	9	3	20	42	40	3	1	,,	8
- in commercial / public services	,,	,,	16	23	9	3	9	25	28	2	1	,,	,,
- in households	,,	,,	,,	,,	,,	,,	11	17	12	1	,,	,,	8

Table 22. Balance of peat, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	580	600	494	414	584	537	583	825	640	616	790	616	364
Export	,,	,,	76	73	,,	112	59	1	36	14	59	81	104
Changes in stocks	116	222	51	124	-113	153	26	-235	-60	182	-282	-159	94
Gross inland consumption	696	822	469	465	471	578	550	589	550	784	449	376	354
Transformed in power, heat and other plants:	445	357	258	258	288	334	377	299	380	688	345	285	202
- in power plants	,,	,,	,,	,,	,,	,,	,,	,,	22	302	6	1	,,
- in heat plants	106	106	95	102	107	109	133	128	133	189	111	135	102
- in geothermal plants	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
- in other industries	339	251	163	156	181	225	244	171	225	197	228	149	100
Consumed in energy sector, total:	,,	126	36	48	10	41	5	11	7	3	,,	,,	,,
- in peat mining enterprises	,,	,,	20	12	9	2	4	11	5	3	,,	,,	,,
- in electricity, gas, steam and air conditioning enterprises	,,	126	15	36	1	39	1	,,	2	,,	,,	,,	,,
Distribution and transmission losses	9	10	5	2	,,	36	22	7	,,	24	,,	,,	,,
Final consumption:	242	329	170	157	173	167	146	272	163	69	104	91	152
- in industry	155	174	43	35	12	13	7	7	3	5	6	5	9
- in commercial / public services	87	58	,,	,,	,,	,,	,,	21	15	10	26	24	44
- in households	,,	97	127	122	161	154	139	244	145	54	72	62	99

Table 23. Balance of peat briquettes, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	264	205	152	138	162	227	226	166	212	194	227	144	95
Biofuel blended	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Import	,,	132	2	,,	,,	39	57	161	217	120	104	49	83
Export	,,	,,	,,	,,	,,	,,	,,	,,	,,	2	2	1	,,
Changes in stocks	-59	-15	-1	9	4	-2		-39	2	-1	-19	42	9
Gross inland consumption	205	322	153	147	166	264	283	288	431	311	310	234	187

Transformed in power, heat and other plants:	,,	,,	,,	3	4	14	3	11	3	,,	6	15	4
- in power plants	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
- in heat plants	,,	,,	,,	3	4	14	3	11	3	,,	6	15	4
Consumed in energy sector, total:	,,	,,	2	6	3	7	,,	,,	,,	,,	,,	,,	,,
- in peat mining enterprises	,,	,,	2	1	1	1	,,	,,	,,	,,	,,	,,	,,
- in electricity, gas, steam and air conditioning enterprises	,,	,,	,,	5	2	6	,,	,,	,,	,,	,,	,,	,,
Distribution and transmission losses	,,	,,	,,	,,	,,	,,	,,	,,	1	,,	,,	,,	,,
Final consumption:	205	322	151	138	159	243	280	277	427	311	304	219	183
- in industry	15	59	,,	,,	1	4	8	9	12	20	18	8	4
- in construction	,,	,,	,,	,,	,,	,,	,,	,,	,,	1	,,	,,	,,
- in transport	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
- in agriculture	,,	,,	,,	,,	,,	,,	,,	3	3	11	7	5	3
- in fishing	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
- in commercial / public services	29	59	1	3	2		46	32	43	48	42	25	14
- in households	161	204	150	135	156	239	226	233	369	231	237	181	162

Table 24. Balance of paraffin and waxes, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Import	,,	,,	,,	60	60	72	168	176	151	165	249	295	520
Export	,,	,,	,,	,,	,,	,,	78	106	101	79	153	204	384
Changes in stocks	,,	,,	,,	,,	,,	,,	,,	,,	4	-1	,,	2	3
Gross inland consumption	,,	,,	,,	60	60	72	90	70	54	85	96	93	139
Non-energy use	,,	,,	,,	60	60	72	90	70	54	85	96	93	139

Table 25. Balance of natural gas, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Import	201957	84929	86453	89806	90787	98605	98083	104363	103830	124570	104651	91655	104017
Export	6102	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
Changes in stocks	,,	,,	-37	57	73	-47	225	-671	-1081	-3501	4022	-326	304
Gross inland consumption	195855	84929	86416	89863	90860	98558	98308	103692	102749	121069	108673	91329	104321
Transformed in power, heat and other plants:	105124	41480	47241	46663	46856	53350	54192	57134	53699	50067	45905	45311	58186
- in power plants	64612	18137	29974	32194	30818	36530	40729	43691	40919	37444	34794	35367	46758
- in heat plants	40512	23343	16960	14105	15054	15550	12126	12086	11969	12508	10780	9339	11083
- in geothermal plants	,,	,,	,,	,,	531	759	752	819	420	90	30	503	345
- in other industries	,,	,,	307	364	453	511	585	538	391	25	301	102	,,

Consumed in energy sector, total:	,,	,,	140	134	134	130	129	130	100	99	98	72	65
- in crude oil extraction enterprises	,,	,,	3	3	3	3	3	3	3	3	2	2	3
- in refineries	,,	,,	28	28	29	28	27	28	5	5	1	6	4
- in electricity, gas, steam and air conditioning enterprises	,,	,,	109	103	102	99	99	99	92	91	95	64	58
Non-energy use	26934	20167	22716	25510	25309	25670	22632	24288	25024	46416	39254	24153	22309
Distribution and transmission losses	1688	1935	1119	1035	635	997	884	420	69	30	,,	4	5
Final consumption:	62109	21347	15200	16521	17926	18411	20471	21720	23857	24457	23416	21789	23756
- in industry	36065	8916	8285	8811	9794	9983	10874	11620	12455	11819	11326	10540	11500
- in construction	1030	219	266	279	366	410	493	513	611	655	677	424	501
- in transport	,,	,,	,,	338	375	322	323	647	1092	1145	1004	1015	1028
- in agriculture	2946	1197	991	1170	1169	1104	1291	1192	1581	1653	1431	1132	1309
- in fishing	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,
- in commercial / public services	12831	3319	1302	1422	1612	1674	2174	2118	2254	3020	2874	2603	2793
- in households	9237	7696	4356	4501	4610	4918	5316	5630	5864	6165	6104	6075	6625

Table 26. Balance of charcoal, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	,,	,,	,,	,,	,,	,,	19	18	19	13	13	9	24
Import	,,	,,	,,	,,	,,	,,	13	14	25	38	70	69	61
Export	,,	,,	,,	,,	,,	,,	21	15	16	16	18	43	38
Changes in stocks	,,	,,	,,	,,	,,	,,	3	3	-4	1	-2	5	1
Gross inland consumption	,,	,,	,,	,,	,,	,,	14	20	24	36	63	40	48
Final consumption:	,,	,,	,,	,,	,,	,,	14	20	24	36	63	40	5
- in commercial / public services	,,	,,	,,	,,	,,	,,	14	20	24	36	63	40	5

Table 27. Balance of wood and wood waste, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	11930	19632	27324	28388	30517	31702	33523	35293	37650	36839	39022	41787	41734
Import	,,	61	4	22	,,	45	252	727	1003	957	1227	1972	2008
Export	,,	,,	255	515	806	984	693	710	1695	1923	2224	4705	5102
Changes in stocks	-14	-381	-54	1507	672	953	349	-498	-503	15	-113	123	444
Gross inland consumption	11916	19312	27019	29402	30383	31716	33431	34812	36455	35888	37912	39177	39084
Statistical difference	,,	,,	,,	,,	1231	1631	1488	457	225	,,	,,	,,	,,
Transformed in power, heat and other plants:	527	558	1640	2867	4105	5007	6392	6273	7272	7552	8899	10375	10408
- in power plants	,,	,,	,,	463	833	758	367	191	784	1597	1864	2331	2472
- in heat plants	527	558	1640	2404	3272	4249	5988	6034	6440	5919	7008	8029	7893

- in other industries	„	„	„	„	„	„	37	48	48	36	27	15	43
Consumed in energy sector, total:	„	„	25	3	4	4	13	13	16	6	2	4	19
- in peat mining enterprises	„	„	„	„	„	„	4	13	9	4	„	0	4
- in refineries	„	„	„	„	„	„	„	„	4	1	1	1	1
- in electricity, gas, steam and air conditioning enterprises	„	„	25	3	4	4	9	„	3	1	1	3	14
Distribution and transmission losses	„	„	12	21	38	38	12	4	17	„	„	„	„
Final consumption:	11389	18754	25342	26511	27467	28298	28502	28979	29375	28330	29011	28798	28657
- in industry	453	756	1218	1812	3140	3849	3986	4007	3586	3480	3273	2631	2920
- in construction	51	105	100	119	196	233	238	185	232	217	177	125	143
- in transport	„	„	„	„	„	„	„	„	„	„	„	„	„
- in agriculture	187	211	272	380	418	520	311	253	264	320	371	400	399
- in fishing	„	„	„	„	„	„	„	„	„	„	„	„	„
- in commercial / public services	1699	1104	1703	1661	1630	1402	1296	1278	1256	1189	1197	1185	1178
- in households	8999	16578	22049	22539	22083	22294	22671	23256	24037	23124	23993	24457	24017

Table 28. Balance of agricultural waste, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	„	„	„	„	112	150	186	96	104	150	174	184	228
Changes in stocks	„	„	„	„	8	7	-21	16	-31	33	-39	-9	11
Gross inland consumption	„	„	„	„	120	157	165	112	73	183	135	175	239
Transformed in power, heat and other plants:	„	„	„	„	46	53	59	64	60	63	88	109	144
- in heat plants	„	„	„	„	46	53	59	64	60	63	88	109	144
Consumed in energy sector, total:									1	„	„	7	3
- in refineries	„	„	„	„	„	„	„	„	„	„	„	7	„
- in electricity , gas, steam and air conditioning enterprises	„	„	„	„	„	„	„	„	1	„	„	„	3
Final consumption:	„	„	„	„	74	104	106	48	12	120	47	59	92
- in industry	„	„	„	„	47	84	91	41	10	76	19	8	11
- in construction	„	„	„	„	„	„	„	„	„	„	„	„	„
- in transport	„	„	„	„	„	„	„	„	„	„	„	„	„
- in agriculture	„	„	„	„	„	3	2	2	„	44	28	51	56
- in commercial / public services	„	„	„	„	„	„	„	„	„	„	„	„	18
- in households	„	„	„	„	27	17	13	5	2	„	„	„	7

Table 29. Balance of bioethanol, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	„	„	„	„	„	„	69	267	268	402	463	661	1060
Import	„	„	„	„	„	„	„	„	70	116	250	94	106
Export	„	„	„	„	„	„	34	222	115	8	66	106	649
Changes in stocks	„	„	„	„	„	„	-32	-10	2	-16	9	-46	-3
Gross inland consumption	„	„	„	„	„	„	3	35	225	494	656	603	514
Transformed in power, heat and other plants:	„	„	„	„	„	„	„	„	153	294	311	1	„
- in other industries	„	„	„	„	„	„	„	„	153	294	311	1	„
Non-energy use	„	„	„	„	„	„	„	„	„	„	11	18	78
Final consumption:	„	„	„	„	„	„	3	35	72	200	334	584	436
- in transport	„	„	„	„	„	„	3	35	72	200	334	584	436

Table 30. Balance of biodiesel, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	„	„	„	„	„	„	82	260	383	917	2390	3873	3299
Import	„	„	„	„	„	„	„	„	227	1156	1639	1222	527
Export	„	„	„	„	„	„	7	168		235	1955	3434	2538
Changes in stocks	„	„	„	„	„	„	-46	27	-21	-76	-158	-80	166
Gross inland consumption	„	„	„	„	„	„	29	119	589	1762	1916	1581	1454
Final consumption:	„	„	„	„	„	„	29	119	589	1762	1916	1581	1454
- in transport	„	„	„	„	„	„	29	119	589	1762	1916	1581	1454

Table 31. Balance of biogas, TJ

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Production	„	„	„	„	62	78	68	77	83	103	125	195	418
Gross inland consumption	„	„	„	„	62	78	68	77	83	103	125	195	418
Transformed in power, heat and other plants:	„	„	„	„	28	30	35	43	42	48	66	108	229
- in power plants	„	„	„	„	„	„	12	27	42	48	66	108	229
- in heat plants	„	„	„	„	28	30	23	16	„	„	„	„	„
Final consumption:	„	„	„	„	34	48	33	34	41	55	59	87	189
- in industry	„	„	„	„	„	„	„	„	6	13	10	17	104
- in agriculture	„	„	„	„	„	9	20	14	9	12	14	17	15
- in commercial / public services	„	„	„	„	34	39	13	20	26	30	35	53	70

ANNEX IV. CO_2 emissions from the installations registered in the GHG Emission Allowance Registry, 2010

