NATIONAL GREENHOUSE GAS EMISSION INVENTORY REPORT 2006 OF THE REPUBLIC OF LITHUANIA

(REPORTED INVENTORY 1990-2004)

Annual report under the UN Framework
Convention on Climate Change

Vilnius, 2007 January

TABLE OF CONTENT

List of figures

List of tables

Executive summary

Lithuania signed the United Nations Convention on Climate Change (UNFCCC) as an Annex I Party in 1992 and ratified it in 1995. The Kyoto Protocol was signed in 1998 and ratified in 2002. Lithuania undertook to reduce its greenhouse gas emissions by 8% below 1990 levels 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 periodically update national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by Montreal Protocol.

The greenhouse gas 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 and SF_6) and indirect (CO, NOx, SO_2, NMVOCs,) greenhouse gases. Greenhouse gas inventory covers the years 1990-2004. For the preparation of the inventory CRF Reporter v.3.0 software has been used. The NIR includes a description of the methodologies and data sources used for estimating emissions by sources and removals by sinks, and a discussion of their trends.

The greenhouse gas inventory is prepared in accordance with the UNFCCC "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories (following incorporation of the provisions of decision 13/CP.9)"(FCCC/SBSTA/2004/8). 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).

An overview of estimated GHG emissions is presented in Table 0-1, which shows GHG emissions by sectors, expressed in CO_2 equivalent and not taking into account GHG emissions/removals from LULUCF, for the years 1990-2005.

Table 0-1. Trends of GHG emissions by sectors, CO2 equivalent, Gg

GHG SOURCES AND SINKS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2004/1990 (%)
1. Energy	33.435	35.595	20.067	16.161	15.201	14.229	14.724	14.271	15.028	12.436	11.121	11.842	11.868	11.941	12.565	-62,42
2. Industrial Processes	3.769	3.801	2.137	1.335	1.460	1.867	2.350	2.199	2.585	2.656	2.714	2.907	3.108	3.111	3.219	-14,58
3. Solvents Use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4. Agriculture	8.847	8.404	5.909	5.034	4.271	4.032	4.121	4.138	3.875	3.601	3.302	3.342	3.435	3.497	3.726	-57,88
5. LULUCF	-10.681	-10.456	-10.465	-9.213	-9.696	-7.839	-8.361	-8.842	-9.255	-9.289	-8.689	-8.462	-7.908	-8.325	-8.629	-19,21
6. Waste	2.008	1.978	1.934	1.606	1.586	1.640	1.612	1.673	1.671	1.501	1.576	1.489	1.426	1.505	1.540	-23,33
Total (without LULUCF)	**48.059**	**49.777**	**30.047**	**24.136**	**22.518**	**21.769**	**22.808**	**22.281**	**23.160**	**20.192**	**18.712**	**19.579**	**19.837**	**20.053**	**21.050**	**-56,20**

Upon its independence from the Soviet Union in 1990, after 50 years of annexation, Lithuania inherited an economy with high energy intensity. It then suffered a blockade of resources, during the period 1991–1993, to which it was particularly vulnerable. This 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 that period, GDP decreased once due to the economic crisis in Russia). These fluctuations were reflected in the country's emissions of greenhouse gases.

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

1   INTRODUCTION

1.1 Background country information

Lithuania is a Central European country with an area of 65,300 square kilometres, and a Baltic coastline of 90 km. The average temperature is – 4.9º C in winter and + 17º C in summer. Its population was 3 425,3 thous. on 1st January 2004 (a decrease of more than 8% comparing with population census data of 1991 January 1st, when it stood at 3 751,5 thous.).

Lithuania re-established its independence from the Soviet Union on 11 March 1990, after 50 years of annexation. It subsequently moved from a centrally planned economy to a market-based system and carried out a substantial program of economic reform, including privatization of state enterprises and price liberalization.

Lithuania inherited from the Soviet Union an economy wherein energy consumption per unit of production was 3 times higher than in comparable Western European industries. After 1990, the Soviet Union critically curtailed the supplies of energy and other resources so that during the period 1991–1993, there was effectively a blockade of the economy. In 1994 only amounted to 56% of its value in 1990 and began to grow only in 1995. The financial and economic crisis in Russia had a negative impact on the Lithuanian economy (as shown by the fact that GDP fell once in 1999). Since 2000 the Lithuanian economy is rapidly growing (GDP per capita at current prices in 2000 – 3528 EUR, in 2005 – 6040 EUR). Unemployment dropped to a level of 11.3 % in 2004 comparing with 2000 when it accounted for 16.4 %.

As is shown in the following Chapters, between 1990 and 2000, greenhouse gas (GHG) emissions decreased significantly as a consequence of the reconstruction of the economy: the decline in industrial production engendered a sharp decrease in fuel consumption and as a result, in greenhouse gas emissions. Once rehabilitation of the economy started, reductions were also achieved through energy efficiency and measures taken to reduce emissions.

It should be pointed out that unofficial fuel supplies during the blockade have compromised the accuracy and the reliability of the official statistical data (in particular for the year 1991). Although statistics have later been revised by comparison with known consumption of primary energy sources, data for those years remain imprecise. This situation was remedied after 1995, when Statistical Data on Energy Balance started to be issued annually.

The main sectors of the economy and their percentage share in the GDP structure are presented in Figure 1.1, including as forecast to 2015 (source: Ministry of Finance, March 2001).
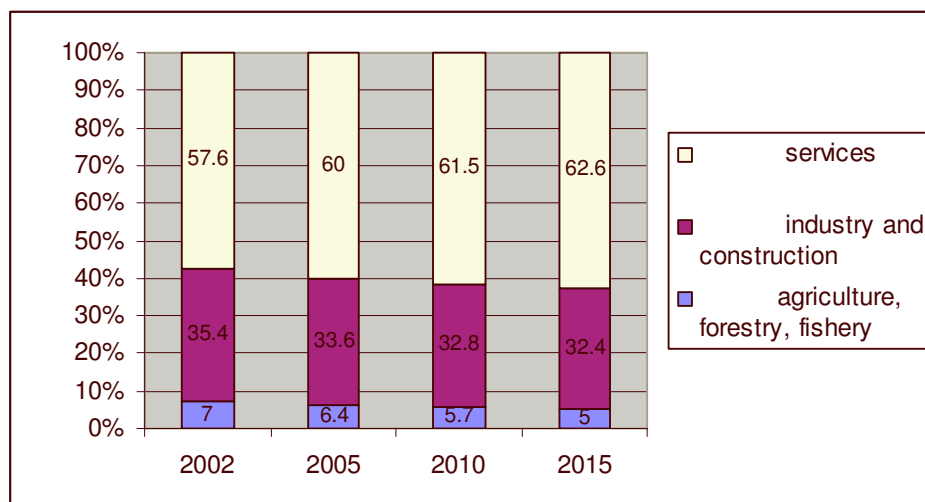
Figure 1.1 Structure of GDP (%) in 2002 and forecast for 2005, 2010 and 2015 (as presented by Ministry of Finance in March 2001)

Lithuania ratified the United Nations Convention on Climate Change (UNFCCC) as an Annex I Party in 1995. The Kyoto Protocol was ratified in 2002, with a commitment to reduce GHG emissions by 8% below 1990 levels in the period 2008 to 2012.

In May 2004, Lithuania became a member state of the European Union. A major policy priority is now to strengthen our membership implementing EU requirements.

1.2 The National Inventory Report

Lithuania provided GHG inventory data for the first time in its first National Communication under UNFCCC (1996). Since 2004, inventory is prepared in common reporting format (CRF). From 2006 inventory is being prepared using *CRF Reporter* software, developed by UNFCCC. In 2006 for the first time complete time series 1990-2004 has been developed and submitted to European Commission and UNFCCC together with Lithuania's Initial Report under the Kyoto protocol.

This is the fourth National Inventory Report (NIR) covering the inventory of greenhouse gas emissions of Lithuania. It is being submitted to the secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), in compliance with the decisions of the Conference of the Parties 3/CP.5 and 11/CP.4. It also was submitted to European Commission and complies with the 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.
The NIR accompanies the GHG inventory for 2004, which was submitted to the UNFCCC secretariat in April 2006. The NIR includes a description of the methodologies and data sources used for estimating emissions by sources and removals by sinks, and a discussion of their trends.

1.3 Institutional arrangement and process for inventory preparation

The single entity responsible for the establishment of the yearly GHG inventory and it's submission to European Commission and UNFCCC is the Ministry of Environment, Environmental Quality Department, Air Division. The Head of that Division is the Focal Point for all matters related to the UNFCCC and for the climate change activities under the EC.

The national system for the estimation of greenhouse gas emissions is established setting up of inventory preparation group (Inventory Group), which consists of experts from various branches of economy as well as institutions of science and studies. The Group's work is coordinated by the Institute of Ecology. Institute of Ecology is responsible for coordination of the process of annual greenhouse gas inventory, compilation of results, data management and archiving, QA/QC procedures. For estimation of GHG emissions and removals in the LULUCF sector extensive use is made of annual statistics with the aim to obtain the most exact and newest data available in Lithuania.