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	594096	1.AA.1.A Public electricity and heat production
2	AB Naujasis kalcitas	LT-2	Whitewash production furnace	132506	25164	1.AA.2.F Other
3	UAB švenčionėlių keramika	LT-3	Furnace for ceramics	14263	1693	1.AA.2.F Other
4	UAB Tauragės keramika	LT-4	Ceramics combustion furnace	10907	0	1.AA.2.F Other
5	UAB Rokų keramika	LT-6	Ceramics combustion furnace	6076	1565	1.AA.2.F Other
6	AB Palemono keramika	LT-7	Ceramics combustion furnace	7950	1565	1.AA.2.F Other
7	AB Dvarčionių keramika	LT-8	Ceramics combustion furnace	11225	5440	1.AA.2.F Other
8	AB Alytaus keramika	LT-10	Ceramics combustion furnace	1563	627	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	14063	1.AA.2.F Other
11	AB Warta Glass Panevėžys	LT-13	Glass melting furnace	23803	18428	1.AA.2.F Other
12	AB ORLEN Lietuva	LT-14	Oil refining factory	2473984	1967110	1.AA.1.B Petroleum Refining
13	AB Klaipėdos kartonas	LT-15	Boiler house	32313	33111	1.AA.2. D Pulp, Paper and Print
14	AB Grigiškės	LT-16	Boiler house	75329	36223	1.AA.2. D Pulp, Paper and Print
15	AB Simega	LT-17	Boiler house	11526	0	1.AA.4.C Agriculture/ Forestry/ Fisheries
16	AB Achema	LT-18	Boiler house	212557	86177	1.AA.2.C Chemicals
17	AB Nordic Sugar Kėdainiai	LT-20	Boiler house, oilcake desiccation	55600	30753	1.AA.2.E Food processing. Beverages and Tobacco
18	AB Anykščių vynas	LT-22	Boiler house	2987	1665	1.AA.2.E Food processing. Beverages and Tobacco
19	AB Lifosa	LT-23	Boiler house	99939	965	1.AA.2.C Chemicals
20	UAB Lino apdaila	LT-24	Boiler house	10607	4737	1.AA.2.F Other
21	AB Danisco Sugar Panevezys	LT-25	Boiler house	0	0	1.AA.2.E Food processing. Beverages and Tobacco
22	AB Klaipėdos nafta	LT-27	Boiler house	19691	28329	1.AA.1.A Public electricity and heat production
23	Ŗ,B, Dembavos šiltnamiai	LT-29	Boiler house	4879	148	1.AA.4.C Agriculture/ Forestry/ Fisheries
24	UAB ARVI cukrus	LT-30	Boiler house	17153	16574	1.AA.2.E Food processing. Beverages and Tobacco
25	AB Įmonių grupė "Alita"	LT-31	Boiler house, desiccation of apple oilcake	3962	1995	1.AA.2.E Food processing. Beverages and Tobacco
26	UAB Pasodėlė	LT-32	Boiler house	4664	0	1.AA.4.C Agriculture/ Forestry/ Fisheries
27	AB Klaipėdos mediena	LT-33	Boiler house	24390	5977	1.AA.4.C Agriculture/ Forestry/ Fisheries
28	UAB Matuizų plytinė	LT-35	Boiler house	14912	0	1.AA.2.F Other
29	AB Jonavos šilumos tinklai	LT-36	Jonava boiler house	28262	35301	1.AA.1.A Public electricity and heat production
30	AB Jonavos šilumos tinklai	LT-37	Girele boiler house	8533	559	1.AA.1.A Public electricity and heat production
31	UAB Mažeikių šilumos tinklai	LT-38	Mazeikiai boiler house	43068	16790	1.AA.1.A Public electricity and heat production
32	UAB Raseinių šilumos tinklai	LT-39	Raseiniai boiler house No 4	8817	3694	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)
33	UAB Ukmergės šiluma	LT-40	Ukmerge boiler house No 1	5941	3734	1.AA.1.A Public electricity and heat production
34	UAB Miesto energija	LT-41	Klaipeda boiler house No 7	0	0	1.AA.1.A Public electricity and heat production
35	UAB Molėtų šiluma	LT-42	Moletai boiler house	8323	9	1.AA.1.A Public electricity and heat production
36	UAB Šilutės šilumos tinklai	LT-43	Šilute boiler house	18726	7319	1.AA.1.A Public electricity and heat production
37	UAB Vilniaus energija	LT-44	Vilnius power plant No 2 (E-2)	412233	326494	1.AA.1.A Public electricity and heat production
38	UAB Vilniaus energija	LT-45	Vilnius power plant No 3 (E-3)	599578	487109	1.AA.1.A Public electricity and heat production
39	UAB Vilniaus energija	LT-46	Vilnius boiler house No 2	18898	19510	1.AA.1.A Public electricity and heat production
40	UAB Vilniaus energija	LT-48	Vilnius boiler house No 8	17944	3	1.AA.1.A Public electricity and heat production
41	UAB Širvintų šiluma	LT-49	Širvintu boiler house No 3	7843	612	1.AA.1.A Public electricity and heat production
42	AB Šiaulių energija	LT-50	Šiauliai southern boiler house	117319	105589	1.AA.1.A Public electricity and heat production
43	AB Klaipėdos energija	LT-54	Gargždai boiler house no, 4	8466	9841	1.AA.1.A Public electricity and heat production
44	AB Klaipėdos energija	LT-55	Power plant	92021	78129	1.AA.1.A Public electricity and heat production
45	UAB Radviliškio šiluma	LT-56	Radviliškis city boiler house	12329	2975	1.AA.1.A Public electricity and heat production
46	UAB Utenos šilumos tinklai	LT-57	Utena boiler house	38267	20465	1.AA.1.A Public electricity and heat production
47	UAB Tauragės šilumos tinklai	LT-58	Taurage - Berže boiler house	20149	1901	1.AA.1.A Public electricity and heat production
48	UAB Šalčininkų šilumos tinklai	LT-60	Šalcininkai boiler house	6013	5948	1.AA.1.A Public electricity and heat production
49	VI Pravieniškių 2-ieji pataisos namai	LT-61	Katiline	4966	4178	1.AA.1.A Public electricity and heat production
50	UAB Varėnos šiluma	LT-62	Varena boiler house	19409	1207	1.AA.1.A Public electricity and heat production
51	AB Panevėžio energija	LT-63	Panevežys boiler house No 2	58223	25230	1.AA.1.A Public electricity and heat production
52	AB Panevėžio energija	LT-64	Rokiškis region boiler house	31807	3749	1.AA.1.A Public electricity and heat production
53	AB Panevėžio energija	LT-65	Panevežys region boiler house No 1	63048	42949	1.AA.1.A Public electricity and heat production
54	AB Panevėžio energija	LT-66	Pasvalys region boiler house	7361	7736	1.AA.1.A Public electricity and heat production
55	AB Panevėžio energija	LT-67	Zarasai boiler house No 4	8159	6975	1.AA.1.A Public electricity and heat production
56	UAB Geoterma	LT-68	Klaipeda geothermal PP	44553	19646	1.AA.1.A Public electricity and heat production
57	AB Kauno energija	LT-69	Petrašiunai PP	21391	5215	1.AA.1.A Public electricity and heat production
58	AB Kauno energija	LT-70	Pergale boiler house	5687	1180	1.AA.1.A Public electricity and heat production
59	AB Kauno energija	LT-71	Šilkas boiler house	2966	1051	1.AA.1.A Public electricity and heat production
60	AB Kauno energija	LT-72	Noreikiškes region boiler house	9976	4639	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	7296	1.AA.1.A Public electricity and heat production
62	AB Kauno energija	LT-74	Jurbarkas region boiler house	9054	9543	1.AA.1.A Public electricity and heat production
63	UAB Ignalinos šilumos tinklai	LT-75	Ignalina boiler house No 2	9679	20	1.AA.1.A Public electricity and heat production
64	UAB Plungės šilumos tinklai	LT-76	Plunge boiler house No 1	19131	872	1.AA.1.A Public electricity and heat production
65	UAB Birštono šiluma	LT-77	Birštonas region boiler house	5014	1607	1.AA.1.A Public electricity and heat production
66	UAB Litesko filialas "Druskininkų šiluma"	LT-78	Druskininkai industry boiler house	40812	31304	1.AA.1.A Public electricity and heat production
67	UAB Litesko filialas "Biržų siluma"	LT-79	Boiler house of Biržai city hall	10320	2044	1.AA.1.A Public electricity and heat production
68	UAB Litesko filialas "Vilkaviškio šiluma"	LT-80	Vilkaviškis boiler house	8027	4955	1.AA.1.A Public electricity and heat production
69	UAB Litesko filialas "Telšų šiluma"	LT-81	Luokeboiler house	14835	7941	1.AA.1.A Public electricity and heat production
70	UAB Litesko filialas "Kelmės šiluma"	LT-82	Mackevicius boiler house	5695	934	1.AA.1.A Public electricity and heat production
71	UAB Litesko filialas "Palangos šiluma"	LT-83	Palanga boiler house	19052	9212	1.AA.1.A Public electricity and heat production
72	UAB Litesko filialas "Marijampolės šiluma"	LT-84	Kazlu Ruda boiler house	5422	1442	1.AA.1.A Public electricity and heat production
73	UAB Litesko filialas "Marijampolės šiluma"	LT-85	Marijampole region boiler house	37160	23952	1.AA.1.A Public electricity and heat production
74	UAB Litesko filialas "Alytaus energija"	LT-86	Alytus region boiler house	95308	66361	1.AA.1.A Public electricity and heat production
75	AB Lietuvos elektrinė	LT-87	Lietuvos PP	546506	1144210	1.AA.1.A Public electricity and heat production
76	UAB Kauno termofikacijos elektrinė	LT-88	Kaunas PP	562251	496369	1.AA.1.A Public electricity and heat production
77	UAB Kaišiadorių šiluma	LT-89	Kaišiadoriai boiler house	8585	4727	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	75097	46088	1.AA.1.A Public electricity and heat production
80	AB Klaipėdos energija	LT-92	Lypkiai regiopn boiler house	21436	53052	1.AA.1.A Public electricity and heat production
81	AB Klaipėdos energija	LT-93	Gargždai boiler house	2210	35	1.AA.1.A Public electricity and heat production
82	AB Pagirių šiltnamiai	LT-94	boiler house	26326	0	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	85027	104247	1.AA.1.A Public electricity and heat production
86	UAB Prienų energija	LT-98	Trakai boiler house	4436	3969	1.AA.1.A Public electricity and heat production
87	UAB Prienų energija	LT-99	Lentvaris boiler house	3236	2043	1.AA.1.A Public electricity and heat production
88	UAB Gargždų plytų gamykla	LT-100	Boiler house	3437	0	1.AA.2.F Other

No	Company	Installation ID	Name of the installation	EUA Allocations	Verified emissions, t CO2	Corresponding CRF Sector (Fuel combustion)
89	UAB Akmenės energija	LT-101	Zalgiris boiler house	13521	6846	1.AA.1.A Public electricity and heat production
90	AB Panevėžio energija	LT-102	Panevežys thermal PP	100300	89899	1.AA.1.A Public electricity and heat production
91	UAB Swedspan Girių Bizonas	LT-103	Fuel combustion plants	67436	33896	1.AA.4.C Agriculture/ Forestry/ Fisheries
92	AB Grigiškės PGC Naujieji Verkiai	LT-104	Boiler house	8152	0	1.AA.2. D Pulp, Paper and Print
93	UAB NEO GROUP	LT-105	Boiler house	59231	41194	1.AA.2.C Chemicals
94	AB Panevėžio energija	LT-106	Kedaniai region boiler house	20963	185	1.AA.1.A Public electricity and heat production
95	UAB Paroc	LT-107	Plants producing stone-wool	70149	44799	1.AA.2.C Chemicals
96	UAB Vilniaus energija	LT-109	Region boiler house No 7	1368	2	1.AA.1.A Public electricity and heat production
97	AB Vilniaus GKG-3	LT-108	Boiler DE-14-25 GM	551	327	1.AA.1.A Public electricity and heat production
98	UAB Agro Neveronys	LT-112	Boiler house	34192	5321	1.AA.4.C Agriculture/ Forestry/ Fisheries
99	UAB Orion Global Pet	LT-113	Boiler house	20637	22446	1.AA.2.C Chemicals
100	UAB Pramonės energija	LT-114	Boiler house	38792	672	1.AA.1.A Public electricity and heat production
101	VĮ "Visagino energija"	LT-115	Thermal boiler house	0	0	1.AA.1.A Public electricity and heat production
			Total:	8155470	6393952	

ANNEX V CRF SUMMARY TABLES

SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

Inventory 2010

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)]	**2,101.52**	**3,210.10**	**3,600.57**	**172.28**	**NA,NO**	**10.70**	**9,095.17**
1. Energy	**12,264.13**	**467.90**	**116.33**				**12,848.36**
A. Fuel Combustion (Sectoral Approach)	12,254.65	206.92	116.30				12,577.87
1. Energy Industries	5,415.87	9.14	20.55				5,445.56
2. Manufacturing Industries and Construction	1,110.26	4.00	5.90				1,120.17
3. Transport	4,496.17	13.93	55.03				4,565.13
4. Other Sectors	1,216.46	179.84	34.67				1,430.97
5. Other	15.89	0.01	0.15				16.05
B. Fugitive Emissions from Fuels	9.48	260.98	0.03				270.49
1. Solid Fuels	NO	NO	NO				NO
2. Oil and Natural Gas	9.48	260.98	0.03				270.49
2. Industrial Processes	**1,488.14**	**NA,NE,NO**	**578.04**	**172.28**	**NA,NO**	**10.70**	**2,249.17**
A. Mineral Products	325.48	NA,NE,NO	NA,NE,NO				325.48
B. Chemical Industry	1,150.30	NO	578.04	NO	NO	NO	1,728.34
C. Metal Production	4.11	NO	NO	NO	NO	NO	4.11
D. Other Production	8.25						8.25
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NO	NA,NO
F. Consumption of Halocarbons and SF_6 [(2)]				172.28	NA,NO	10.70	182.98
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**89.25**		**3.37**				**92.62**
4. Agriculture		**1,661.74**	**2,796.59**				**4,458.33**
A. Enteric Fermentation		1,194.95					1,194.95
B. Manure Management		466.79	287.91				754.70
C. Rice Cultivation		NO					NO
D. Agricultural Soils [(3)]		NA	2,508.68				2,508.68
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)]	**-11,741.94**	**1.03**	**26.34**				**-11,714.57**
A. Forest Land	-12,303.63	0.06	23.10				-12,280.47
B. Cropland	-30.28	0.04	1.98				-28.26
C. Grassland	535.50	0.93	1.25				537.69
D. Wetlands	56.47	NE,NO	NE,NO				56.47
E. Settlements	NA,NE,NO	NA,NE	NA,NE				NA,NE,NO
F. Other Land	NE,NO	NA,NE	NA,NE				NA,NE,NO
G. Other	NE	NE	NE				NE
6. Waste	**1.93**	**1,079.43**	**79.90**				**1,161.25**
A. Solid Waste Disposal on Land	NA	954.42					954.42
B. Waste-water Handling		125.01	79.79				204.80
C. Waste Incineration	1.93	NA	0.11				2.03
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	608.93	0.43	2.45				611.81
Aviation	145.35	0.06	1.37				146.78
Marine	463.59	0.36	1.08				465.03
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**4,463.90**						**4,463.90**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	20,809.74
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	9,095.17

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	**33,086.71**	**35,239.17**	**19,745.82**	**15,764.25**	**14,887.62**	**13,814.88**	**14,284.90**	**13,804.13**	**14,532.89**	**12,120.81**	**10,526.28**
A. Fuel Combustion (Sectoral Approach)	33,085.66	35,236.44	19,740.69	15,758.31	14,880.07	13,804.53	14,272.10	13,786.65	14,510.52	12,101.68	10,500.24
1. Energy Industries	13,961.10	15,072.56	8,878.19	7,499.96	7,473.59	6,577.84	7,274.67	6,701.85	7,555.82	6,118.49	5,197.57
2. Manufacturing Industries and Construction	5,954.99	6,073.16	2,880.12	1,846.39	1,872.96	1,565.21	1,436.62	1,429.27	1,412.03	1,080.51	1,010.18
3. Transport	7,475.16	7,631.17	5,135.60	4,020.34	3,305.79	3,828.87	3,869.57	4,204.19	4,331.14	3,796.44	3,361.22
4. Other Sectors	5,694.42	6,459.55	2,846.77	2,391.62	2,227.74	1,832.60	1,691.24	1,451.34	1,211.54	1,106.24	931.26
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	1.05	2.73	5.13	5.94	7.55	10.35	12.80	17.48	22.37	19.13	26.04
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	1.05	2.73	5.13	5.94	7.55	10.35	12.80	17.48	22.37	19.13	26.04
2. Industrial Processes	**3,362.83**	**3,344.48**	**1,799.47**	**846.34**	**1,077.91**	**1,363.93**	**1,593.36**	**1,435.15**	**1,562.55**	**1,455.96**	**1,440.89**
A. Mineral Products	2,141.57	2,021.42	1,082.27	500.33	483.17	423.90	405.41	441.96	509.43	419.56	358.63
B. Chemical Industry	1,190.53	1,296.58	699.37	330.48	579.64	925.12	1,173.17	977.91	1,037.24	1,020.08	1,066.34
C. Metal Production	21.41	17.17	8.50	6.21	5.79	5.59	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	100.50	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)	**-6,318.44**	**-6,982.06**	**-6,877.98**	**-817.09**	**-6,215.39**	**-3,812.86**	**1,696.79**	**-97.04**	**-7,670.87**	**-7,205.28**	**-7,610.68**
A. Forest Land	-7,207.49	-7,206.73	-7,119.26	-7,206.22	-6,733.19	-4,098.09	1,437.52	-360.23	-7,943.00	-7,601.21	-8,545.17
B. Cropland	354.81	136.01	140.14	78.29	141.53	138.79	136.00	128.92	132.82	136.72	171.59
C. Grassland	461.51	15.93	28.41	200.39	58.43	71.58	48.57	67.19	71.35	90.38	118.83
D. Wetlands	72.73	72.73	72.73	179.75	75.27	74.85	74.70	67.08	67.96	168.83	74.51
E. Settlements	NA,NE,NO	NA,NE,NO	NA,NE,NO	5,301.21	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	567.81
F. Other Land	NE,NO	NE,NO	NE,NO	629.49	242.58	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	1.76
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**3.99**	**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	3.99	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	**30,235.60**	**31,706.51**	**14,768.99**	**15,897.10**	**9,850.57**	**11,468.58**	**17,674.23**	**15,240.70**	**8,522.38**	**6,467.81**	**4,453.37**
Total CO_2 emissions excluding net CO_2 from LULUCF	**36,554.04**	**38,688.56**	**21,646.97**	**16,714.18**	**16,065.96**	**15,281.44**	**15,977.44**	**15,337.74**	**16,193.26**	**13,673.09**	**12,064.05**
Memo Items:											
International Bunkers	**715.81**	**1,002.67**	**1,163.83**	**643.06**	**620.36**	**587.90**	**533.92**	**291.21**	**244.22**	**312.92**	**376.66**
Aviation	399.27	480.54	194.69	107.93	114.57	118.04	96.66	90.81	81.85	76.07	73.40
Marine	316.54	522.13	969.14	535.13	505.79	469.86	437.26	200.41	162.37	236.85	303.27
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	1,305.99	1,305.99	1,306.98	1,951.43	2,017.63	2,116.49	2,318.92	2,373.39	2,616.59	2,712.27	2,959.86

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	Change 1990/2010 year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**11,147.24**	**11,216.82**	**11,185.70**	**11,803.48**	**12,475.23**	**12,623.76**	**12,774.58**	**12,546.45**	**11,367.90**	**12,264.13**	**-62.93**
A. Fuel Combustion (Sectoral Approach)	11,108.48	11,181.13	11,154.24	11,778.63	12,457.39	12,608.81	12,761.86	12,535.89	11,358.39	12,254.65	-62.96
1. Energy Industries	5,663.93	5,465.06	5,327.13	5,497.94	5,753.90	5,301.65	4,790.94	4,869.99	4,894.25	5,415.87	-61.21
2. Manufacturing Industries and Construction	985.54	1,066.34	1,076.79	1,170.53	1,264.71	1,463.38	1,433.69	1,270.53	1,017.39	1,110.26	-81.36
3. Transport	3,557.64	3,679.18	3,724.81	4,059.99	4,320.63	4,578.96	5,329.83	5,283.85	4,368.40	4,496.17	-39.85
4. Other Sectors	900.65	969.48	1,022.04	1,040.85	1,105.73	1,252.77	1,191.60	1,099.24	1,067.07	1,216.46	-78.64
5. Other	0.72	1.08	3.47	9.32	12.41	12.05	15.81	12.28	11.27	15.89	100.00
B. Fugitive Emissions from Fuels	38.76	35.69	31.46	24.85	17.84	14.96	12.71	10.55	9.51	9.48	804.88
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and Natural Gas	38.76	35.69	31.46	24.85	17.84	14.96	12.71	10.55	9.51	9.48	804.88
2. Industrial Processes	**1,508.33**	**1,563.26**	**1,311.33**	**1,520.51**	**1,619.04**	**1,849.95**	**2,945.71**	**2,450.68**	**1,489.33**	**1,488.14**	**-55.75**
A. Mineral Products	361.61	356.92	366.24	430.19	447.82	598.59	598.99	520.27	303.71	325.48	-84.80
B. Chemical Industry	1,130.57	1,190.14	929.02	1,073.75	1,153.98	1,234.19	2,328.45	1,915.94	1,173.01	1,150.30	-3.38
C. Metal Production	7.80	7.20	7.27	7.05	7.19	6.87	6.54	5.00	4.03	4.11	-80.82
D. Other Production	8.35	9.00	8.81	9.52	10.05	10.31	11.74	9.47	8.58	8.25	-11.44
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	0.00
3. Solvent and Other Product Use	94.54	94.21	93.80	93.30	92.72	92.17	91.67	91.19	90.68	89.25	-11.19
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)	**-7,870.12**	**-2,472.69**	**-8,814.49**	**-5,341.11**	**-2,810.88**	**-3,951.66**	**-1,774.80**	**-7,562.75**	**-10,980.31**	**-11,741.94**	**85.84**
A. Forest Land	-11,221.90	-2,847.23	-9,122.00	-5,653.98	-3,030.05	-4,707.62	-3,421.80	-8,242.98	-11,316.12	-12,303.63	70.71
B. Cropland	16.35	192.90	3.77	-3.50	-3.94	-463.25	-645.67	-616.69	-564.80	-30.28	-108.54
C. Grassland	195.45	123.49	146.45	155.67	167.32	657.87	612.56	586.55	565.15	535.50	16.03
D. Wetlands	94.94	58.16	157.30	160.70	55.78	57.60	66.57	62.80	80.02	56.47	-22.36
E. Settlements	2,661.66	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	251.88	1,335.00	372.55	255.44	NA,NE,NO	0.00
F. Other Land	383.37	NE,NO	NE,NO	NE,NO	NE,NO	251.88	278.54	275.03	NE,NO	NE,NO	0.00
G. Other	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**	**-51.69**
A. Solid Waste Disposal on Land	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	-51.69
D. Other	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**	**0.00**
Total CO_2 emissions including net CO_2 from LULUCF	**4,882.42**	**10,403.84**	**3,782.36**	**8,079.26**	**11,381.80**	**10,619.45**	**14,037.89**	**7,526.18**	**1,968.24**	**2,101.52**	**-93.05**
Total CO_2 emissions excluding net CO_2 from LULUCF	**12,752.54**	**12,876.52**	**12,596.85**	**13,420.37**	**14,192.68**	**14,571.11**	**15,812.69**	**15,088.93**	**12,948.55**	**13,843.46**	**-62.13**
Memo Items:											
International Bunkers	**425.00**	**445.68**	**455.62**	**480.10**	**614.96**	**614.59**	**594.80**	**526.81**	**533.75**	**608.93**	**-14.93**
Aviation	98.25	83.44	93.48	105.90	139.13	158.13	198.08	229.43	109.95	145.35	-63.60
Marine	326.75	362.24	362.14	374.20	475.83	456.46	396.71	297.38	423.80	463.59	46.45
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO_2 Emissions from Biomass	3,220.16	3,477.27	3,672.13	3,851.30	3,894.47	4,090.34	4,121.55	4,365.30	4,480.65	4,463.90	241.80

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	18.40	19.37	14.10	15.43	15.43	16.05	17.06	17.75	18.81	18.93	19.33
A. Fuel Combustion (Sectoral Approach)	11.29	11.91	6.69	7.68	7.35	7.41	8.15	8.32	8.51	8.73	8.65
1. Energy Industries	0.40	0.46	0.28	0.25	0.24	0.21	0.23	0.21	0.26	0.19	0.18
2. Manufacturing Industries and Construction	0.35	0.37	0.20	0.12	0.13	0.11	0.11	0.12	0.13	0.10	0.10
3. Transport	1.80	2.10	1.36	1.03	0.85	1.03	1.04	1.14	1.11	1.00	0.78
4. Other Sectors	8.74	8.98	4.85	6.28	6.13	6.06	6.77	6.85	7.02	7.43	7.59
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	7.47	7.42	7.75	8.08	8.64	8.91	9.43	10.29	10.20	10.67
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	7.11	7.47	7.42	7.75	8.08	8.64	8.91	9.43	10.29	10.20	10.67
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	**206.37**	**193.56**	**146.67**	**123.24**	**108.88**	**103.65**	**102.06**	**106.07**	**94.25**	**87.29**	**77.22**
A. Enteric Fermentation	154.23	145.32	113.22	94.14	80.65	75.80	75.78	78.07	68.49	64.44	56.72
B. Manure Management	52.14	48.24	33.45	29.10	28.23	27.85	26.29	28.00	25.75	22.85	20.50
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
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**	**0.22**	**0.14**	**0.14**	**0.14**	**0.14**	**0.14**	**0.10**	**0.13**	**0.13**
A. Forest Land	0.02	0.01	0.13	0.05	0.05	0.05	0.05	0.05	0.01	0.05	0.04
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	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
F. Other Land	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**51.51**	**52.52**	**53.37**	**53.92**	**54.05**	**53.96**	**54.07**	**54.21**	**54.28**	**54.12**	**54.42**
A. Solid Waste Disposal on Land	43.19	44.23	45.14	45.73	45.94	45.91	46.08	46.27	46.39	46.31	46.64
B. Waste-water Handling	8.31	8.29	8.23	8.18	8.11	8.05	7.99	7.94	7.90	7.81	7.77
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	**276.57**	**265.76**	**214.47**	**192.73**	**178.57**	**173.87**	**173.36**	**178.21**	**167.45**	**160.47**	**151.11**
Total CH_4 emissions excluding CH_4 from LULUCF	**276.47**	**265.66**	**214.26**	**192.60**	**178.43**	**173.74**	**173.23**	**178.08**	**167.36**	**160.33**	**150.98**
Memo Items:											
International Bunkers	0.02	0.03	0.04	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
Aviation	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marine	0.01	0.02	0.04	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
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	Change 1990/2010 year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	20.37	20.31	20.45	20.36	21.17	21.64	21.24	21.77	22.05	22.28	21.08
A. Fuel Combustion (Sectoral Approach)	8.90	8.96	9.14	9.20	9.48	9.87	9.52	9.76	9.66	9.85	-12.72
1. Energy Industries	0.23	0.26	0.27	0.32	0.32	0.34	0.34	0.38	0.43	0.44	8.98
2. Manufacturing Industries and Construction	0.12	0.18	0.22	0.23	0.23	0.24	0.24	0.22	0.17	0.19	-45.98
3. Transport	0.80	0.80	0.81	0.84	0.89	0.85	0.79	0.75	0.69	0.66	-63.09
4. Other Sectors	7.75	7.72	7.83	7.81	8.04	8.43	8.15	8.41	8.37	8.56	-2.01
5. Other	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	11.46	11.35	11.31	11.16	11.69	11.77	11.72	12.01	12.40	12.43	74.70
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and Natural Gas	11.46	11.35	11.31	11.16	11.69	11.77	11.72	12.01	12.40	12.43	74.70
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**	**-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	0.00
B. Chemical Industry	0.06	0.06	0.08	0.09	0.08	0.10	0.10	0.11	NO	NO	-100.00
C. Metal Production	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	0.00
3. Solvent and Other Product Use											
4. Agriculture	**80.83**	**83.92**	**86.30**	**85.37**	**86.01**	**88.34**	**88.05**	**84.88**	**80.59**	**79.13**	**-61.66**
A. Enteric Fermentation	58.00	59.81	61.82	60.96	61.18	63.19	64.55	61.98	58.77	56.90	-63.11
B. Manure Management	22.83	24.11	24.48	24.42	24.83	25.15	23.50	22.91	21.82	22.23	-57.37
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
E. Prescribed Burning of Savannas	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	0.00
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Land Use, Land-Use Change and Forestry	**0.10**	**0.18**	**0.15**	**0.14**	**0.04**	**0.43**	**0.03**	**0.06**	**0.14**	**0.05**	**-53.66**
A. Forest Land	0.01	0.10	0.06	0.03	0.01	0.16	0.01	0.01	0.04	0.00	-83.96
B. Cropland	0.00	0.00	0.00	0.00	0.01	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	-47.70
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0.00
F. Other Land	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0.00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
6. Waste	**55.33**	**55.77**	**55.88**	**54.81**	**53.80**	**52.71**	**52.22**	**52.16**	**51.88**	**51.40**	**-0.20**
A. Solid Waste Disposal on Land	48.10	48.68	49.17	48.32	47.45	46.79	46.31	45.80	45.70	45.45	5.22
B. Waste-water Handling	7.23	7.09	6.71	6.49	6.35	5.92	5.91	6.36	6.18	5.95	-28.40
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
D. Other	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**	**0.00**
Total CH_4 emissions including CH_4 from LULUCF	**156.70**	**160.24**	**162.86**	**160.78**	**161.10**	**163.21**	**161.64**	**158.98**	**154.66**	**152.86**	**-44.73**
Total CH_4 emissions excluding CH_4 from LULUCF	**156.59**	**160.05**	**162.71**	**160.64**	**161.06**	**162.78**	**161.60**	**158.92**	**154.52**	**152.81**	**-44.73**
Memo Items:											
International Bunkers	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	1.95
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-63.60
Marine	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.02	48.46
Multilateral Operations	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	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**1.01**	**0.90**	**0.63**	**0.56**	**0.52**	**0.51**	**0.42**	**0.41**	**0.41**	**0.34**	**0.30**
A. Fuel Combustion (Sectoral Approach)	1.01	0.90	0.63	0.56	0.52	0.51	0.42	0.41	0.41	0.34	0.30
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	0.80	0.67	0.50	0.41	0.37	0.37	0.27	0.27	0.25	0.19	0.16
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	**18.23**	**16.31**	**10.13**	**8.15**	**6.71**	**6.50**	**7.90**	**8.18**	**7.70**	**7.55**	**7.38**
A. Enteric Fermentation											
B. Manure Management	2.82	2.61	1.93	1.57	1.34	1.24	1.23	1.26	1.10	1.02	0.90
C. Rice Cultivation											
D. Agricultural Soils	15.42	13.70	8.20	6.58	5.37	5.26	6.67	6.92	6.60	6.52	6.49
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	**0.08**	**0.08**	**0.08**	**0.09**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**
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	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
F. Other Land	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
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	**22.90**	**21.00**	**13.70**	**11.77**	**9.74**	**9.73**	**11.81**	**12.38**	**12.82**	**12.81**	**13.35**
Total N_2O emissions excluding N_2O from LULUCF	**22.82**	**20.92**	**13.62**	**11.68**	**9.66**	**9.65**	**11.73**	**12.30**	**12.74**	**12.73**	**13.27**
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	Change 1990/2010 year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**0.32**	**0.33**	**0.33**	**0.35**	**0.36**	**0.38**	**0.42**	**0.44**	**0.36**	**0.38**	**-62.98**
A. Fuel Combustion (Sectoral Approach)	0.32	0.33	0.33	0.35	0.36	0.38	0.42	0.44	0.36	0.38	-62.99
1. Energy Industries	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.06	0.07	0.07	-12.21
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	-46.79
3. Transport	0.16	0.16	0.16	0.17	0.18	0.19	0.23	0.24	0.17	0.18	-77.92
4. Other Sectors	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11	13.54
5. Other	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	832.65
1. Solid Fuels	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	832.65
2. Industrial Processes	**5.61**	**6.06**	**6.31**	**6.99**	**7.79**	**7.81**	**10.04**	**9.38**	**2.12**	**1.86**	**-37.78**
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	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	-37.78
C. Metal Production	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	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	-96.53
4. Agriculture	**7.66**	**8.14**	**8.33**	**8.32**	**8.41**	**8.34**	**8.97**	**8.51**	**8.87**	**9.02**	**-50.53**
A. Enteric Fermentation											
B. Manure Management	0.93	0.96	1.00	0.99	1.01	1.04	1.04	0.99	0.94	0.93	-67.04
C. Rice Cultivation											
D. Agricultural Soils	6.73	7.18	7.33	7.33	7.40	7.30	7.93	7.52	7.94	8.09	-47.51
E. Prescribed Burning of Savannas	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	0.00
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
5. Land Use, Land-Use Change and Forestry	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**	**0.18**	**0.16**	**0.16**	**0.16**	**0.08**	**7.06**
A. Forest Land	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	4.84
B. Cropland	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.08	0.08	0.01	1,073.24
C. Grassland	0.01	0.01	0.01	0.01	0.00	0.02	0.00	0.00	0.01	0.00	-47.70
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0.00
F. Other Land	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0.00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
6. Waste	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**	**0.26**	**0.26**	**-0.23**
A. Solid Waste Disposal on Land											
B. Waste-water Handling	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.26	0.26	-0.15
C. Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-38.15
D. Other	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**	**0.00**
Total N_2O emissions including N_2O from LULUCF	**14.16**	**15.10**	**15.54**	**16.22**	**17.11**	**17.09**	**19.94**	**18.75**	**11.81**	**11.61**	**-49.27**
Total N_2O emissions excluding N_2O from LULUCF	**14.08**	**15.02**	**15.46**	**16.13**	**17.04**	**16.91**	**19.78**	**18.59**	**11.65**	**11.53**	**-49.47**
Memo Items:											
International Bunkers	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**-45.54**
Aviation	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	-63.60
Marine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.46
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO_2 Emissions from Biomass											