Ministry of Environment annually submits GHG inventory reports to European Commission and UNFCCC secretariat. Before submission, reports are forwarded to the National Climate Change Committee for final approval. A National Committee on Climate Change has been set up in 2001. It consists of experts from academia, government and non-governmental organizations (NGOs) and has an advisory role. The main objective of the Committee is to ensure attaining the goals related to the restriction of GHG emissions as set in the National Sustainable Development Strategy and implementing the measures for attaining such goals. The Committee also has to organize the implementation of the provisions of the UNFCCC and coordinate compliance with the requirements of the Kyoto Protocol and EU legal acts related to the UNFCCC.

Figure 1.2. illustrates the structure of the emission inventory system in Lithuania.

National GHG Emission Inventory System in Lithuania
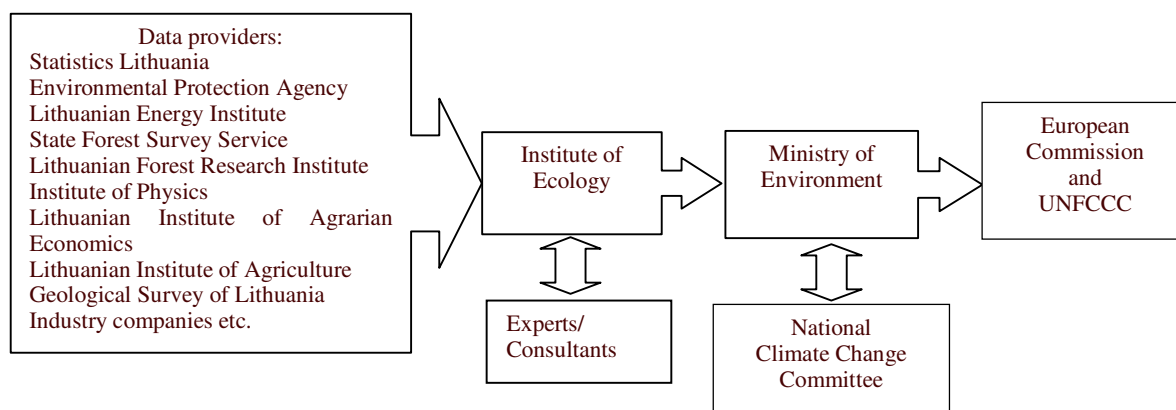
1.4 Methodologies and data sources used

The greenhouse gas 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 and SF_6) and indirect (CO, NOx, NMVOCs, SO_2) greenhouse gases. Greenhouse gas inventory covers the years 1990-2005.

The GHG inventories are 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)*. Emission factors used are either country specific (used for Energy sector, except fugitive emissions) or internationally recommended default factors, mainly those provided in *IPCC Good Practice Guidance* and in *EMEP/CORINAIR Emission Inventory Guidebook*.

Lithuania's GHG emission inventory includes all major emission sources identified by the *IPPC Good Practice Guidance* with some exceptions, which supposed to have minor effect on the total GHG emissions. All Lithuania's territory is covered by GHG inventory.

Activity data necessary for the calculation of GHG emissions is collected from published materials, if it is possible. Not published data is gathered from relevant authorities (institutes, industry companies etc.) on the request of the Ministry of the Environment.

The main data providers for GHG inventory estimation are the Department of Statistics under the Government of Lithuania (Statistics Lithuania), State Forest Survey Service and Environmental Protection Agency:

- Statistics Lithuania (Statistical Yearbooks of Lithuania, Sectoral Yearbooks on energy balance, agriculture, commodities, natural resources and environmental protection);
- State Forest Survey under the Service Ministry of Environment (Lithuanian Statistical Yearbooks of Forestry);
- Environmental Protection Agency (waste water and waste data).

Statistics Lithuania has to announce annually under the established procedure the main sustainable development indices in the main annual yearbooks of statistics of Lithuania, with specific indices to be issued in other publications.

State Forest Survey Service is responsible for establishment of national forest inventory and forestry information system, implementation of Lithuania's forests state monitoring, collection and management of statistical data etc. State Forest Survey Service is established under the Ministry of Environment.

The Environment Protection Agency (EPA) is a subsidiary institution of the Ministry of Environment. It is responsible, among others, for environmental quality monitoring, gathering and storing of environmental data and information as well as for assessment and prognosis of environmental quality. One of the main tasks of the EPA is managing, processing and reporting of information.

1.5 Key source categories

Key sources for the GHG inventory for year 2004 were analyzed according to *Good Practice Guidance* (2000). The Level assessment of the key source analysis was conducted, following the Tier 1 approach. The contribution of each source category to the national total was calculated. Any source category that met the 95% threshold was identified as a key source category.

The results of the analysis are provided in Table 1-1.

Table 1-1. Key source analysis 2004

Key source description	GHG	Emissions, Gg CO2 equivalent	Level assessment %	Cumulative total %
Stationary combustion, gas	CO2	5213,30	24,77	24,77
Road vehicle	CO2	3639,35	17,29	42,05
Nitric acid	N2O	1723,60	8,19	50,24
Direct emissions from soils	N2O	1610,61	7,65	57,89
Stationary combustion, oil	CO2	1380,18	6,56	64,45
Enteric fermentation	CH4	1223,58	5,81	70,26
Ammonia production	CO2	1072,78	5,10	75,36
Solid waste	CH4	951,76	4,52	79,88
Stationary combustion, coal	CO2	660,44	3,14	83,02
Wastewater	CH4	508,52	2,42	85,43
Stationary combustion, petroleum coke	CO2	388,65	1,85	87,28
Manure management	N2O	335,27	1,59	88,87
Cement production	CO2	330,36	1,57	90,44
Indirect emissions from soils	N2O	247,65	1,18	91,62
Fugitive emissions	CH4	236,06	1,12	92,74
Railways	CO2	229,18	1,09	93,83
Stationary combustion, LPG	CO2	203,26	0,97	94,79
Manure management	CH4	190,71	0,91	95,70

1.6 Completeness and time-series consistency

Lithuania's GHG emission inventory includes all major emission sources identified by the IPPC Good Practice Guidance with some exceptions reported as "not estimated" (NE) (listed in Table 1-2, without LULUCF sector), which supposed to have minor effect on the total GHG emissions. Emissions are not estimated mainly due to lack of activity data and/or methodology.
Activity data and emission factors/parameters used for estimations are consistent and adequate through the 1990-2004.
All Lithuania's territory is covered by GHG inventory.

Table 1-2. List of GHG emission sources not covered in inventory

Sector	Gas	Not estimated categories
1. Energy	CO_2, CH_4	1B2bv Natural gas, other leakage

2. Industry	CO_2	2A3 Limestone and dolomite use
		2A5 Asphalt roofing
		2A6 Road paving with asphalt
		2D2 Other production: food and drink
	HFC, SF_6	2F Consumption of Halocarbon's and SF_6 1990-2004 (actual emissions, except of SF_6 from Electrical Equipment 2F7)
3. Solvent and other product use	CO_2, N_2O	3 Solvent and other product use
4. Agriculture	CH_4	4A10 Enteric fermentation: other livestock
		4B10 Manure management: other livestock
6. Waste	CO_2	6A Solid waste disposal on land
	N_2O	6B Wastewater handling
		6C Waste incineration
	CH_4	6C Waste incineration

1.7 Uncertainty evaluation

Uncertainty estimation was implemented using Tier 1 approach of *IPCC Good Practice Guidance*. Quantitative uncertainties assessment was carried out for the emission level 2004 and for 1990-2004 (1995-2004 for F-gases) trend in emissions for all source categories (except LULUCF & 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 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.

The estimated uncertainties for total GHG and for CO_2, CH_4, N_2O and F-gases are presented in Annex 2. N_2O emissions from agricultural soils, N_2O emission from fuel combustion sectors and N_2O from manure management are the sources with highest uncertainty in the GHG inventory.

The uncertainty as % of total national emissions in 2004 by different gases emissions is as follows:

CO_2 ±1.8%

CH_4 ±3.4%

N_2O ±8.4%

F-gases ±0.1%

The total GHG emission in the year 2004 is estimated with an uncertainty of ±9.22% and the trend of GHG emission 1990-2004 has been estimated to be ±1.87%.

1.8 Quality assurance and quality control

Institute of Ecology is responsible for coordination of the process of annual greenhouse gas inventory, compilation of results, data management and archiving, and also for development and implementation of the QA/AC plan.

Several QC activities were carried out each year at the various stages of the inventory compilation process - processing, handling, documenting, cross-checking, recalculations and visual inspections. Those activities are implemented by sectoral experts and inventory compiler. Inventory quality checking procedures became more efficient now when complete time series 1990-2004 of GHG inventory were compiled. GHG inventory review and checking are also performed by Air Division of the Ministry of Environment as a part of inventory approval process.

In order to improve further data integrity, correctness, and completeness, QA/AC plan will be developed and implemented. The plan will include Tier 1 General Inventory Level QC procedures outlined in Table 8.1 of *IPCC Good Practice Guidance*, and a peer review of the inventory estimates.

QC system incorporates various activities aimed at ensuring transparent data flow through all inventory process including data collection and processing, documentation, archiving and reporting. The general QC checks to be performed during the inventory include:

- Assumptions and criteria for the selection of activity data and emission factors are documented;
- Transcription errors in data input and reference;
- Correctness of calculations of emissions;
- Correctness of emission parameters, units, conversion factors;
- Integrity of database files;
- Consistency in data between source categories;
- Correctness of transcription and aggregation of intermediate data;
- Correctness of calculation of uncertainties;
- Integrity of archiving arrangements in the organisations involved in the inventory process;

QC activities also include review of internal documentation, supporting data, comparison of emission estimates to previous estimates, consistency and completeness of time series, etc.