TABLE 10 EMISSION TRENDS HFCs, PFCs and SF6 (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)
Emissions of HFCs[3] - ($Gg\ CO_2$ equivalent)	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**NA,NO**	**4.67**	**5.70**	**7.01**	**8.69**	**10.91**	**14.03**
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	NA,NO	NA,NO	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	NA,NO	NA,NO	0.00	0.00	0.00	0.00	0.01	0.01
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	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	NA,NO	NA,NO	NA,NO	NA,NO	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**	**NA,NO**	**0.05**	**0.05**	**0.08**	**0.11**	**0.17**	**0.22**
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 SF6 (Part 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change 1990/2010 year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs(3) - ($Gg\ CO_2$ equivalent)	**18.59**	**23.89**	**32.22**	**44.53**	**60.53**	**80.23**	**104.21**	**135.65**	**150.83**	**172.28**	**100.00**
HFC-23	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	100.00
HFC-41	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	0.00
HFC-125	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	100.00
HFC-134	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	0.03	0.04	0.05	0.07	0.07	0.08	100.00
HFC-152a	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-143	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	0.00	0.00	0.01	0.01	0.01	0.01	100.00
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-245ca	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	0.43	0.50	0.91	1.10	1.08	1.25	100.00
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**	**0.00**
CF_4	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	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	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	0.00
$c\text{-}C_4F_8$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	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	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	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	0.00
Emissions of SF6(3) - ($Gg\ CO_2$ equivalent)	**0.30**	**0.40**	**1.93**	**0.86**	**1.38**	**0.99**	**0.84**	**6.24**	**5.00**	**10.70**	**100.00**
SF_6	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	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)
CO_2 emissions including net CO_2 from LULUCF	30,235.60	31,706.51	14,768.99	15,897.10	9,850.57	11,468.58	17,674.23	15,240.70	8,522.38	6,467.81	4,453.37
CO_2 emissions excluding net CO_2 from LULUCF	36,554.04	38,688.56	21,646.97	16,714.18	16,065.96	15,281.44	15,977.44	15,337.74	16,193.26	13,673.09	12,064.05
CH_4 emissions including CH_4 from LULUCF	5,808.01	5,580.89	4,503.97	4,047.41	3,749.87	3,651.36	3,640.66	3,742.45	3,516.51	3,369.78	3,173.38
CH_4 emissions excluding CH_4 from LULUCF	5,805.78	5,578.85	4,499.40	4,044.57	3,747.02	3,648.51	3,637.81	3,739.60	3,514.51	3,366.97	3,170.61
N_2O emissions including N_2O from LULUCF	7,097.57	6,510.45	4,248.16	3,647.45	3,019.89	3,017.42	3,662.23	3,836.94	3,973.64	3,971.46	4,139.69
N_2O emissions excluding N_2O from LULUCF	7,072.97	6,485.93	4,223.32	3,619.93	2,995.14	2,992.65	3,637.40	3,812.07	3,948.81	3,946.52	4,114.71
HFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	4.67	5.70	7.01	8.69	10.91	14.03
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	NA,NO	0.05	0.05	0.08	0.11	0.17	0.22
Total (including LULUCF)	**43,141.18**	**43,797.85**	**23,521.12**	**23,591.97**	**16,620.32**	**18,142.08**	**24,982.87**	**22,827.18**	**16,021.33**	**13,820.13**	**11,780.69**
Total (excluding LULUCF)	**49,432.78**	**50,753.35**	**30,369.70**	**24,378.68**	**22,808.12**	**21,927.32**	**23,258.40**	**22,896.50**	**23,665.37**	**20,997.66**	**19,363.61**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)
1. Energy	33,787.38	35,924.56	20,238.64	16,261.95	15,373.22	14,311.23	14,773.95	14,304.84	15,054.79	12,624.41	11,026.04
2. Industrial Processes	4,295.65	4,323.57	2,513.58	1,594.98	1,663.38	2,020.88	2,493.06	2,429.39	2,846.52	2,809.13	3,031.45
3. Solvent and Other Product Use	197.61	195.83	193.87	191.53	188.98	186.36	183.75	181.17	178.61	176.07	173.54
4. Agriculture	9,986.44	9,121.67	6,221.24	5,114.09	4,366.54	4,192.15	4,591.80	4,762.76	4,365.87	4,173.12	3,910.53
5. Land Use, Land-Use Change and Forestry(5)	-6,291.60	-6,955.50	-6,848.58	-786.71	-6,187.80	-3,785.24	1,724.47	-69.32	-7,644.04	-7,177.53	-7,582.92
6. Waste	1,165.70	1,187.72	1,202.37	1,216.13	1,216.00	1,216.69	1,215.84	1,218.34	1,219.59	1,214.93	1,222.06
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	**43,141.18**	**43,797.85**	**23,521.12**	**23,591.97**	**16,620.32**	**18,142.08**	**24,982.87**	**22,827.18**	**16,021.33**	**13,820.13**	**11,780.69**

TABLE 10 EMISSION TRENDS

SUMMARY (Part 2 of 2)

GREENHOUSE GAS EMISSIONS	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change 1990/2010 year
	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	(%)
CO_2 emissions including net CO_2 from LULUCF	4,882.42	10,403.84	3,782.36	8,079.26	11,381.80	10,619.45	14,037.89	7,526.18	1,968.24	2,101.52	-93.05
CO_2 emissions excluding net CO_2 from LULUCF	12,752.54	12,876.52	12,596.85	13,420.37	14,192.68	14,571.11	15,812.69	15,088.93	12,948.55	13,843.46	-62.13
CH_4 emissions including CH_4 from LULUCF	3,290.60	3,365.00	3,419.96	3,376.30	3,383.11	3,427.40	3,394.36	3,338.54	3,247.93	3,210.10	-44.73
CH_4 emissions excluding CH_4 from LULUCF	3,288.43	3,361.15	3,416.88	3,373.37	3,382.28	3,418.45	3,393.70	3,337.34	3,244.97	3,209.06	-44.73
N_2O emissions including N_2O from LULUCF	4,390.24	4,682.54	4,818.57	5,026.73	5,305.26	5,298.90	6,180.57	5,811.78	3,660.28	3,600.57	-49.27
N_2O emissions excluding N_2O from LULUCF	4,365.13	4,657.36	4,793.42	5,001.05	5,281.75	5,243.59	6,131.46	5,762.69	3,610.11	3,574.23	-49.47
HFCs	18.59	23.89	32.22	44.53	60.53	80.23	104.21	135.65	150.83	172.28	100.00
PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
SF_6	0.30	0.40	1.93	0.86	1.38	0.99	0.84	6.24	5.00	10.70	100.00
Total (including LULUCF)	**12,582.14**	**18,475.66**	**12,055.04**	**16,527.67**	**20,132.08**	**19,426.97**	**23,717.85**	**16,818.39**	**9,032.28**	**9,095.17**	**-78.92**
Total (excluding LULUCF)	**20,425.00**	**20,919.31**	**20,841.30**	**21,840.18**	**22,918.62**	**23,314.37**	**25,442.89**	**24,330.85**	**19,959.47**	**20,809.74**	**-57.90**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change 1990/2010 year
	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	CO_2 eq (Gg)	(%)
1. Energy	11,673.78	11,745.46	11,718.80	12,338.90	13,032.76	13,197.17	13,349.42	13,138.91	11,944.06	12,848.36	-61.97
2. Industrial Processes	3,266.84	3,468.58	3,304.01	3,733.45	4,096.37	4,355.05	6,164.59	5,501.82	2,302.17	2,249.17	-47.64
3. Solvent and Other Product Use	171.18	168.99	166.73	164.36	161.92	131.36	121.75	95.53	100.34	92.62	-53.13
4. Agriculture	4,071.53	4,285.64	4,394.51	4,371.33	4,413.71	4,440.02	4,631.10	4,419.59	4,443.42	4,458.33	-55.36
5. Land Use, Land-Use Change and Forestry(5)	-7,842.86	-2,443.66	-8,786.26	-5,312.51	-2,786.53	-3,887.40	-1,725.04	-7,512.46	-10,927.19	-11,714.57	86.19
6. Waste	1,241.67	1,250.65	1,257.25	1,232.14	1,213.85	1,190.77	1,176.02	1,175.00	1,169.47	1,161.25	-0.38
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (including LULUCF)(5)	**12,582.14**	**18,475.66**	**12,055.04**	**16,527.67**	**20,132.08**	**19,426.97**	**23,717.85**	**16,818.39**	**9,032.28**	**9,095.17**	**-78.92**

Annex VI. 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	2056177	399	3595	2396	399	0	**2062967**	6790
Cropland	0	2434822	399	0	0	0	**2435220**	-400
Grassland	0	399	1310073	0	0	0	**1310473**	-3594
Wetlands	0	0	0	362668	0	0	**362667**	-2397
Settlements	0	0	0	0	309944	0	**309944**	-399
Other land	0	0	0	0	0	48728	**48728**	0
Initial	***2056177***	***2435620***	***1314067***	***365064***	***310343***	***48728***	***6530000***	0

1991

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2062967	399	3595	2396	399	0	**2069757**	6790
Cropland	0	**2396078**	**0**	0	0	0	**2396078**	-39142
Grassland	0	**38743**	**1306878**	0	0	0	**1345621**	35148
Wetlands	0	0	0	360270	0	0	**360270**	-2397
Settlements	0	0	0	0	309545	0	**309545**	-399
Other land	0	0	0	0	0	48728	**48728**	0
Initial	***2062967***	***2435220***	***1310473***	***362667***	***309944***	***48728***	***6530000***	0

1992

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2069757	399	3195	1997	0	399	**2075748**	5991
Cropland	0	**2356936**	**0**	0	0	0	**2356936**	-39142
Grassland	0	**38743**	**1342426**	0	0	0	**1381169**	35548
Wetlands	0	0	0	358273	0	0	**358273**	-1997
Settlements	0	0	0	0	309545	0	**309545**	0
Other land	0	0	0	0	0	48329	**48329**	-399
Initial	***2069757***	***2396078***	***1345621***	***360270***	***309545***	***48728***	***6530000***	0

1993

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2075748	1198	3994	0	0	0	**2080941**	5193
Cropland	0	**2310605**	**0**	1198	1997	3994	**2317794**	-39142
Grassland	0	**25562**	**1369986**	10385	12781	24764	**1443478**	62309
Wetlands	0	2796	1997	346690	0	4394	**355877**	-2396
Settlements	0	14379	5192	0	294767	1598	**315936**	6391
Other land	0	2396	0	0	0	13580	**15977**	-32352
Initial	***2075748***	***2356936***	***1381169***	***358273***	***309545***	***48329***	***6530000***	0

1994

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2080541	0	2396	399	399	0	**2083737**	2796
Cropland	0	**2278652**	**0**	0	0	0	**2278652**	-39142
Grassland	0	**39142**	**1441082**	0	0	0	**1480224**	36746
Wetlands	0	0	0	355477	0	0	**355477**	-400
Settlements	0	0	0	0	315536	0	**315536**	-400
Other land	399	0	0	0	0	15977	**16376**	399
Initial	***2080941***	***2317794***	***1443478***	***355877***	***315936***	***15977***	***6530000***	0

1995

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2083737	0	1598	799	0	0	**2086133**	2396
Cropland	0	**2239508**	**0**	0	0	0	**2239508**	-39144
Grassland	0	**39144**	**1478626**	0	0	0	**1517770**	37546
Wetlands	0	0	0	354679	0	0	**354679**	-798
Settlements	0	0	0	0	315536	0	**315536**	0
Other land	0	0	0	0	0	16376	**16376**	0
Initial	***2083737***	***2278652***	***1480224***	***355477***	***315536***	***16376***	***6530000***	0

1996

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2086133	399	3195	1598	0	0	**2091325**	5192
Cropland	0	**2196891**	**0**	0	0	0	**2196891**	-42617
Grassland	0	**42218**	**1514575**	0	0	0	**1556793**	39023
Wetlands	0	0	0	353081	0	0	**353081**	-1598
Settlements	0	0	0	0	315536	0	**315536**	0
Other land	0	0	0	0	0	16376	**16376**	0
Initial	***2086133***	***2239508***	***1517770***	***354679***	***315536***	***16376***	***6530000***	0

1997

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2091325	799	2396	399	0	0	**2094920**	3595
Cropland	0	**2154274**	**0**	0	0	0	**2154274**	-42617
Grassland	0	**41818**	**1554397**	0	0	0	**1596215**	39422
Wetlands	0	0	0	352682	0	0	**352682**	-399
Settlements	0	0	0	0	315536	0	**315536**	0
Other land	0	0	0	0	0	16376	**16376**	0
Initial	***2091325***	***2196891***	***1556793***	***353081***	***315536***	***16376***	***6530000***	0

1998

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2094920	0	3595	0	0	399	**2098914**	3994
Cropland	0	**2111657**	**0**	0	0	0	**2111657**	-42617
Grassland	0	**42617**	**1592620**	0	0	0	**1635237**	39022
Wetlands	0	0	0	352682	0	0	**352682**	0
Settlements	0	0	0	0	315536	0	**315536**	0
Other land	0	0	0	0	0	15977	**15977**	-399
Initial	***2094920***	***2154274***	***1596215***	***352682***	***315536***	***16376***	***6530000***	0

1999

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2098515	399	1598	1198	0	0	**2101710**	2796
Cropland	0	**2069040**	**0**	0	0	0	**2069040**	-42617
Grassland	0	**42218**	**1633639**	0	0	0	**1675857**	40620
Wetlands	399	0	0	351483	0	0	**351883**	-799
Settlements	0	0	0	0	315536	0	**315536**	0
Other land	0	0	0	0	0	15977	**15977**	0
Initial	***2098914***	***2111657***	***1635237***	***352682***	***315536***	***15977***	***6530000***	0

2000

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2101710	399	1997	2396	0	399	**2106903**	5193
Cropland	0	**2026423**	**0**	0	0	0	**2026423**	-42617
Grassland	0	**41020**	**1673061**	799	399	399	**1715678**	39821
Wetlands	0	0	0	348687	0	399	**349087**	-2796
Settlements	0	1198	799	0	314737	399	**317134**	1598
Other land	0	0	0	0	399	14379	**14778**	-1199
Initial	***2101710***	***2069040***	***1675857***	***351883***	***315536***	***15977***	***6530000***	0

2001

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2106903	799	2396	0	0	0	**2110098**	3195
Cropland	0	**1983407**	**0**	0	0	399	**1983806**	-42617
Grassland	0	**35427**	**1707690**	399	1198	399	**1745113**	29435
Wetlands	0	0	1598	348687	0	1198	**351483**	2396
Settlements	0	6391	3195	0	315936	0	**325521**	8387
Other land	0	399	799	0	0	12781	**13979**	-799
Initial	***2106903***	***2026423***	***1715678***	***349087***	***317134***	***14778***	***6530000***	0

2002

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2110098	0	3994	0	0	0	**2114092**	3994
Cropland	0	**1941189**	**0**	0	0	0	**1941189**	-42617
Grassland	0	**42617**	**1741119**	0	0	0	**1783736**	38623
Wetlands	0	0	0	351483	0	0	**351483**	0
Settlements	0	0	0	0	325521	0	**325521**	0
Other land	0	0	0	0	0	13979	**13979**	0
Initial	***2110098***	***1983806***	***1745113***	***351483***	***325521***	***13979***	***6530000***	0

2003

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2113693	799	3595	1198	0	0	**2119284**	5192
Cropland	0	**1898572**	**0**	0	0	0	**1898572**	-42617
Grassland	0	**41818**	**1780141**	0	399	0	**1822358**	38622
Wetlands	399	0	0	350285	0	0	**350684**	-799
Settlements	0	0	0	0	325122	0	**325122**	-399
Other land	0	0	0	0	0	13979	**13979**	0
Initial	***2114092***	***1941189***	***1783736***	***351483***	***325521***	***13979***	***6530000***	0

2004

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2118885	399	6391	1598	0	0	**2127273**	7989
Cropland	0	**1855955**	**0**	0	0	0	**1855955**	-42617
Grassland	0	**42218**	**1815967**	0	0	0	**1858185**	35827
Wetlands	399	0	0	348687	0	0	**349087**	-1597
Settlements	0	0	0	399	325122	0	**325521**	399
Other land	0	0	0	0	0	13979	**13979**	0
Initial	***2119284***	***1898572***	***1822358***	***350684***	***325122***	***13979***	***6530000***	0

2005

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2127273	799	5592	1598	0	399	**2135660**	8387
Cropland	0	**1813334**	**0**	0	0	0	**1813334**	-42621
Grassland	0	**41822**	**1852593**	0	0	0	**1894415**	36230
Wetlands	0	0	0	347489	0	0	**347489**	-1598
Settlements	0	0	0	0	325521	0	**325521**	0
Other land	0	0	0	0	0	13580	**13580**	-399
Initial	***2127273***	***1855955***	***1858185***	***349087***	***325521***	***13979***	***6530000***	0

2006

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2134861	799	5592	1598	0	0	**2142850**	7190
Cropland	0	**1812535**	**69997**	0	0	0	**1882532**	69198
Grassland	0	**0**	**1818826**	0	0	0	**1818826**	-75589
Wetlands	0	0	0	345891	0	0	**345891**	-1598
Settlements	399	0	0	0	325521	0	**325921**	400
Other land	399	0	0	0	0	13580	**13979**	399
Initial	***2135660***	***1813334***	***1894415***	***347489***	***325521***	***13580***	***6530000***	0

2007

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2142850	2796	3195	1997	0	399	**2151237**	8387
Cropland	0	**1879337**	**72393**	0	0	0	**1951730**	69198
Grassland	0	**0**	**1737646**	799	0	0	**1738445**	-80381
Wetlands	0	0	1198	343096	0	0	**344294**	-1597
Settlements	0	399	3595	0	325921	0	**329915**	3994
Other land	0	0	799	0	0	13580	**14379**	400
Initial	***2142850***	***1882532***	***1818826***	***345891***	***325921***	***13979***	***6530000***	0

2008

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2151237	1598	3994	399	0	0	**2157229**	5992
Cropland	0	**1949733**	**70796**	0	399	0	**2020928**	69198
Grassland	0	**0**	**1661258**	399	399	399	**1662455**	-75990
Wetlands	0	0	799	343495	0	0	**344294**	0
Settlements	0	399	799	0	329116	0	**330314**	399
Other land	0	0	799	0	0	13979	**14778**	399
Initial	***2151237***	***1951730***	***1738445***	***344294***	***329915***	***14379***	***6530000***	0

2009

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	Net change
Forest land	2156430	0	3195	0	0	0	**2159625**	2396
Cropland	0	**2020928**	**69199**	0	0	0	**2090127**	69199
Grassland	0	**0**	**1590061**	0	0	0	**1590061**	-72394
Wetlands	399	0	0	344294	0	0	**344693**	399
Settlements	399	0	0	0	330314	0	**330714**	400
Other land	0	0	0	0	0	14778	**14778**	0
Initial	***2157229***	***2020928***	***1662455***	***344294***	***330314***	***14778***	***6530000***	0

2010

Land category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	**Final**	**Net change**
Forest land	2159625	399	5592	399	0	0	**2166016**	6391
Cropland	0	2087731	5592	0	0	0	**2093323**	3196
Grassland	0	1997	1578879	1198	0	0	**1582074**	-7987
Wetlands	0	0	0	343096	0	0	**343096**	-1597
Settlements	0	0	0	0	330714	0	**330714**	0
Other land	0	0	0	0	0	14778	**14778**	0
Initial	***2159625***	***2090127***	***1590061***	***344693***	***330714***	***14778***	***6530000***	0

ANNEX VII. IMPROVEMENTS IN RESPONSE TO RECOMMENDATIONS PROVIDED IN THE 2011 ARR

No.	ERT recommendations	Reference to para of the ARR 2011	Lithuania`s response	Where in the NIR/CRF
Cross-cutting issues				
1.	The ERT strongly recommends that Lithuania put in place the action plan to improve its LULUCF reporting and report the corresponding emissions and removals from KP-LULUCF activities in accordance with the requirements defined in the annex to decision 15/CMP.1.	Para 25	The action plan to improve LULUCF reporting was implemented: corresponding emissions and removals from KP-LULUCF activities were recalculated in accordance with the requirements defined in the annex to decision 15/CMP.1 according to implemented Study-1 and Study-2 results, the number of legislation improving data collection system was approved, permanent staff of State Forest Service was complemented by 6 officials (2 specialists responsible for LULUCF and KP-LULUCF estimates, 4 specialists employed to conduct sampling of non-forest land), enhanced QA/QC system etc.	Chapters 11; 13
2.	The ERT recommends that Lithuania take into account the results of the key category analysis when prioritizing the inventory improvements and that the Party include in its implementation plan the activities related to the use of higher-tier methods in line with the decision trees contained in the IPCC good practice guidance.	Para 30	Results of the key category analysis when prioritizing the inventory improvements were taken into account, e.g. as a planned improvements in this submission emissions from road transportation were recalculated using Tier 2 method (previously used Tier 1), estimates from LULUCF sector were considerably improved - emissions/removals from Cropland and Grassland were estimated for the first time (identified as a key	Through the NIR

			categories) etc. In future inventories we will also prioritize improvements according to key categories analysis results.	
3.	The ERT recommends that Lithuania plan longer-term inventory improvements and include these plans in the inventory improvement plan.	Para 31	Some longer-term inventory improvements were included in the last inventory improvement plan (implementation of the Norway Grants partnership project, experimental evaluation of country specific methane producing capacities (B_0)). We will take into account this recommendation also when developing next inventory improvement plan.	-
4.	The ERT recommends that Lithuania further consider the level of disaggregation used for the key category analysis, by taking into account country-specific issues, such as the level at which the EFs are applied, in line with the IPCC good practice guidance and the IPCC good practice guidance for LULUCF. The ERT also recommends that Lithuania report on the rationale for such disaggregation. The ERT also notes that Lithuania does not follow the IPCC good practice guidance for LULUCF to identify the key categories for KP-LULUCF activities. The ERT recommends that Lithuania follow the guidance on establishing the relationship between the activities under the Kyoto Protocol and the associated key categories in the UNFCCC inventory, as provided in chapter 5.4.4 of the IPCC good practice guidance for LULUCF.	Para 33	In this submission 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. Lithuania also followed the IPCC good practice guidance for LULUCF to identify the key categories for KP-LULUCF activities. In this submission only CO_2 emissions from Forest management were identified as a key category in KP-LULUCF.	Chapter 1.5; Annex I
5.	The ERT recommends that Lithuania report consistently the key categories in the NIR and in CRF table 7 in its next annual submission.	Para 34	Key categories in the NIR and in CRF table 7 are reported consistently in this submission.	Chapter 1.5; Annex I

6.	The ERT recommends that Lithuania use the key category analysis to guide the choice of methods and QA/QC activities in line with the IPCC good practice guidance and report thereon in the next annual submission.	Para 35	Please see the comment to para 30 above.	-
7.	The ERT recommends that Lithuania provide more transparent information in the next annual submission, in particular, on the use of expert judgement to estimate the uncertainties.	Para 37	Uncertainties were reported more transparently in this submission. Further re-evaluation/justification of uncertainties is planned for the next submission.	Through the NIR
8.	The ERT also noted that the uncertainties used in the analysis (the tables contained in annex 2 to the NIR) are not fully consistent with the description in chapter 1.7 of the NIR. The ERT recommends that Lithuania improve the consistency within the NIR in its next annual submission.	Para 38	The consistency between NIR and CRF was improved in this submission.	-
9.	The ERT recommends that Lithuania include the solvent and other product use sector in the uncertainty analysis in its next annual submission.	Para 39	Solvent and other product use sector is included in the uncertainty analysis in this submission.	Chapter 1.7; Annex II
10.	The ERT reiterates the recommendation from the previous review report that Lithuania include more precise justification for the recalculations and how they contribute to real inventory improvements and to time-series consistency.	Para 41	More detailed explanations on the recalculations made are included in this submission.	Through the NIR
11.	The ERT recommends that Lithuania ensure time-series consistency for all categories and report them, in the NIR, in particular where methods, data sources or EFs change over time.	Para 42	The number of recalculations increasing time-series consistency, especially in energy, agriculture and LULUCF sectors were made in this submission.	Through the NIR
12.	The ERT encourages Lithuania to develop and implement category-specific QC procedures for the key categories and those individual categories in which significant methodological changes and/or data revisions have occurred, in accordance with the IPCC good practice guidance.	Para 44	The number category-specific QC and verification procedures were developed and implemented in this submission (Energy, IP, Agriculture, Waste sectors). Category-specific QC procedures in Industrial processes and Waste sector were implemented for the first time.	Through the NIR