Activity data required for compilation of GHG inventory are provided mainly by Lithuanian Statistics and some other institutions involved in collection of statistical data such as Lithuanian Environmental Protection Agency, Lithuanian State Forest Survey Service, Lithuanian Geological Survey etc. Such institutions are providing official national statistical data and have established their own QC procedures. Institute of Ecology as the GHG inventory compiler should obtain necessary information about QC procedures used in statistical institutions in order to confirm that adequate QC procedures have been implemented.

The responsibility for establishment and maintaining of the GHG inventory database is placed on the Institute of Ecology. Agencies/sectoral experts responsible for GHG inventories in separate sectors will establish their own databases covering relevant sectors. Efficient information flow between the sectoral databases and the main database will be ensured by establishing data exchange procedures.

Both the central database at the Institute of Ecology and databases at the agencies/experts responsible for inventories in separate sectors comprise all information required to produce the national emissions inventory including:

- Activity data;
- Emission factors used;
- Assumptions and criteria for selection of activity data and emission factors;
- Methods used and criteria for their selection;
- Interim calculations for source category estimates, aggregated estimates and recalculations of previous estimates;
- Information on the uncertainty associated with activity data and emission factors;

The documentation for every annual inventory will be archived in such a way that every inventory estimate can be fully documented and reproduced if necessary. Tracing back of each separate data item to its original source should be possible including any changes or updating of activity data or emission factors.

Quality Assurance (QA) activities include a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. Key source categories should be reviewed every year to ensure that the inventory represents the best possible estimates of emissions and sinks given the current state of scientific knowledge and data available. Non-key categories should also be reviewed at least once in several years taking into consideration changing methodologies, data sources, etc.

1.9 Recalculations and improvements

In response to the latest international expert review coordinated by UNFCCC (In-country review of the 2005 GHG inventory submission, 2005 October), in 2006 significant improvements of the GHG inventory have been made:

Cross-cutting issues
For the first time complete time series 1990-2004 of GHG emissions were estimated. GHG inventory compiled using consistent activity data sets and emission factors through all years. More transparent National Inventory report (NIR) providing more precise descriptions of the methodologies, activity data and emission factors used was elaborated. A number of missing emission sources were included in GHG inventory for the first time.

Energy
In 2004, a new national energy balance for the years 1990–2003 was published by Statistical Department. Current estimates/recalculations of emissions for all years are based on the use of this revised energy balance with consistent data set.
GHG emissions from manufacturing subcategories of the Manufacturing Industries and Construction category level were reported in the CRF tables at the specific disaggregated level (previously reported only at the total).
In 1990 CRF tables the disaggregated emissions from all combustion sources were reported (previously reported only totals).
A number of missing fugitive emissions sources were reported for the first time:
-Emissions from oil exploration
-oil production
-oil refining & storage

-natural gas distribution
-natural gas transmission
-oil venting and flaring
-gas venting

Industry

CO_2 emissions from cement production were recalculated using clinker production as activity data obtained directly from cement plant. Country-specific calcium oxide (CaO) content was also provided by cement producer.
Emission from nitric acid production and ammonia production were reported using estimations provided by national chemical companies.
Emission from soda ash use was introduced for the first time.
For the first time SF_6 emission from electrical equipment was incorporated in the inventory.

Agriculture

Direct N_2O emissions from agricultural soils were supplemented estimating nitrogen from animal manure application, nitrogen fixed by N-fixing crops, nitrogen in crop residues returned to soils and emission from organic soils (histosols).
For estimation of emission from synthetic fertilizer application, revised activity data was used.

For the first time indirect soils emission from atmospheric deposition and nitrogen leaching and runoff were estimated.

Waste

First Order Decay method (IPCC Tier 2 method) was applied for calculation of CH_4 emission from waste disposal sites. National values of DOC (degradable organic carbon) were applied. Updated activity data, separated for managed and unmanaged waste disposal sites was used for emission calculation.

Revised emission estimates methodology (using updated methane conversion factor) for wastewater handling emissions was introduced.

For the first time waste incineration emissions and emissions from human sewage were incorporated in the inventory.

2   TRENDS IN GHG EMISSIONS

2.1 Emission trends for aggregated greenhouse gas emissions

Aggregated emissions of GHG expressed in Gg CO_2 equivalent (without CO_2 removals and emissions from the LULUCF sector) have decreased by approximately 56% during the period 1990–2004 (Figure 2.1).
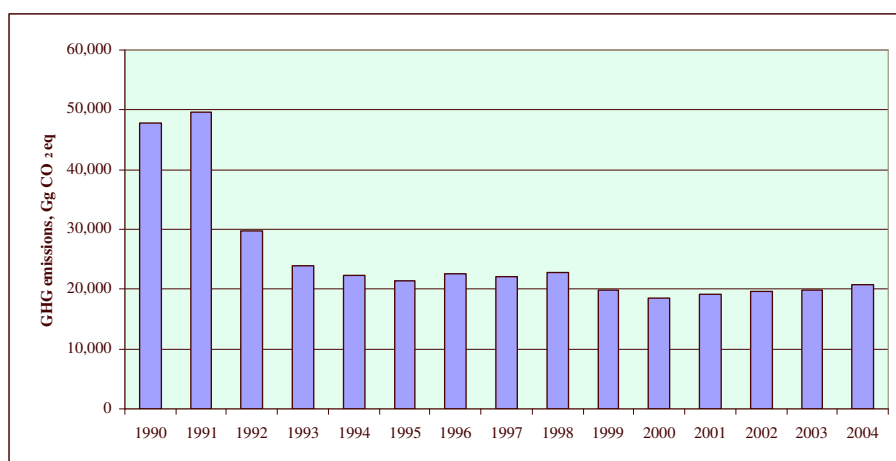
Figure 2.1. Emission trends for aggregated GHG (Gg CO_2 eq)

A rapid decrease of GHG emissions has followed the decline of the national economy in the 1990s. The reduction of GHG emissions from 1990 to 2000 was about 60%. Towards the mid 1990s, Lithuania's GDP began to rise and the reduction in emissions slowed down. The annual increase of GHG emissions in 2000-2004 was approximately 4% annually.

2.2 Emission trends by gas

The decline in the emissions of the main greenhouse gases between 1990 and 2004 is shown in Figure 2.2.
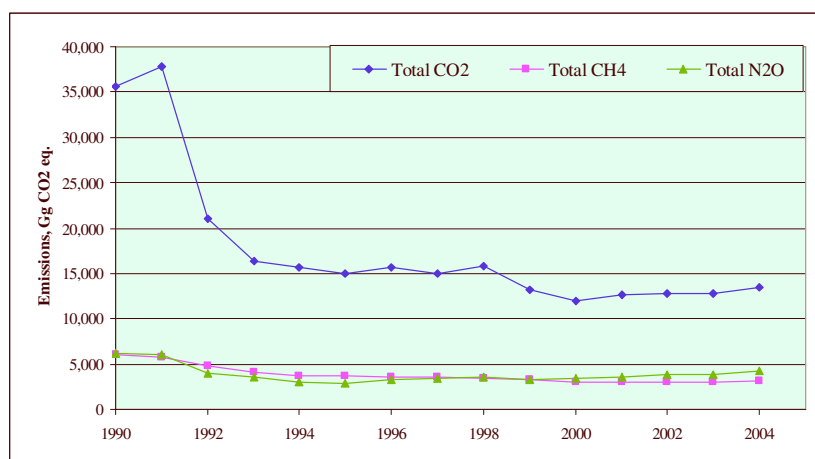
Figure 2.2. Trends of GHG emissions by gas in CO_2 equivalent, Gg

Emissions of all three gases were increasing continuously from 2000 to 2004. This increase mainly follows the growth in industrial output as reflected by the growth of GDP.

2.2.1 Carbon dioxide emissions

The largest amounts of carbon dioxide emissions are a result of fuel combustion processes in various sectors.

In 1995, CO_2 emissions from transport increased as the automobile fleet rapidly increased due to the imported second-hand passenger cars. In 1995 and 1996 emission dropped as the fleet of passenger cars shifted from Russian cars to western manufactured, more environmentally friendly cars.

CO_2 emissions from biomass have increased more than 2.5 times since 1990 (Table 2-1). Consumption of biomass as fuel was facilitated by the government via the promotion of the use of renewable energy sources. It was also regarded as a cleaner and cheaper fuel source. In addition, a number of boiler houses have switched from heavy fuel oil to biomass as a result of a programme of Activities Implemented Jointly mainly with Scandinavian countries.

Table 2-1. CO_2 emission from biomass in 1990-2004 (Gg)

Year	CO_2 emissions from biomass, Gg
1990	1215,43
1991	1215,43
1992	1216,35
1993	1816,11
1994	1877,72
1995	1969,72
1996	2158,32
1997	2209,01
1998	2435,15

1999	2524,19
2000	2645,17
2001	2791,74
2002	2949,79
2003	3050,62
2004	3114,85

2.2.2 Methane emissions

Methane emissions have decreased from approximately 6 to about 3 thousand Gg CO_2 equivalent from 1990 to the year 2000 but remained fairly constant since the year 2000 changing within the limits of approximately 3 to 3.1 thousand Gg CO_2 equivalent.

Major part of methane emissions is generated in agricultural sector and the decrease was caused mainly by restructuring of agricultural sector after independence resulting in substantial decline in the number of cattle. The second major source of methane emissions is waste management comprising about 40% of the total where emissions have also decreased but less dramatically. Though methane emissions in energy sector were decreasing continuously throughout the whole 1990-2004 period, emissions from the year 2000 remained stable because of stabilisation of agricultural sector.

2.2.3 Nitrous oxide emissions

N_2O emissions have decreased roughly by half from 1990 to 1995 but then started moving up again reaching 4 thous. Gg CO_2 equivalent in 2004 compared to 6 thous. Gg CO_2 equivalent in 1990.

From 1990 to 1995 N_2O emissions were decreasing in all sectors (energy, industry, agriculture and waste). Reduction of N_2O emissions in agriculture continued to the year 2000 (with slight increase in 1996-1997) then N_2O emissions started increasing but in 2004 reached only about 56% of the 1990 level.

Increase in emissions from 1995 was mainly caused by very substantial growth of N_2O emissions in industry - industrial emissions in 2004 exceeded 1990 level more than 2 times. As a result, the share of industrial emissions in the total N_2O emissions increased from 12 in 1990 to 40 in 2004, while the share of agricultural N_2O emissions decreased from 81 in 1990 to 54 in 2004.

2.3 Emission trends by source

The trends of GHG emissions by sectors are presented in a Table 2-2 showing GHG emissions by sectors, expressed in CO_2 equivalent and not taking into account GHG emissions/removals from LULUCF.

Table 2-2. Trends of GHG emissions by sectors, CO$_2$ equivalent, Gg

GHG SOURCES AND SINKS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2004/1990 (%)
Energy	33.435	35.595	20.067	16.161	15.201	14.229	14.724	14.271	15.028	12.436	11.121	11.842	11.868	11.941	12.565	-62,42
Industrial Processes	3.769	3.801	2.137	1.335	1.460	1.867	2.350	2.199	2.585	2.656	2.714	2.907	3.108	3.111	3.219	-14,58
Solvents Use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Agriculture	8.847	8.404	5.909	5.034	4.271	4.032	4.121	4.138	3.875	3.601	3.302	3.342	3.435	3.497	3.726	-57,88
LULUCF	-10.681	-10.456	-10.465	-9.213	-9.696	-7.839	-8.361	-8.842	-9.255	-9.289	-8.689	-8.462	-7.908	-8.325	-8.629	-19,21
Waste	2.008	1.978	1.934	1.606	1.586	1.640	1.612	1.673	1.671	1.501	1.576	1.489	1.426	1.505	1.540	-23,33
Total (without LULUCF)	48.059	49.777	30.047	24.136	22.518	21.769	22.808	22.281	23.160	20.192	18.712	19.579	19.837	20.053	21.050	-56,20

The major source of GHG has been energy sector, which is responsible for 61 % of all GHG emissions (in Gg CO$_2$ equivalent) in 2004, not taking into account removals/emissions from LULUCF sector.

The most significant reduction in GHG emissions was observed immediately after declaration of independence from 1991 to 1993 when the total emissions decrease d by more than 50% mainly due to sharp decline of activities in energy and industrial sectors. The decrease was noticeable in all subsectors but especially sharp in manufacturing and construction where GHG emissions decreased approximately 3 times.

Reduction of GHG emissions in agriculture was less dramatic but still reached about 40% in two years. Another reduction of GHG emissions in energy and agriculture sectors occurred in 1998-2000 though emissions from industrial processed were continuously increasing from 1995. From the year 2000 GHG emissions are slightly increasing in all sectors except waste.

In waste sector, GHG evaluated GHG emissions were decreasing throughout the whole period under consideration mainly due to decline in waste disposal on land.

Restructuring of the Lithuanian economy since the declaration of independence has changed quite substantially the structure of GHG emissions. The share of energy sector in the total emissions has decreased while the shares of industry and waste sector has increased (see Figure 1.1)
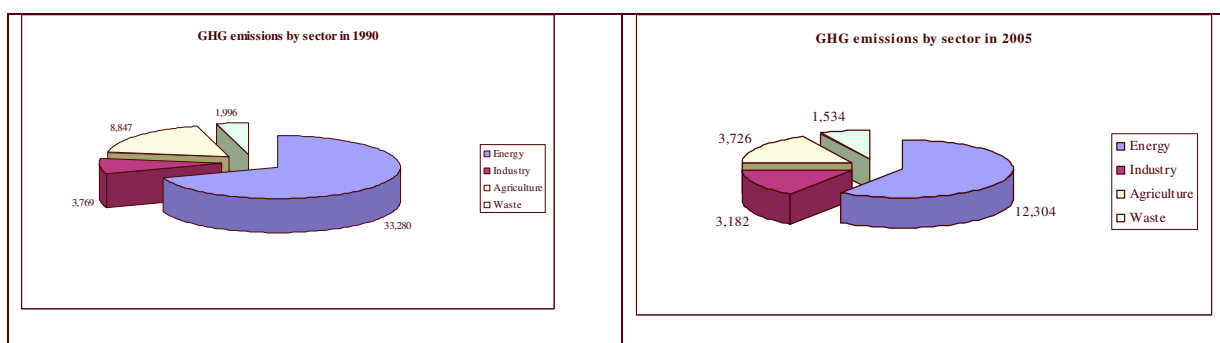
Figure 2.3. Shares of GHG emissions by sector in 1990 and 2004 in CO$_2$ equivalent

In LULUCF sector, average annual increase of forest area in 1990-2004 was approximately 10.7 thous. ha. The fastest increase of forest area was observed during the last 8 years reaching 20 and more thous. ha per year.

Forest expansion strategy for 2004-2020 and its implementation measures are set in the Lithuanian Forest Area Expansion Program developed and approved by the joint Order of the Ministers of Environment and Agriculture No. 616/471 on December 2, 2002.

The Programme aims at additional increase of forest area by 196 thous. ha or approximately 12 thous. ha annually. It is estimated that forest area is currently expanding by approximately 4-5 thous. ha annually as a result of natural, spontaneous forest growth in unmanaged land areas. In order to attain the target set in the Programme, it is planned to plant additionally 7 thous. ha of forest each year. Current and forecasted variations of forest area are shown in Figure 2.4.
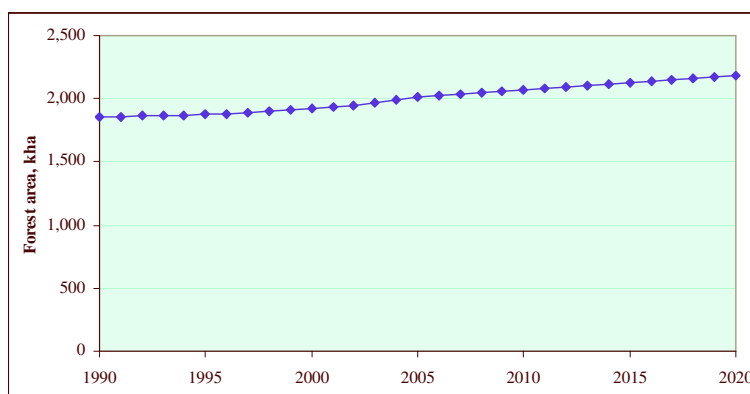
Figure 2.4. Forecasted variation of forest area

Changes in forest carbon stocks are determined mainly by expansion of forest area and, especially, by variations in wood extraction. The extent of fellings has increased substantially after declaration of independence and transition to market economy resulting in overall reduction of annual carbon sequestration value.

According to the Lithuanian Forestry Law, cuttings cannot exceed annual norms set for both state and privately owned forests. Cutting norms are established in accordance with the methodology developed by the Ministry of Environment and approved in 2001 and amended in 2003. The volume of extracted wood has stabilised after approval of the methodology but certain growth of wood extraction should be expected in the future. It was assumed that the total volume of extracted wood is going to increase by approximately 70 thous. m^3 (Figure 2.5). Such increase in cuttings is balanced by the annual biomass increment ensuring stable annual carbon sequestration of approximately 2.5 thou. Gg (approximately 8.9 thous. Gg CO_2) (see Figure 2.6).
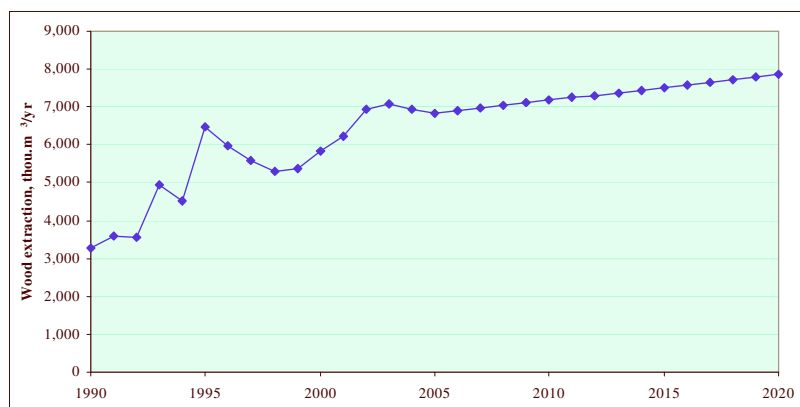
Figure 2.5. Variations and forecasted trend of wood extraction (including round wood and fuel wood)
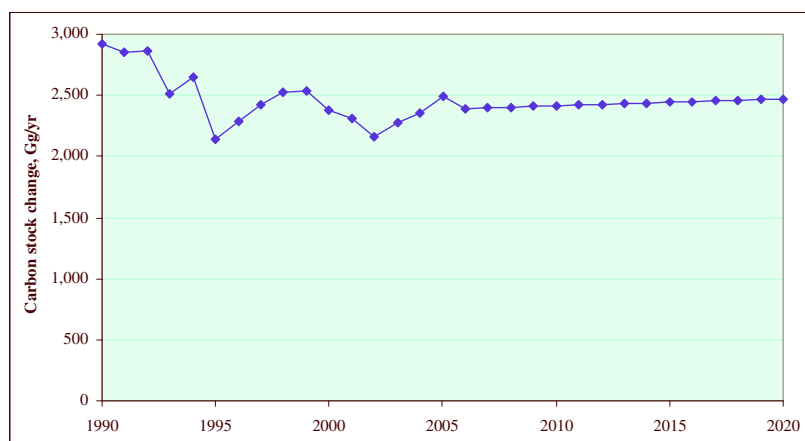
Figure 2.6. Variation and forecast of carbon stock change