13.	The ERT noted that there are no national QA procedures in place, and such procedures are not currently planned. The ERT encourages Lithuania to develop permanent national QA procedures and include them in the QA/QC plan.	Para 45	We will put efforts to establish permanent national QA procedures and will include them in the 2013 QA/QC plan.	-
14.	The ERT noted that the QA/QC plan does not specify the quality objectives. During the review, Lithuania provided the ERT with an updated QA/QC plan with specifying the quality objectives. The ERT welcomes this improvement and recommends that Lithuania include this information in its next NIR.	Para 47	Information on QA/QC plan quality objectives is included in the NIR.	Chapter 1.6.1
15.	The ERT recommends that Lithuania further strengthen its QA/QC system and report more transparently on how the QA/QC activities are integrated as part of the functions of the national system, and on how the implementation of the QA/QC plan is ensured in the new arrangements for the national system.	Para 48	In 2011 EPA was assigned as QA/QC manager of the Lithuanian GHG inventory. In the beginning of 2012 the Climate change division was established within the EPA consisting of 5 officials. QA/QC activities implemented during the work with this submission is described in the NIR.	Chapter 1.6
16.	The ERT considers that the NIR is still not sufficiently transparent and reiterates the recommendation made in the previous review report that Lithuania improve the transparency of its reporting, in particular with regard to the sectoral chapters of the NIR.	Para 50	The transparency in sectoral chapters was considerably improved in this submission.	Through the NIR
17.	The ERT recommends that Lithuania implement the Archive Improvement Plan and ensure that the improved archiving system conforms to the requirements related to the archived inventory information contained in the annex to decision 19/CMP.1. The ERT further recommends that the Party report on the improved archiving system and ensure that, in its next annual submission, it is be able to demonstrate that the archive is fully in line with the requirements of the annex to decision 19/CMP.1.	Para 53	Archive Improvement Plan implementation will be finalised in June 2012 according to schedule and ability to demonstrate that the archive is fully in line with the requirements of the annex to decision 19/CMP.1. will be ensured.	Chapter 1.6
	Energy			
18.	The ERT recommends that Lithuania archive detailed information on the derivation of all country-specific EFs, in order to enhance transparency.	Para 62	Country specific emission factors were archived in the central archive database by	-

			EPA.	
19.	The ERT recommends that Lithuania use the default EFs from the Revised 1996 IPCC Guidelines for fuels (for which EFs were obtained from studies conducted in different countries or selected from the *EMEP/CORINAIR Emissions Inventory Guidebook)* and report on their use in its next annual submission, in case it cannot provide a justification for the use of other, non country-specific data.	Para 63	In this submission country specific emission factors (which are in range of default EFs proposed by IPCC) and IPCC default emission factors for emission estimates were used. Previously used Corinair emission factors for some fuels were replaced by IPCC defaults.	Chapters 3; 10.1
20.	The ERT recommends that Lithuania continue to report estimates of emissions from peat combustion using CO_2 EF for peat from the Revised 1996 IPCC Guidelines unless a country-specific EF is available and justifiable.	Para 64	Emissions from peat combustion were estimated using CO_2 EF for peat from the Revised 1996 IPCC Guidelines.	Chapters 3; 10.1
21.	The ERT recommends that Lithuania use the default CH_4 and N_2O EFs emissions from the Revised 1996 IPCC Guidelines and/or the IPCC good practice guidance for all fuels and categories, where available (even if only broadly applicable) and report thereon in the next annual submission. The ERT strongly recommends that Lithuania explain the appropriateness of the use of EFs from sources other than the Revised 1996 IPCC Guidelines and the IPCC good practice guidance in its next annual submission.	Para 66	In this submission country specific emission factors (which are in range of default EFs proposed by IPCC) and default emission factors for emission estimates were used. Previously used Corinair emission factors for some fuels were replaced by IPCC defaults.	Chapters 3; 10.1
22.	The ERT reiterates the recommendation made in the previous review reports that Lithuania correctly document the tier of the methodological approaches used in the energy sector.	Para 67	The tiers of the methodological approaches used in the energy sector were correctly documented in appropriate activity sections in this submission.	Chapter 3
23.	The ERT recommends that Lithuania continue to estimate emissions from gaseous fuels using the reference approach in a similar manner and provide, in its next annual submission, an explanation of the non-energy use of gaseous fuels in the documentation boxes in CRF tables 1.A(c) and 1.A(d).	Para 70	For the reference approach non-energy use of fuels has been subtracted. The share of natural gas allocated for non-energy use, i.e. process emissions from ammonia production, are included in category 2.B.1 Ammonia Production.	Chapter 3.2.3
24.	The ERT reiterates the recommendations of the previous review reports that Lithuania seek to develop a consistent set of AD for aviation fuel (international	Para 71	Following advice from experts it was decided to distinguish GHG emissions from aviation	Chapters 3.4.1;

	use). If the issue regarding the AD cannot be resolved, and if data exist to split domestic and international aviation emissions from 2001 onwards, the ERT recommends that Lithuania address the time-series inconsistency issue by extrapolating emissions from bunkers and civil aviation for the period prior to 2001, in accordance with the IPCC good practice guidance. The ERT also reiterates the recommendation of the previous review report that Lithuania include, in annex 2 to the NIR, a description of how the consistency of the AD is ensured.		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. Following the recommendation of ERT, the estimates of aviation gasoline consumption were linearly interpolated for the period 1996-1999 since effect of annual fluctuations was considered negligible. Trend extrapolation of GHG from jet kerosene for 1990-2000 was evaluated in combination with surrogate data.	10.1
25.	CH_4 emissions from biomass have been estimated using a tier 1 approach. The ERT recommends that Lithuania estimate these emissions using a tier 2 approach, in line with the IPCC good practice guidance.	Para 72	A study on the revision of the emission factors used for energy sector was initiated by Ministry of Environment. The tender for this study was announced in March 2012. It is expected that results of this study will be presented in 2013 submission.	Chapter 10.2
26.	The ERT identified areas for further improvement, such as the development of additional country-specific EFs for CO_2 emissions from fuel combustion, using detailed (and certified) laboratory measurements of the properties of natural gas used in the country, available in some of its chemical facilities.	Para 76	Please see the comment to para 72 above.	Chapter 10.2
	Industrial processes and solvent use			
27.	Lithuania used the notation key "NE" to report emissions for the entire time-series for some categories (e.g. CO_2 emissions from asphalt roofing and road paving with asphalt; CH_4 and N_2O emissions from glass production; CO_2 emissions from food and drink production; CO_2 emissions from chemical products, manufacture and processing and other (food and drink); and N2O emissions from degreasing and other uses of N_2O, except for the use of N_2O for anaesthesia in solvent and other product use), for which methodologies and/or	Para 81	In this submission, CO2 emissions from asphalt roofing and CO2 emissions from food and drink production were calculated for the first time. We will consider the possibility of estimating remaining emissions, for which methodologies and/or EFs are not available in the IPCC good practice guidance in the next	Chapters 4.2.5, 4.5.2; 10.1

	EFs are not available in the IPCC good practice guidance or the Revised 1996 IPCC Guidelines. The ERT encourages Lithuania to explore the possibility of estimating these emissions in its next annual submission.		submissions.	
28.	The ERT recommends Lithuania to provide in the NIR of its next annual submission a clear explanation on why it reports some categories as partly complete, if applicable.	Para 82	Emissions were reported as "partly complete" for the reason that some emissions are not estimated due to unavailability of IPCC methodologies or EFs.	-
29.	The ERT noted that no category-specific QA/QC activities for the industrial processes sector have been reported in the NIR, and encourages that the Party implement category-specific QA/QC activities and report thereon in the next annual submission.	Para 83	Category-specific QA/QC activities were implemented for part of the Industrial processes sector categories (comparison with EU ETS data, comparison of the IPCC defaults with plant-specific EFs) in this submission.	Chapter 4
30.	The ERT notes that the calculated CKD correction factor (0.5-2.3 per cent) is in line with the default CKD correction factor from the IPCC good practice guidance (2 per cent) and encourages Lithuania to include the time-series of the CKD correction factor in the NIR of its next annual submission.	Para 85	The time-series of the CKD correction factor is provided in the NIR 2012.	Table 4-3
31.	The ERT recommends that Lithuania explain variations in the implied emission factor (IEF) for ammonia (NH_3) production, in particular for those years where the inter-annual differences are most significant.	Para 87	Explanation on variations in the implied emission factor for ammonia production is provided in the NIR 2012.	Chapter 4.3.1.1
32.	N_2O emissions from nitric acid production were estimated for the period 1990-2008 using a mean value of the unit-specific baseline EFs, as unit-specific production data were not available. The ERT recommends that Lithuania define which of the production units were in operation in 1990 and each year thereafter and report annual emissions using the mean value of EFs of the actually operating units. The emissions for 2009 were calculated using a mean value of the measured EFs after the installation of the catalysts. The ERT recommends that Lithuania use the unit-specific AD and EFs in the next annual submission.	Para 90	Recalculation was made for the entire time series (1990-2010) using plant and production unit specific emission factors and unit specific activity data.	Chapters 4.3.2; 10.1

33.	The ERT notes that the uncertainty estimates in the 2011 annual submission are the same as those reported in the 2010 annual submission, and recommends that the Party reassess the uncertainty of the EFs, since it is currently using measured emission data to estimate N_2O emissions.	Para 91	Uncertainty of EF for calculation of emission from nitric acid production was re-evaluated.	Chapter 4.3.2
34.	The ERT recommends that Lithuania collect country-specific AD, calculate both the actual and the potential emissions for the entire time-series of HFC emissions from foam blowing and better describe the methodology and data used in its next annual submission.	Para 93	Country-specific AD was collected, both actual and potential emissions of HFC emissions from foam blowing was calculated and used methods were described in this submission.	Chapter 4.7.2
35.	The ERT recommends that Lithuania include information on planned improvements which will improve the completeness and accuracy of the F-gases emission estimates in its next annual submission, in order to improve the transparency of its reporting.	Para 95	To improve F-gases estimates, a study to determine the quantity of fluorinated gases use in Lithuania during 1990-2011 was initiated in 2012. It is expected that this study will cover all remaining reporting gaps and improved methods for emissions calculations and recommendations how to enhance F-gases data collection system will be developed. Procurement procedure for this study was started in April 2012. Study results are to be ready in August 2012.	Chapters 4.7.1.5, 10.2
36.	The ERT reiterates the recommendations in the previous review reports that Lithuania re-evaluate the leakage rates of SF6 emissions from electric equipment on the basis of the type of application and report the emissions of F-gases remaining in products at decommissioning.	Para 96	SF6 emissions from electric equipment will be reviewed during the implementation of the Study to determine the quantity of fluorinated gases use in Lithuania during 1990-2011. Study results are to be ready in August 2012.	Chapters 4.7.7., 10.2

Agriculture				
37.	The ERT strongly recommends that Lithuania increase the transparency and consistency of its estimation methods and reporting in its next annual submission, by providing explanatory and background information to justify the use of country-specific EFs and methodologies. The time-series has several one-year step changes (e.g. milk production in 1999 and synthetic fertilizers consumption in 2006), which are not explained or documented in the 2011 NIR or in the CRF tables. The ERT recommends that Lithuania include the trend analyses and provide information on the key drivers in its next annual submission.	Para 103	Information on the trend analyses and the key drivers in agricultural sector is provided in the NIR.	Chapter 6.1
38.	The ERT strongly recommends that Lithuania implement additional QA/QC procedures to ensure the verification of the national data at each level of AD collection, EF estimation and emission estimation.	Para 105	QA/QC procedures were strengthened in this submission. Verification of the AD, EF and emission estimation was performed by QA/QC manager Environmental Protection Agency.	-
39.	The ERT reiterates the recommendation in the previous review report that Lithuania clearly describe in the NIR the differences in the data collection systems and justify why the data from the Register are used for cattle only and not for other animal species. The ERT strongly recommends that Lithuania harmonize the reporting for all animal categories by using the most accurate data source.	Para 107	The data from the Register was used for cattle and sheep. The differences in the data collection systems are described in the NIR.	Chapter 6.2.2
40.	The ERT recommends that Lithuania obtain country-specific data and harmonize the methodology used to estimate emissions from enteric fermentation from swine, in order to ensure the consistency of the entire time-series. The ERT recommends that Lithuania explain the decrease in the value of EF for swine in 2009 and include corresponding information in the next annual submission.	Para 108	The methodology used to estimate emissions from enteric fermentation from swine was harmonized in this submission and country specific EFs from enteric fermentation from swine were used for entire time-series. Furthermore, emission from non-dairy cattle was also recalculated in order to ensure time-series consistency.	Chapters 6.2.5, 10.1
41.	The ERT recommends that Lithuania correct the animal mass information for non-dairy cattle animals for enteric fermentation and harmonize with	Para 110	The information on animal mass of non-dairy cattle was made consistent in all	-

	information reported for manure management for the entire time-series and report MCF in table 4.B(a) as a percentage.		subcategories and MCF was reported in table 4.B(a) as a percentage.	
42.	The ERT recommends that Lithuania explain the changes in the country-specific N-excretion rates for non-dairy cattle and recalculate the entire time-series since 1990 using a consistent methodology, in order to increase the consistency and transparency of its reporting in the next annual submission.	Para 111	N-excretion rates of non-dairy cattle were recalculated for the entire time-series since 1990 using a consistent methodology.	Chapters 6.3.2.5, 10.1
43.	Lithuania has estimated direct N_2O emissions from agricultural soils using a tier 1 methodology and default EFs and other parameters from the IPCC good practice guidance. The ERT encourages Lithuania to use a higher-tier method and explore country-specific EFs for the estimation of emissions from this category.	Para 112	We will investigate the possibility to use a higher-tier method and explore country-specific EFs for the estimation of emissions from this category in the future submissions.	-
44.	The ERT reiterates the recommendation in the previous review report that Lithuania improve the data collection on synthetic fertilizer consumption and improve the category-specific QA/QC activities in order to improve the transparency of its reporting in the next annual submission.	Para 113	In this submission activity data on synthetic fertilisers use was revised and updated for all time series. The used sources are clearly described in NIR and documented in the GHG inventory archive.	Chapters 6.5.1.2, 10.1
45.	The ERT reiterates the recommendation in the previous review report that Lithuania include the background data used for calculation of FracGRAZ in the NIR of its next annual submission.	Para 114	The background data used for calculation of FracGRAZ is provided in the NIR.	Chapter 6.5.1.2, Table 6-51
46.	The ERT encourages Lithuania to use a higher-tier method and use the country-specific EFs for the estimation of emissions from Indirect soil category and increase the transparency of its reporting from this category.	Para 115	We will investigate the possibility to use a higher-tier method and country-specific EFs for the estimation of emissions from this category in the future submissions.	-
Land use, land-use change and forestry				
47.	The ERT reiterates the recommendations in the previous review report that Lithuania provide estimates of emissions and removals for the mandatory categories, such as cropland and grassland, CH_4 and N_2O emissions from biomass burning (other than for forest land remaining forest land), and N2O emissions	Para 120	Emissions and removals from the mandatory categories, such as cropland and grassland, CH_4 and N_2O emissions from biomass burning (other than for forest land remaining forest	Chapter 7.1.5; Table 7-7