3   ENERGY SECTOR (Sector 1)

3.1 Overview of the energy sector

3.1.1   Energy industries

The extensive energy sector inherited from the Soviet period does not conform to the current requirements of the energy market (in terms of efficiency, management principles, structure, etc.). Therefore the recent national policy relating to this sector has focused primarily on its substantial reorganisation and privatization, as well as the implementation of the relevant European Union (EU) Directives.

Energy capacities are sufficiently developed: power plants, an oil refinery, an oil import and export terminal, a trans-shipment terminal for petroleum products, natural gas and district heating systems. The primary energy balance is well-structured (and dominated by natural gas, petroleum products and nuclear energy); a possibility to use different fuels in the majority of energy enterprises ensures reliable energy supply as well as better control over environmental pollution.

However, the available energy potential is not fully utilized; national electricity and gas networks have no direct connections to Western European energy systems and depend on a single supplier of natural gas from Russia; electricity networks and substations are worn; a number of towns and settlements have no natural gas supply system; in district heating systems for the residential sector, energy is inefficiently used.

The Ignalina Nuclear Power Plant (NPP) plays a key role in the Lithuanian energy sector, as it produces about 80% of the electricity currently produced nationally. It has an installed capacity of 3000 MW in two RB MK-1500 (large power channel reactor) reactors. The electricity produced at Ignalina is used not only for domestic purposes, but is exported as well. Following the Accession Agreement to the EU, Lithuania closed the first reactor on 31st December 2004 and the second reactor shall be closed by 2010. The share of electricity produced in Ignalina will be taken over mainly by the Lithuanian Thermal Power Plant, the largest combined heat and power plants at Vilnius and Kaunas. Thus, the projected energy demand after the decommissioning of Ignalina NPP can be fully met by using the existing generating capacity.

New Draft National Energy Strategy currently under discussion in Lithuania sets the objectives to diversify energy sources including nuclear power and to expand input of renewable energy sources. The Strategy foresees construction of the new regional nuclear power station in cooperation with other Baltic States and Poland which should start operating not later than 2015.

The energy industries use 46% of all fuel used in combustion processes. Shares of different fuel types in the total consumption by the energy industries are presented in Figure 3.1.
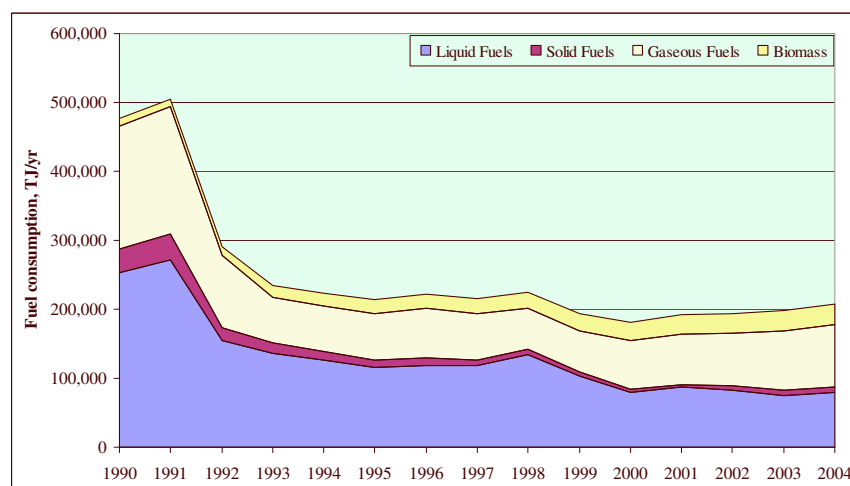
Figure 3.1. Variations of fuel consumption (in TJ) by energy industries

Crude oil and natural gas are mainly imported from Russia. Crude oil and other inputs to refineries constituted about 74 % of 2004 energy imports and natural gas accounted for about 20 % of those imports. The indigenous production of oil is of high quality and mainly used in manufacturing of lubricants and other petroleum derivatives.

3.1.2 Manufacturing industries and construction

Fuel combustion in manufacturing industries and construction is shown in Figure 3.2. Overall fuel consumption in the sector has declined approximately 5 times from 1991 to 1999 but started increasing by approximately 6% annually from the year 2000.

Fuel consumption declined substantially in all subsectors but the most dramatic reduction is observed in pulp and paper industry where decline was continuing actually throughout all the period and comprised only 25 TJ in 2004.
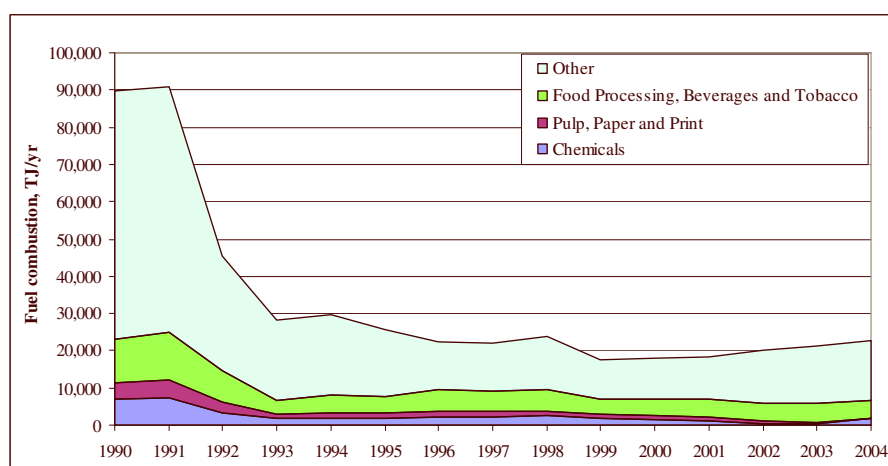
Figure 3.2. Fuel combustion in manufacturing industries and construction sector in 1990-2004

Relative distribution of fuel combustion in manufacturing industries and construction sector is shown in Figure 3.3. The major part of fuel (approximately 60 to 70 %) is consumed in construction which is attributed to "other" industries. Relative fuel consumption in food processing, beverages and tobacco industries has increased during the period from approximately 14% in 1990 to more than 21% in 2004.
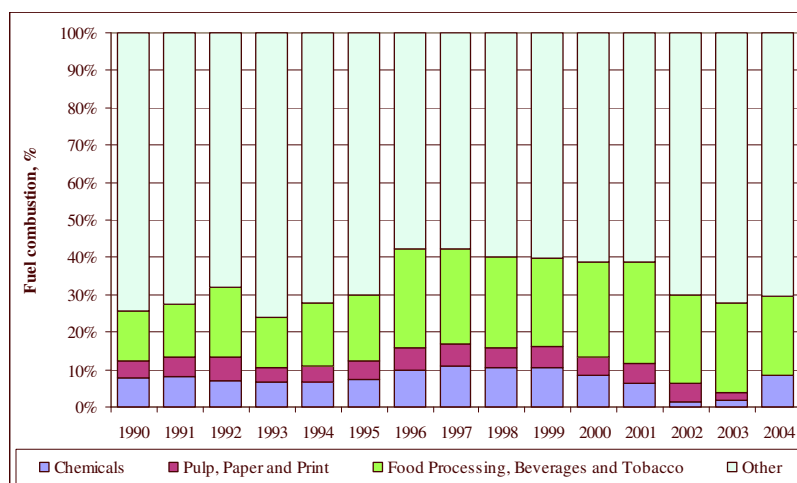
Figure 3.3. Relative distribution of fuel combustion in manufacturing industries and construction sector

3.1.3 Transport sector

One of the long term priorities of Lithuanian transport policy as set out in the Long-term economic development strategy of Lithuania until 2015 is the reduction of the negative impact of transport on the environment.

The density of transport routes as well as the number of road vehicles has increased rapidly during the last decade. During that period, the number of personal cars more than doubled. All passenger cars younger than 5 years (about 3.2% of all transport fleet in 2004) with petrol engines have catalysers installed.

Passenger cars are mostly using petrol fuel, whereas buses and heavy duty vehicles run mainly on diesel fuel. The use of liquefied natural gas is strongly influenced by the fluctuation of fuel prices. There are plans to promote railway transport. Marine transport is developed in the only large Lithuanian port, Klaipeda.

55% of fuel consumed in the transport sector is diesel fuel, followed by gasoline and liquefied petroleum gas, as shown in Figure 3.4. In navigation diesel fuel and fuel oil are used. As regards aviation, aviation gasoline, kerosene type jet fuel and gasoline type jet fuel are used for aviation. Railways use diesel fuel. Fuel used in the transport sector in 2004 is presented in Figure 3.4.
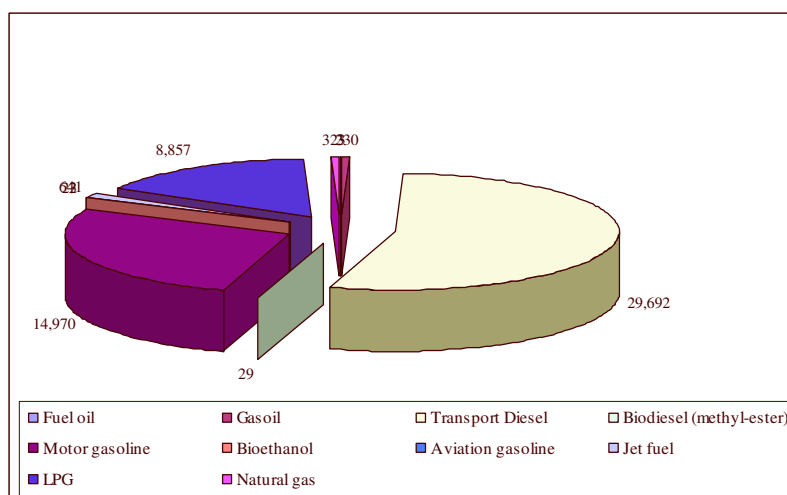
Figure 3.4. Fuel used (TJ) in the transport sector in 2004

3.1.4 Other sectors

Other sectors consist of fuel combustion in commercial/institutional, residential and agriculture/forestry/fishing sectors. In residential and institutional/commercial sectors the major part of fuel is combusted for district heating.

Consumption of different types of fuel (in TJ) in other sectors is shown in Figure 3.5.
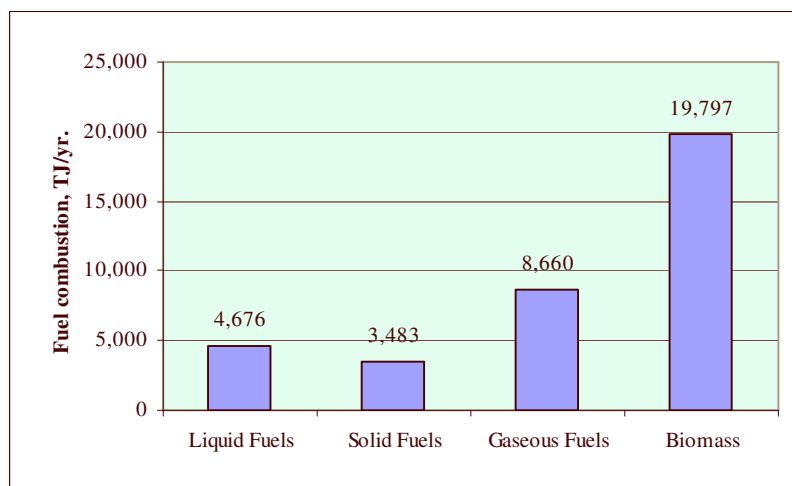
Figure 3.5. Fuel used (TJ) in other sectors in 2004

3.2 Greenhouse gas emission sources in energy sector

GHG emissions from the energy sector – fuel combustion and fugitive – constitute more than half (60% in 2004) of the total GHG emissions. As the key source analysis has revealed, energy sector – fuel combustion activities are responsible for 7 key source categories of GHG emissions (CO_2) and fugitive emissions from oil and gas operations (CH_4) for 1 key source.

Table 3-1. Key GHG emission sources in energy sector in 2004

Source	GHG	Emission, Gg CO_2 eq	Share in the total emissions %
Stationary combustion, gas	CO2	5213,30	24,77
Road vehicle	CO2	3639,35	17,29
Stationary combustion, oil	CO2	1380,18	6,56
Stationary combustion, coal	CO2	660,44	3,14
Stationary combustion, petroleum coke	CO2	388,65	1,85
Fugitive emissions	CH4	236,06	1,12
Railways	CO2	229,18	1,09
Stationary combustion, LPG	CO2	203,26	0,97

3.2.1   Energy industries

The energy industries were responsible for 46% of the total GHG emissions from the energy sector in 2004 (5,720 Gg out of 12,565 Gg). More than two thirds of CO_2 emissions (67% in 2004) from the energy industries are from public electricity and heat production. Petroleum refining is done at JSC Mazeikiu Nafta – the only petroleum refining company in Lithuania and is responsible for over 30% of the CO_2 emissions inform the energy industries.

Shares of CO_2, CH_4, N_2O emissions from fuel combustion in energy industries are presented in Figure 3.6. GHG emissions from manufacture of solid fuels and other energy industries are very small.
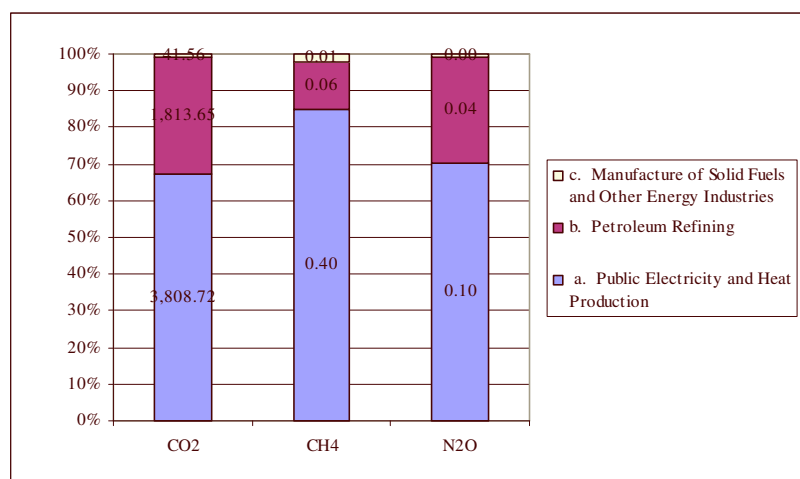
Figure 3.6. CO_2, CH_4 and N_2O emissions (Gg) from fuel combustion in energy industry in 2004

3.2.2 Manufacture and construction

In this subsector emissions are included from fuel combustion in:
- Chemicals production;
- Pulp, paper and print industry;
- Food processing, beverages and tobacco production;
- Other.

As the manufacture and construction sectors mainly use gaseous fuels, the largest share of CO_2 emissions originate from this type of fuel. Shares of CO_2 emissions (in Gg) from different types of fuel in fuel consumed in manufacture and construction are presented in Figure 3.7.
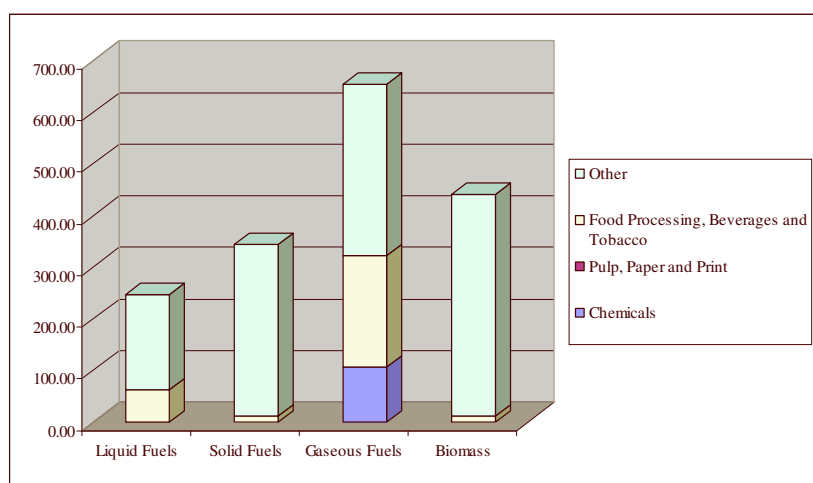
Figure 3.7. CO_2 emissions (Gg) from different types of fuel consumed in different manufacture and construction sectors in 2004

Manufacturing and construction activity also emit CH_4 and N_2O in small quantities - 0,25 Gg and 0,04 Gg respectively.

3.3 Methodological issues

For calculation of GHG emissions in the energy sector Tier 2 Sectoral approach has been used. Emissions of direct greenhouse gases, i.e. CO_2, CH_4 and N_2O, are calculated on the basis of activity data – amount and sort of fuel used - and national/Corinair emission factors. Activity data had been obtained from Lithuanian Statistics publication "Energy balance".

National 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].

---

1 (1) 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 Rahmenübereinkommen der Vereinten Nationen über Klimaänderungen. Bundesumweltminiisterium. Bundesumweltministerium für Umwelt, Naturschutz und Reaktorsicherheit.

The emission factors calculated apply to CO_2 and SO_2, NO_x, CO, CH_4, N_2O, NMVOC and particulate matter, for the different sectors for the following types of fuels: coal, fuel wood, natural gas, orimulsion, heating gas oil, petrol, kerosene, other processed fuel, flammable secondary energy sources.

Emission factors were assigned to a number of energy generating facilities categories that are in line with the categories used in national fuel and energy balance.