	from disturbance associated with land-use conversion to cropland categories in order to improve the completeness of its reporting. The ERT also recommends that Lithuania review its use of the notation keys reported in the CRF tables and report using the notation key „NO“ any activities that do not occur in the country.		land) were reported in this submission. Notation keys “NO” were used for activities and land use changes that do not occur in Lithuania.	
48.	The ERT notes that the revision of the allocation of land to different land categories has resulted in a substantial increase in the area under the category other land, but a justification of this increase has not been provided. Also, the ERT notes that forest land has been converted to other land and reiterates the recommendation in the previous review reports that Lithuania present more detailed information on the type of land use/land cover allocated to the distinct land categories, particularly other land. The ERT also notes that large inter-annual changes in area occurred since 1990, especially for cropland (e.g. an increase of 30.6 per cent between 1990 and 1991); grassland (e.g. a decrease of 63.9 per cent between 1990 and 1991); and other land (e.g. a decrease of 42.4 per cent between 1994 and 1995) and strongly recommends that Lithuania provide a clear explanation of how it estimates area under each land category and the corresponding inter-annual changes.	Para 121	Land use transition matrix was developed from *Study-1* and *Study-2* results and is presented in this submission.	Chapter 7.1.4; Annex VI
49.	The ERT notes that Lithuania has revised the land allocation to the category other land for the period 2001-2009 without an explanation of the reasons for the revision. In addition, the figures for the period 1990-2000 have not been revised, resulting in time-series inconsistencies, not only for the category other land but also for the other land categories, particularly grassland. The ERT strongly recommends that Lithuania improve reporting on the time-series consistency, especially for all the years prior to 2000. In the absence of country-specific data, the ERT recommends that Lithuania implement an adequate methodological approach to ensure time-series consistency in accordance with the IPCC good practice guidance for LULUCF. The ERT also notes that, due to the revisions of the CRF tables prior to the review, the information provided in the NIR (e.g. table 7.2) has not been updated, leading to inconsistencies between	Para 122	Land use transition matrix was developed from *Study-1* and *Study-2* results and is presented in this submission. Consistency in time-series data and in data between NIR and CRF is assured in this submission.	Chapter 7.1.4; Annex VI

	the data reported in the NIR table 7.2 and in CRF table 5.F.			
50.	Following a strong recommendation in the previous review report, Lithuania has used data from the NFI as the main data source for its 2011 annual submission. Lithuania reported in the NIR that, in some cases, these data had to be harmonized with those from the Stand Forest Inventory (SFI), but no information has been provided on how this harmonization was achieved. The ERT strongly recommends that Lithuania provide this information in its next annual submission.	Para 123	For this submission Lithuania uses data received after finalizing two studies (Study-1 and Study-2), that were launched with the purpose comprehensively identify land use areas as well as emissions and removals of CO_2.	Chapter 7
51.	The ERT recommends that Lithuania strengthen its QA/QC procedures to avoid providing misinformation in its next annual submission and that it reviews the recalculations introduced in its 2011 annual submission, incorporating the necessary changes in its next annual submission.	Para 124	QA/QC procedures to avoid providing misinformation were strengthened in State Forest Service and Environmental Protection Agency (QA/QC manager of Lithuania's GHG inventory) for this submission.	Chapter 7
52.	The reporting on forest land remaining forest land is complete. However, the ERT reiterates the recommendation in the previous review report that noted a lack of transparency of the reporting of the carbon changes in the dead organic matter (dead wood and litter) and mineral soil pools. The ERT recommends that Lithuania address the issues raised in paragraphs 126-128 below in relation to dead wood and litter pools, respectively.	Para 125	Estimations were improved according new activity data (Study-1) and are presented in this submission.	Chapter 7.2;
53.	Lithuania reported in the 2011 NIR that the carbon stock changes in dead wood in forest land remaining forest land are calculated using the same method (the stock change method) as that used to estimate the carbon stock changes in living biomass. However, the ERT notes that this is not consistent with the methods suggested in the IPCC good practice guidance for LULUCF (equations 3.2.11 and 3.2.12), and strongly recommends that Lithuania revise the estimates provided for dead wood in its next annual submission, applying the adequate methodology and conducting the necessary recalculations.	Para 126	Required dead wood data was revised and corrected. Dead wood is calculated for 'Forest land remaining Forest land'. Biomass of dead trees stems is calculated by using stock change method and employing equation 3.2.12 from *IPCC Good Practice Guidance for LULUCF*.	Chapters 7.2.1.2; 7.2.2.5; 7.2.3.2
54.	To estimate the carbon stock changes in litter, Lithuania has used a tier 1 methodology and assumed that the average transfer rates in and out of the litter	Para 127	Recalculations were made according to Study-	Chapter 7.2.3.2

	pool are equal and the net carbon stock change is therefore equal to zero. However, Lithuania has reported the net carbon stock change in dead organic matter in forest land remaining forest land due to the transition of land converted to forest land after the 20-year default time period. The carbon stock change is equal to the default average carbon stock in litter and the area transferred. The ERT notes that this approach requires a corresponding decrease in the carbon stock in litter in land converted to forest land, in order to ensure that a net effect of the transfer is equal to zero since there was no real change in the carbon stock in forest land, only an allocation of the carbon stock in forest land remaining forest land and land converted to forest land. Since Lithuania uses the notation key „NA" for the net carbon stock change in dead organic matter in land converted to forest land, the final result is an overestimation of emissions. The ERT recommends that Lithuania revise this issue in its next annual submission. Alternatively, the ERT recommends that Lithuania simply assume that the carbon stock changes are equal to zero, if it continues to report using a tier 1 methodology, without increasing the carbon stock at every transition realized.		1 data results.	
55.	To estimate the carbon stock changes in mineral soils, Lithuania used a tier 1 methodology and assumed that the carbon stock in this pool remains constant. However, Lithuania has reported that the mineral soils pool is treated in a similar way to the litter pool (see para. 127 above). The ERT recommends that Lithuania follow the same procedure as outlined above for the litter pool. However, the ERT encourages Lithuania to provide the evidence to demonstrate that no changes in the management of forest, land types and disturbance regimes occur, in order to support the assumption of the zero carbon stock change. Otherwise, a higher-tier method, rather than the default method, should be applied. For organic soils, Lithuania has used the appropriate methodological approach and default values from the IPCC good practice guidance for LULUCF to estimate the carbon stock changes.	Para 128	Lithuanian assumed that carbon stock balance in mineral soil in Forest land remaining forest land as well as Land converted to forest land is equal to 0, what corresponds to IPCC GPG Tier1.	Chapter 7.2.2.6
56.	The ERT notes that Lithuania has provided in the relevant CRF tables, the total area of organic soils (drained and not drained) in forest land (approximately 15.7 per cent of the total forest land area) in order to estimate the changes in the	Para 129	Information on the area of drained organic soils is provided in the documentation box of	Chapter 7.2.1.1

	carbon stock from the organic soils pool. However, the net emissions are calculated for the drained organic soils only, which correspond to 7.9 per cent of the soils in forest land and 50.3 per cent of the total area of organic soils. The ERT recommends that Lithuania provide information on the area used to estimate the emissions (drained organic soils only) in the documentation box of the relevant CRF tables in the next annual submission.		the relevant CRF tables in this submission.	
57.	The ERT recommends that Lithuania explain, in its next annual submission, the need to estimate the carbon losses from fellings separately, and how these losses have been integrated into the final estimate. The ERT recommends that, if necessary, Lithuania provide revised estimates in the next annual submission.	Para 130	By using carbon stock change method (method 2) fellings are eliminated from calculations.	Chapter 7.2.1.3
58.	In the 2010 annual submission, the removals from land converted to forest land amounted to 1,403.70 Gg CO_2, while in the 2011 annual submission, despite the increase in the area converted, net removals totalled only 0.01 Gg CO_2. During the review, Lithuania has not provided an explanation for this. The ERT strongly recommends that Lithuania review the reporting of this subcategory in its next annual submission.	Para 131	Updated estimations of removals from land converted to forest land prepared using new activity data are presented in this submission.	Chapter 7.2.3.1
59.	Lithuania continues not to report the carbon stock changes in cropland, on the basis that management practices have not changed. The ERT notes that Lithuania has not followed the recommendation in the previous review report that Lithuania consider horticultural plantations, such as orchards and berry plantations, as cropland or provide a justification for classifying them as settlements. The ERT reiterates the recommendation in the previous review report that Lithuania improve the reporting on the cropland category in its next annual submission, in order to ensure greater accuracy, comparability, completeness and transparency.	Para 132	In this submission cropland definition has changed. 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. 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	Chapter 7.3

			others). All calculations are improved.	
60.	The ERT noted that Lithuania has not followed the recommendation in the previous review reports to estimate emissions and removals from mineral and organic soils in cropland, which is likely to be a key category, due to the substantial area of land involved and the changes to the area of croplands and the change in land management practices following the collapse of the former Soviet kolkhoz-based system.	Para 133	In this submission emissions and removals from cropland (changes in carbon stocks in soils) are reported for the first time.	Chapter 7.3.2.2
61.	Lithuania has not reported emissions and removals for grassland and has used the notation key „NE“ for all pools and sub-categories, except for forest land converted to grassland, for which the notation key „NA“ has been used. The ERT notes that the area under grassland has been relatively stable since 2001. However, the ERT also noted that, between 2000 and 2001, there was an increase of 10.1 per cent in the grassland area and that the grassland area of 1,111 kha in 1990 decreased to 400.7 kha in 1991 (a decrease of 63.9 per cent). Additionally, the ERT noted inconsistencies in the activity data reported in the NIR and in CRF table 5.C, particularly for the period 2001-2005. Lithuania has reported in the NIR that all grassland is managed, but it has not assessed the grassland area burned each year to estimate non-CO_2 emissions. Although the total area of grassland is reported, Lithuania has not separated grassland in mineral soils and in organic soils. The ERT strongly recommends that Lithuania report this category in its next annual submission, review the data provided for the early years of the time-series (particularly 1990) and identify the occurrence of fires in the different land categories.	Para 134	In this submission emissions and removals from grassland are included. Lithuania uses new activity data received after finalizing two studies (*Study-1* and *Study-2*).	Chapter 7.4
62.	Lithuania has reported emissions from organic soils for wetlands remaining wetlands as well as emissions and removals for all pools in the forest land converted to wetlands subcategory, assuming the instant oxidation of all biomass and dead organic matter, which are estimated using country-specific data. The ERT notes that Lithuania has not provided the area of wetlands separated into managed and unmanaged land (e.g. natural rivers and lakes) and recommends that Lithuania do so in its next annual submission. Lithuania has used the notation key „NE“ to report all other conversions to wetlands, due to	Para 135	Recalculations for separation of unmanaged and managed wetlands were made and the results presented in this submission (see paragraph “Wetlands” in NIR).	Chapter 7.5

	a lack of data. The ERT recommends that Lithuania provide more transparent information regarding the types of conversions that take place (e.g. rewetting of peat lands drained for forestry purposes, conversion to flooded land) in its next annual submission.			
63.	Lithuania has reported emissions from forest land converted to other land, assuming that all emissions take place in the year of conversion. However, the ERT notes that Lithuania has not provided transparent information on the transition from forest land to other land, and recommends that Lithuania provide the necessary information in its next annual submission, in order to justify this type of conversion, or else review the allocation of land to other land categories.	Para 136	Complete land transition matrix is provided in this submission for the first time.	Chapter 7.1; Annex VI
64.	Lithuania has not provided estimates of emissions from liming on cropland, explaining that dolomite has not been produced in the country for the last 10 years. However, as noted in the previous review report, dolomite can be imported and applied. The ERT thus reiterates the recommendation in the previous review report that Lithuania provide, in its next annual submission, additional documentation showing that liming has not occurred in the country.	Para 137	CO_2 emission from agricultural lime application was reported in this submission.	Chapter 7.3.2.2.1
65.	Lithuania has estimated non-CO_2 emissions from wildfires only for forest land remaining forest land. However, the ERT noted that Lithuania does not refer to the correct equation in the NIR, and uses the value for biomass consumption (19.8 t/ha) from table 3A.1.13 of the IPCC good practice guidance for LULUCF incorrectly, since it already 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, the ERT recommends that Lithuania apply the correct EFs for CH_4 and N_2O, as indicated in table 3.A.1.16 of the IPCC good practice guidance for LULUCF in its next annual submission. The ERT concluded that Lithuania has underestimated non-CO_2 emissions from wildfires by using the incorrect values in equation 3.2.20 and recommends that Lithuania revise these emissions in its next annual submission.	Para 138	Emissions were recalculated in this submission according to ERT recommendations.	Chapter 7.2.1.4
66.	Biomass burning on lands other than forest land has been reported using the notation key „NA" and „NE" in CRF table 5(V), and no explanation is provided for	Para 139	Notation key "NO" has been used for	CRF: 5(V)

	this in the NIR. While the ERT noted that forest land is not converted to grassland or cropland, the ERT reiterates the recommendation in the previous review report that Lithuania provide an explanation for this reporting decision in its next annual submission. The ERT also recommends that Lithuania revise the use of notation key „NA" for prescribed burning and use the notation key „NO" instead.		prescribed burning in this submission.	
Waste				
67.	Lithuania provided some information about the status of waste sector (section 8.1.1) in the 2011 NIR, but the ERT considers that this information needs to be extended and updated by adding the information for the most recent years. The ERT recommends that Lithuania provide, in the NIR of its next annual submission, a more detailed overview of the status of the waste sector, including historical information and the latest information on the amount of waste generated, information on measures and practices in waste treatment and waste incineration.	Para 143	Overview of the Lithuanian waste management sector includes description of data collection principles, discussion on data reliability involving experts from the Ministry of Environment and Environmental Protection Agency, review of data on disposal of waste of industrial and commercial origin, evaluation of historic waste disposal starting from 1950 using available data on population changes, economic development, and recorded waste disposal, review of waste disposal practices in cities, towns and rural areas, information on construction of new landfills and amounts of waste disposed of in old and new landfills, review of available data on waste composition, information on methane recovery, description of installations for waste incineration.	p. 286-300, 305-310, 315-316
68.	The ERT recommends that Lithuania provide information on the key parameters used for the estimation of emissions from industrial solid waste (e.g. degradable organic carbon (DOC) and methane correction factor) in its next annual submission.	Para 145	Information provided.	Chapter 8.2.2
69.	The ERT notes that emissions from stored sewage sludge in the 2011 annual	Para 146	Emissions from stored sewage sludge in this	Chapter 8.2.2