Different emission factors are set depending on the sector, where fuel is used: electricity production, heat power stations, industry, small enterprises, households, transport. Moreover, different transport means are distinguished: motor cars, railways, water transport, air transport and agricultural machines.

Table 3-2. Categories of energy generating facilities in national fuel and energy balance and national emission factors sheets (Prof. B. Jaskelevicius, P. Liuga, 1997)

Fuel combustion sector	Categories of the national energy and fuel balance
1. Power plants	Production of electricity and thermal energy
2. Heat boiler houses	Energy companies
3. Industry	Industrial manufacturing
	Construction engineering and mounting works
4. Small companies	Municipal domestic needs
	Agricultural activities
	Other
5. Households	Households
6. Transport	Transport

Annex 1 presents national emissions factors for the following 19 types of fuel: oil, coal, fuel wood, natural gas, peat, other natural fuel, heavy fuel oil, orimulsion, household furnace fuel, vehicle gasoline, diesel fuel oil, aviation gasoline, liquefied natural gas, kerosene, other processed fuel, combustible auxiliary energy resources, other products of refinery and shale oil.

Corinair emission factors have been used for petroleum coke (CO_2 – 101 t/TJ, CH_4 – 1.5 kg/TJ, N_2O – 1.4 kg.TJ) and biogas (CO_2 – 41.9 t/TJ, CH_4 – 1.5 kg/TJ, N_2O – 1.95 kg.TJ) fuels.

3.4 Comparison of sectoral and reference approaches

Carbon dioxide emissions from energy sectors should be 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 or fuel products brought into the country.

Difference between sectoral and reference approach is presented in the tables below. Difference was calculated excluding non-energy fuel use and feedstocks. The reasons of the differences are mainly due to statistical differences in fuel consumption and that fuel losses (transformation, transport etc.) are not taken into account in the reference approach.

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).

Table 3-3. Differences between sectoral and reference approaches

Difference (%) in fuel consumption														
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3,08	1,64	-1,10	-0,08	-0,57	3,26	0,67	-1,89	1,80	3,09	-0,48	-0,84	-1,15	0,90	1,93
Difference (%) in CO_2 emission														
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0,61	-0,88	-2,32	-0,43	-1,86	4,83	1,71	5,99	4,68	1,67	0,02	0,10	0,12	1,72	3,35

3.5 Emissions of Precursor Gases

The inventory of ozone precursors (CO, NO_X and NMVOCs) and aerosol precursor (SO_2) gases are reported in the CRF from 2002 onwards. Emission estimates for precursors in the relevant subcategories: nitrogen oxides (NO_x), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC) are mainly emitted from the energy sector as a result of organic fuel combustion and oil processing. Data on precursors emissions are reported annually under Convention of Long-Range Transboundary Air Pollution (CLRTAP) and used as a data source for GHG inventories.

3.6 Uncertainties

There is a certain level of uncertainty for the fuel combustion sector. Data on fuel consumption are collected by the Lithuanian Statistical Department which prepares the annual report "Energy balance". Some categories defined in the CRF do not exactly match the categories of energy commodities and economic sectors identified in the national statistics. Therefore the final figures for fuel consumption and respective emissions have had to be calculated by grouping data selected from the Energy Balance, suing one's best judgment.

3.7 International bunkers fuels

The Lithuanian Statistical Yearbook provides data on marine bunkers. Data on gas/diesel oil and residual fuel oil is available, where the later makes about 82% of total GHG emissions from marine bunkers. National emissions factors are used to estimate CO_2, CH_4 and N_2O emissions.

Since 2001, three types of aviation fuel are distinguished: aviation gasoline, gasoline type jet fuel and kerosene type jet fuel.
Following advice from experts[2] 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. GHG emissions due to multilateral operations are not available.

---

2 IDR Lithuania 17-21 May, 2004, Branca Americano (Brazil); consultant Domas Balandis (Lithuania), consultant Romas Lenkaitis (Lithuania).

3.8 Fugitive emissions from oil and gas operations

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.

A key source analysis on 2004 emissions shows that fugitive emissions from oil and gas operations CH_4 are one of a key source.

3.8.1 Methodological issues

Emissions were calculated using emission factors (Table 3-4) provided in IPCC guidelines and based on activity data obtained from various sources: Geological Survey of Lithuania (number of drilling, testing, servicing wells), Statistics Lithuania publication "Energy balance" (oil production and refining), JSC "Lietuvos dujos" (length of pipelines). There are no mining activities in Lithuania, thus no fugitive emissions from solid fuels exists.

Table 3-4. Emission factors used for estimation of emissions from oil and gas operations.

Category	Subcategory	Emission Type	Emission factor			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	Fugitives	2.5E-03	1.6E-05	0	Gg/yr and per km of transmission pipeline
		Venting	1E-03	8.5E-06	0	Gg/yr and per 10^6 m^3 gas withdrawals
Gas distribution	All	All	6.15E-04	0	0	Gg/yr and per km of distribution mains
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

4   INDUSTRIAL PROCESSES (Sector 2)

4.1 Overview of the industry sector

After the economic recession in the 1990's, Lithuania's industrial production and economy started to grow, as reflected by the growth of the GDP. Trends of some of the main industrial activities are presented in Figure 4.1.
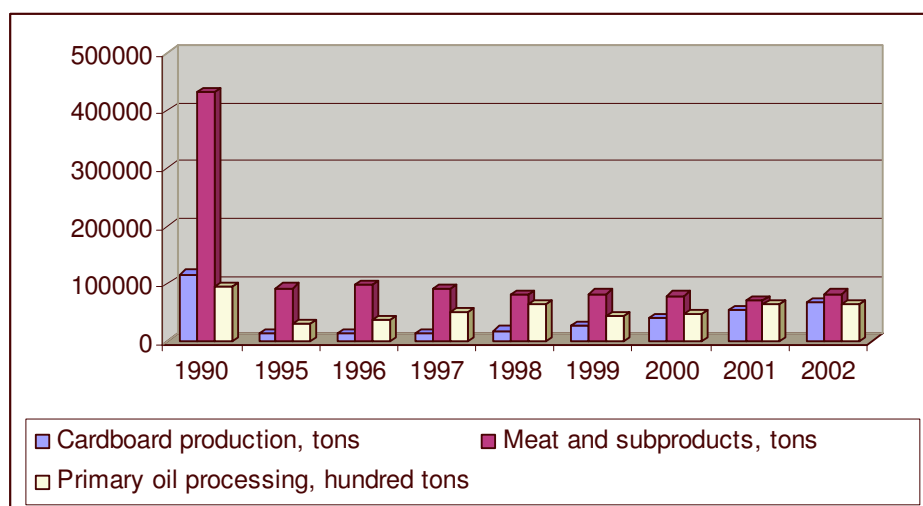
Figure 4.1. Trends of cardboard production, primary oil processing and meat production in 1990, 1995–2002.

Only a few industries directly contribute to GHG emissions. A particular mention should be made of the "Akmenes Cementas" cement factory and the "Achema" nitrogen fertilizers factory which are the largest producers as well as the largest suppliers to the national market.

Cement production has recently increased due to the growth of the national construction market. For 2002-2003, it was increasing by 19% per year. However, consumption was still 3,5 times lower than the EU average (143 kg compared to 508 kg cement/per capita)

Production of fertilizers is a strong industry branch. The main producer of nitric acid and ammonia is SC "Achema" that has increased its production mainly due to export possibilities.

4.2 Greenhouse gas sources from industrial processes

Emission from industrial processes occur when chemical reactions result in the production of CO_2 (as in cement production) and a portion of it is released to the atmosphere or when GHG themselves are used in the industrial processes.

Four sources of GHG are identified in the industry sector, 3 of which fall within the key source categories. GHG sources from industrial processes are provided in Table 4-1.

Table 4-1. GHG emissions from main industrial sources (Gg CO$_2$ equivalent)

Source	GHG	1990	1995	2000	2004	Share in the total emissions % in 2004
2.B.2. Nitric acid production	N$_2$O	771.3	540.2	1,308.5	1723,60	8,19
2.B.1. Ammonia production	CO$_2$	1,189.6	925.5	1,067.1	1072,78	5,10
2.A.1. Cement production	CO$_2$	1,570.7	289.9	277.4	330,36	1,57

4.2.1 Mineral industry

4.2.1.1 Source category description

Cement and lime industry are present in Lithuania.

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$_2$. Stock company "Akmenes Cementas" is the only company in Lithuania, which manufactures cement.

Lime production emits CO$_2$ through the thermal decomposition (calcination of the calcium carbonate in limestone to produce quicklime or through the decomposition of dolomite to produce dolomite quicklime.

There are no soda ash production in Lithuania, but carbon dioxide is emitted from the use of soda ash.

4.2.1.2 Methodological issues

Cement
CO$_2$ emission from cement production sector is calculated according to IPCC Tier 2 methodology – using data for clinker production, the CaO content of the clinker and correction factor for the loss of Cement Kiln Dust (CKD).
Data on annual production of clinker and CaO content of the clinker is provided by cement production company "Akmenes cementas".

Lime
CO$_2$ emission from lime production is estimated on the basis of IPCC methodology. Activity data was obtained from Statistics Lithuania annual publication "Production of commodities".
Lime production data was converted to hydrated lime using correction factor 0.97 provided in IPCC Good Practice Guidance. Due to disaggregated data for the breakdown of lime types is not available, the default ratio value for high-calcium/dolomite lime was used (85/15). For CO$_2$ emission estimation IPCC default emission factors were used:
- 785 kg CO$_2$ per tonne of high calcium quicklime;
- 913 kg CO$_2$ per tonne of dolomite quicklime.