	submission are estimated based on the same method as the one used by the previous ERT for the adjustment applied in the previous review report. The ERT recommends that Lithuania use the methodology from the IPCC good practice guidance to estimate these emissions in its next annual submission, ensuring the consistency of the reporting for the entire time-series.		submission were estimated using methodology from the IPCC good practice guidance.	
70.	The ERT recommends that the Party estimate historical waste composition or provide an explanation why the waste composition is estimated to remain constant over the entire time period.	Para 147	There are no data whatsoever related to waste composition prior to 1996 when it was evaluated for the first time. Measured waste composition data obtained between 1996 and 2004 show that it was fairly constant. The main biodegradable component (about 50% of the total) of waste is organic kitchen waste which, most probably, hasn't changed throughout the whole period. We believe that other biodegradable components, like paper, wood, green waste, also haven't changed substantially during the investigation period. Therefore the assumption that fractions of biodegradable waste were more or less stable could be considered fairly reliable.	
71.	Lithuania has used the methodology from the 2006 IPCC Guidelines to estimate CH_4 emissions from solid waste disposal on land, but it has not provided in the NIR a justification for doing so. The ERT recommends that Lithuania provide a justification for the choice of methodology in its next annual submission.	Para 148	Justification for using First Order Decay (FOD) method for estimating methane emissions from landfills is provided in Section 8.2.2 of the NIR.	Chapter 8.2.2
72.	Lithuania has incorrectly reported CH_4 emissions from wastewater handling in CRF table 6.B, where it has reported the methane generation amount instead of the net emissions. This resulted in an overestimation of CH4 emissions by 8.4 per cent for 2009. The ERT recommends that Lithuania correct this mistake in its next annual submission.	Para 149	Corrected	CRF table 6.B
73.	The ERT strongly reiterates the recommendation in the previous review report	Para 150	The total methane emissions from wastewater handling were separated into	Chapter 8.2.2

	that Lithuania follow the decision tree in figure 5.2 of the IPCC good practice guidance to select the appropriate equation to estimate CH_4 emissions from domestic wastewater handling and recalculate these emissions for the entire time-series to ensure consistency in its next annual submission.		emissions from wastewater as such, and emissions from sewage sludge. Emissions from sewage sludge comprising the main part of the total emissions were calculated together with the emissions from solid waste landfills.	
74.	During the review week, the ERT reviewed the wastewater database at EPA and noted that there are data on chemical organic demand and biological organic demand concentration available before and after pre-treatment at different industrial sources. Hence, the ERT recommends that Lithuania separate CH_4 emissions from industrial wastewater and CH_4 emissions from domestic wastewater, where possible, using the methodologies from the Revised 1996 IPCC Guidelines and the IPCC good practice guidance.	Para 151	As noted in the NIR (Section 8.3.1, p. 306) according to the information provided by the Lithuanian Water Suppliers Association 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. As further discussed in the NIR, only BOD is measured regularly in all discharge points while COD measurements are not regular and cannot serve as representative background for estimation of methane emissions.	Chapter 8.3.1
75.	The ERT recommends Lithuania to improve the transparency of its reporting in its next annual submission by providing further information on the type of waste incineration facility and its abatement technique on the waste incineration	Para 152	More detailed information on waste incineration facility was provided in NIR 2012.	Chapter 8.4.1

	plants.			
KP-LULUCF				
76.	Lithuania has used the notation key „NO" to report CO_2 emissions from liming and N_2O emissions from fertilizer application, explaining that these activities do not occur in the country. The Party has also used the notation key „NO" to report emissions from disturbances associated with land-use conversion to croplands since these conversions are not considered to be relevant. The ERT recommends that the Party provide emissions to improve the completeness of its reporting or provide additional information to justify that these activities are not occurring in Lithuania.	Para 156	According to Directorate General of State Forests there were no forest fertilization and liming occurring since 1990 to 2010 in Lithuania. According to *Study-1* results there were no conversion of Forest land to Cropland during 1990-2010.	Chapter 11.3.1.1
77.	Lithuania has provided land-use transitions using approach 2 from the IPCC good practice guidance for LULUCF, and has adopted method 1 to identify and report activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol. Lithuania has defined the entire country as the unit of land, on which to report these activities, and has not provided the criteria for this choice. The ERT recommends that Lithuania provide the reasons for the choice of reporting method 1 to improve the transparency of the reporting (e.g. how the decision tree in figure 4.2.4 of the IPCC good practice guidance for LULUCF has been used to guide the decision).	Para 157	In this submission Lithuania adopted method 2 in combination with approach 3 to identify and report activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol.	Chapters 11.1.3, 11.2
78.	The ERT also notes that, according to the IPCC good practice guidance for LULUCF (table 4.2.2 on page 4.26), the combination of approach 2 and reporting method 1 can only be used if additional spatial information is available by re-compiling detailed inventory information, while ensuring appropriate spatial resolution to meet the definition requirements. The ERT recommends that Lithuania provide information, in its next annual submission, on how it plans to implement this requirement.	Para 158	In this submission Lithuania adopted method 2 in combination with approach 3 to identify and report activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol.	Chapters 11.1.3, 11.2
79.	Although Lithuania has provided a transition matrix both in the NIR and in the KP-LULUCF CRF tables, it is not clear how the annual changes in afforestation, reforestation and deforestation are assessed or estimated. Since the main data source is NFI, which collects annual data on some of the permanent sample	Para 159	Lithuania has considered ERT recommendations and provided clear information about annual changes in A/R/D and how data on annual land areas	Chapters 11.1.3, 11.2

	plots, the ERT recommends that Lithuania include a detailed description of how these annual changes are identified and/or estimated, and how the methods and supplementary information and data used, if any, in its next annual submission.		identification was derived.	
80.	Lithuania has reported CO_2, CH_4 and N_2O emissions from biomass burning for activities under Article 3, paragraph 3, of the Kyoto Protocol using the notation key „IE“, since these are included in the forest management activity subject to Article 3, paragraph 4, of the Kyoto Protocol. The ERT notes that since Lithuania has applied the stock change method to estimate the changes in carbon stock in forest land, then the decrease in biomass (and the associated CO_2 emissions) due to biomass burning should be reflected in the reduced merchantable volume. Reporting CO_2 emissions from biomass burning could lead to double-counting. Additionally, the ERT noted that Lithuania uses the value of 19.8 t/ha in table 3A.1.13 of the IPCC good practice guidance for LULUCF for wildfires in other temperate forest and the combustion factor of 0.45 in table 3A.1.12 of the IPCC good practice guidance for LULUCF for all other temperate forests. However, the value of 19.8 t/ha already represents the product of the mass of fuel available and the combustion factor to be used in the equation referred to by Lithuania. Thus, the estimates provided for the non-CO_2 emissions from biomass burning are underestimated. The ERT recommends that Lithuania review all the emissions from biomass burning using the appropriate input data. The ERT also recommends that Lithuania explain how it assess (or plan to assess) the changes in the carbon stock in afforestation and reforestation areas due to biomass burning to ensure the accurate reporting and accounting.	Para 160	Lithuania has re-estimated emissions from wildfires for Forest management and Afforestation/Reforestation activities separately and corrected emission factors values in this submission.	Chapter 11.3.1.1Chapter 11.3.1.1
81.	Lithuania has indicated that CO_2 emissions from liming are not occurring, since the major producers of dolomite in the country report the discontinuity of dolomite production in the last 10 years. The ERT reiterates the recommendation in the previous review report that Lithuania provide additional information and documentation to support this statement, since Lithuania could also import dolomite from other countries.	Para 161	According to Directorate General of State Forests there were no forest fertilization and liming occurring since 1990 to 2010 in Lithuania.	Chapter 11.3.1.1
82.	Lithuania has reported the activities under Article 3, paragraphs 3 and 4, of the	Para 162	Lithuania has considered ERT	Chapter 11.1.2

	Kyoto Protocol using two main sources of data, the Lithuanian State Forest Cadastre (LSFC) and the NFI from the SFS. However, whereas information about forest land area and other statistics are provided by LSFC for 1990 onwards, data for afforestation and reforestation, and deforestation and forest management from NFI are only available from 1998 onwards. There is still a lack of harmonized data for afforestation and reforestation, and deforestation and forest management for the period 1990-1998, and Lithuania has reported in the NIR that these data gaps will be filled by comparing and analyzing data from LSFC and SFS for the period 1998-2009. The ERT recommends that Lithuania provide transparent information on how the data collected from the different sources have been harmonized, including possible necessary changes in definition (e.g. the country-specific and UNFCCC definitions for reforestation). The ERT suggests that Lithuania refer to the methodological approaches in the IPCC good practice guidance for LULUCF addressing the time-series consistency.		recommendations and provided all information from Study-1 according to IPCC GPG.	
83.	The ERT noted that, although Lithuania has a very detailed NFI in place, based on permanent sample plots distributed along the entire country, the capacity to identify afforestation and reforestation activities, which entails assessing areas outside the forest land area, was not clearly demonstrated during the review week. Lithuania has reported as afforestation and reforestation the naturally regenerating lands that were previously used for agricultural activities and have been abandoned. However, the ERT notes that not all abandoned lands may regenerate to become a forest according to the forest thresholds defined by Lithuania. Therefore, the ERT suggests that Lithuania develop some indicators to support the likelihood of abandoned lands becoming forest and justify the inclusion of abandoned land under afforestation and reforestation when sufficient evidence exists that land will indeed become forest. In addition, considering that afforestation and reforestation are associated with direct human-induced conversion, the ERT recommends that Lithuania provide information on how it distinguishes the human-induced conversion from the natural (non-human induced) regeneration in its next annual submission.	Para 164	Information associated A/R (human induced and natural) is provided according to *Study-1* results. In the previous submission afforestation and reforestation area was accounted together without differentiation into natural and human induced. In this submission area of afforested and reforested areas is divided and only human induced afforestation and reforestation is accounted. Natural afforestation and reforestation is included in Forest management area.	Chapters 11.1.2, 11.2, 11.4.1
84.	Lithuania has indicated in the NIR that it will further develop the methods to demonstrate that the activities under Article 3, paragraph 3, of the Kyoto	Para 165	Lithuania is receiving declarations concerning afforestation and reforestation annually. All	Chapter 11.1.3

	Protocol began on or after 1 January 1990 and before 31 December 2012 and are directly human-induced, and that it will provide information on the land area estimation as well as the methods to estimate removals and emissions. The Party also indicated that the estimates presented in the 2011 annual submission for 2008 and 2009 may change at the end of the commitment period. During the review, Lithuania also informed the ERT that it considers abandoned areas in the process of regeneration as afforestation and reforestation, and that some of these lands are formally reported by the landowners to the Government for the entitlement to compensation. However, not all landowners apply for this compensation. The ERT recommends that Lithuania keep, in its national system, information about the lands abandoned and entitled to compensation, since this can be useful information to demonstrate that the definitions of afforestation and reforestation are met.		this information is included in the National carbon stock accounting system, constatntly checked, analysed and included in estimations.	
85.	The ERT notes that GHG emissions from wildfires for afforestation and reforestation lands have been reported using the notation key „IE“, but the Party does not provide any information on this, either in the NIR or the relevant CRF table. During the review, Lithuania explained that these emissions are included in GHG emissions from forest management. The ERT notes that these emissions should be reported separately and recommends that the Party do so in its next annual submission.	Para 166	Lithuania has re-estimated emissions from wildfires for Forest management and Afforestation/Reforestation activities separately and the results are presented in this submission.	Chapter 11.3.1.1
86.	Lithuania has reported emissions from deforestation for the first time in the 2011 submission that are related to conversion of forest land to wetlands, settlements and other land. However, Lithuania has not included emissions from deforestation due to conversion to grassland and cropland, which are reported as „NE“ in the 2011 annual submission due to the lack of data. The ERT recommends that Lithuania improve the completeness of its reporting on deforestation, by including emissions from the conversion of forest land to grassland or cropland. The estimate of emissions reported for deforestation in the KPLULUCF CRF tables is consistent with those emissions estimated for forest land converted to other land-use categories under the Convention.	Para 167	Lithuania has considered ERT recommendations and provided new activity data according to Study-1 results. Deforested areas in the previous submission were modelled based on expert judgement, thus *Study-1* provided precise data about deforested areas since 1990.	Chapter 11

87.	In the 2011 annual submission, Lithuania has reported the forest management area in the CRF tables for 2008 as the area of forest land remaining forest land in 2007 plus one twentieth of the land converted to forest land in 1990 (10.7 kha) minus the deforestation that occurred in 2008. In 2009, a similar approach has been implemented, with the forest management area being equal to the area of forest land remaining forest land in 2008 plus one twentieth of the land converted to forest land in 1990 (10.7 kha) minus the deforestation that occurred in 2009. The areas reported for these two years are equal to 1,904.78 kha and 1,914.56 kha, respectively. However, the ERT notes that the area of forest management in any year of the commitment period should be equal to the total area of forest land (forest land remaining forest land plus land converted to forest land) in 1990 minus the accumulated deforestation from 1990 to the year of reporting, since Lithuania has reported that all forest land is land under forest management. This changes the values reported for the 2008 and 2009 to 1,925.31 kha and 1,924.39 kha, respectively. The ERT recommends that Lithuania correct these figures in its next annual submission.	Para 168	Lithuania has considered ERT recommendations, provided new activity data according to *Study-1* results and reported land areas correctly in this submission.	Chapter 11
88.	The ERT also recommends that Lithuania partition the forest land into forest land under Article 3, paragraph 3, and forest land under Article 3, paragraph 4, in order to avoid possible overlaps and double-counting in subsequent years. The ERT also recommends that Lithuania include, in its next annual submission, information about the practices for stewardship and the use of forest land introduced since 1990, in order to improve the transparency of its reporting under the Kyoto Protocol and to demonstrate that the changes in carbon stock are due to actions, policies and measures implemented since 1990.	Para 169	Lithuania has considered ERT recommendations and provided new activity data according to *Study-1* in order to improve transparency of the reporting and to avoid data overlapping. The list of the main legal acts forming forest policy in Lithuania is provided in this submission.	Chapter 11.5.3.2