Soda ash use
The methodology described in the IPCC Guidelines is used. CO$_2$ emission from the use of soda ash was estimated using consumption data and default emission factor EF=415 kg CO$_2$/Na$_2$CO$_3$.

Activity data source – Statistics Lithuania annual publication "Raw materials".

4.2.2 Chemical industry

4.2.2.1 Source category description

In GHG inventory this source category includes estimations of:
- Emissions from ammonia and nitric acid and
- Emissions from methanol production

The production of nitric acid generates nitrous oxide as a by-product of the high temperature catalytic oxidation of ammonia. Nitric acid is used as a raw material in the manufacture of nitrogen–based fertilizer. The only producer of nitric acid and ammonia in Lithuania is SC "Achema".

4.2.2.2 Methodological issues

Ammonia and nitric acid production
The estimations of CO_2 and N_2O emissions from production of ammonia and nitric acid were provided by national chemical company SC "Achema". All estimation background data is considered as confidential.

Methanol production
For CH_4 emission calculation emission factor (2 kg CH_4/tonne production) provided in IPCC Guidelines was used. Data on methanol production is obtained from Statistics Lithuania publication "Production of Commodities".

4.2.3 Sources of F-gases

4.2.3.1 Source category description

In accordance with 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. Their use is also common in semiconductor manufacturing. Emissions of HFCs and SF_6 occur as leakage from use of equipment and form the destruction of such equipment after use.

Fluorinated gases, monitored under the UNFCCC, are not produced in Lithuania and national consumption is covered only by import. According to Chemicals Registry and Lithuania's Customs department data, HFC's and SF_6 are being imported to Lithuania.

HFCs are currently used in refrigeration technologies as a cooling medium, where they substitute banned CFCs and partially regulated halogenated chlorofluorohydrocarbons HClFCs. The estimation of quantities, and therefore emissions, is made difficult due to lack of data. The only local producer of refrigerators SC "Snaige" has shifted to non-GHG reagents in their production.

SF_6 is characterized by excellent insulating properties and is thus used primarily as an insulating medium in high-voltage electro technology and energy production. Emissions of SF_6 in Lithuania are calculated from SF_6 use in electrical equipment.

Since there are no records about PFC's import/export in the Chemicals Registry during 1995-2004, it is assumed that PFC emission does not occur in Lithuania.

Inventory data of F-gases is presented in the table below (Table 4-2).

Table 4-2. Emission of F-gases (Gg CO$_2$ eq) in 1995-2004

Gas/Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
HFCs	44.61	90.81	18.56	41.63	158.06	30.14	14.04	34.50	21.94	36.83
PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF$_6$	0.05	0.05	0.08	0.11	0.17	0.22	0.30	0.40	1.93	0.86

4.2.3.2   Methodological issues

HFCs consumption in 1995-2004 is estimated following IPCC Guidelines Tier 1. As there was a lack of data on each consumer group an aggregated data on emissions of those GHG was estimated according to potential emissions. Potential emissions were calculated from consumption, which was defined as import minus export. The method assumes that actual emissions should not exceed potential emissions. The import and export data are collected from the Custom Department, which is under the obligation to collect data on all halocarbons that fall under Montreal Protocol. Those data are then sent to the Ministry of Environment, Division of Chemical Substances and forwarded to the Air Division. Then amounts of HFCs were calculated using default shares on the amount of certain chemical in a mixture.

SF$_6$ emission is calculated from SF$_6$ use in electrical equipment. Activity data (SF$_6$ amount filled in electrical equipment and emissions from equipment breakdown) was obtained directly from energy supply companies. It was assumed that emissions due to leakage and maintenance losses are 1% of annual stocks.

4.2.4   Uncertainties

There is a certain level of uncertainty in the activity data for estimation of emissions from industry. As mentioned before, the data are collected from available national statistical data and these are not always the most appropriate.
However it should be mentioned that emission estimations from some industrial processes, which are identified as a key categories, are quite precise due to some industrial companies provided plant specific data necessary for GHG calculations (ammonnia, nitric acid, cement production).
Possibilities for further improvements are related mainly to increasing the coverage of the inventory from industrial processes (F-gases etc.).

5   SOLVENT AND OTHER PRODUCTS USE (Sector 3)

5.1 Overview of solvent and other products use sector

The management and information on solvent used in Lithuania heavily depends upon the implementation of the provisions of EC Directive 1999/13/EC on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations. A strategy of implementation of the Directive was prepared in 2001 (AAPC, Autumn 2001) that includes preliminary inventory of sources of Volatile Organic Compounds (VOC), estimation of amounts of solvents used, and identification of ways to reduce and to manage VOC emissions in the future.

The requirements of the Directive are currently being transposed into national law and an emission reduction plan is being prepared. The emission reduction plan sets limits of VOC for installations applicable from now until 2008. The implementation of VOC emission reduction plan should decrease amount of VOC emitted in Lithuania.

The number of installations in Lithuania covered by EC Directive 1999/13/EC is evaluated at 123. The total solvent use is approximately 2600 ton per year. (These figures are only approximate and will need to be adjusted in future). The current system for issuing permits for the use of natural resources, and the newly developed rules for granting IPPC permits in particular, also involves VOC control. A substantial number of installations subject to the Directive 1999/13/EC will be covered by the permitting system but some small installations, especially dry cleaning and vehicle refinishing plants, will operate without permits.

The enterprises are obliged to perform emission source monitoring (inventories) in accordance with the Guidelines for Inventory of Pollutant Emissions to the Atmosphere[3]. The Regional Environmental Protection Departments (8 regional authorities of the Ministry of Environment) shall maintain the list of the enterprises that have an obligation to perform stationary emission source monitoring and shall control its implementation.

Activities analysed and covered by the aforementioned directive are as follows:
- Heatset web offset printing
- Flexography
- Surface cleaning
- Vehicle refinishing
- Other coating
- Winding wire coating
- Coating of wooden surfaces
- Dry cleaning
- Foot wear manufacture
- Manufacturing of pharmaceutical products

Therefore, a large number of the source categories in the IPCC Category 3: Solvent and other Product Use are covered, however detailed information by category is not available for the time being.

---

3 According to the decision of the Department of Environmental Protection (now Ministry of Environment) No 126, from September, 1991

5.2 Greenhouse gas sources in solvent and other products use sector

5.2.1.1 Source category description

Solvents and related compounds are a significant source of emissions of non-methane volatile organic compounds (NMVOCs), which are a precursor of troposphere ozone and as such, an indirect greenhouse gas. Some of these products are manufactured from fossil fuels, and their oxidation in the atmosphere is a source of CO_2; however, they are not an important source of CO_2 emissions. This category also includes evaporative emissions of other greenhouse gases, for example, N_2O emissions from solvent use in medical applications and in the food industry.

5.2.1.2 Methodological issues

Direct emissions of GHG from solvent and other products were not estimated so far.

In the future there is a potential to complement the inventory, using the outcomes of the implementation of the EU Directive 1999/13/EC, that would require preparation of an annual inventory of emissions from solvent use.

The IPCC Guidelines uses the CORINAIR methodology for processing NMVOC emissions in this category. The manual for CORINAIR can be used in conversion of data from the CORINAIR (i.e. SNAP) structure to the IPCC classification. Data on NMVOC emissions have been included in the CRF. CO_2 and N_2O emissions have not been estimated.

6   AGRICULTURE (Sector 4)

6.1 Overview of agricultural sector

The area utilized for agriculture makes up over 53 % of the total area of the country.

Between the two world wars, the land-tenure structure was characterized by high level of the land use (agricultural farming lands reached up to 67 % of the total country's territory, with arable land at 47 %), low level of forest cover (less than 20 %) and a very small amount of urbanized territory. During the years of Soviet annexation, more intensive cultivation practices emerged, with larger fields and extensive building of drainage dykes (which, incidentally, sharply reduced the area of other natural biotopes such as meadows, long-fallow lands, bushes, swamps etc). The general share of agricultural farming lands and arable lands decreased, and as a result, waste-lands reaching 20-50 km^2 of area were formed. During this period the share of built up areas increased sharply- urbanization development took up to some thousand hectares of land every year.

Since independence, farming has been privatised. The land reform is changing the structure of agricultural land from the point of view of its users. The number of farmers' farms is increasing, while the number of agricultural partnerships and other kinds of agricultural enterprises and the area of land at their disposal is diminishing.

Agriculture remains one of the major sectors in the national economy. Although agriculture and the food industry contribute a substantial part of the GDP, the share of the sector's input to the GDP constantly declines.
The structure of the agricultural production has changed significantly during the recent decade. In 1990 livestock production constituted the major part of the agricultural production (54.5%); while in 2004 crop production took a leading position at 57.3%.

Although the Lithuanian food industry is expected to have the niche in the EU Common Market, it requires restructuring and modernisation, in order to comply with quality, hygiene, food safety and environmental requirements.

6.2 Greenhouse gas sources in the agricultural sector

Greenhouse gas emissions from agriculture category in Lithuania consist of emissions of methane and nitrous oxide. Agriculture is the second largest source of greenhouse gases, emitting 44 % of all methane and 47 % of nitrogen oxide emissions.

Methane emissions are derived from animal breeding, primarily from enteric fermentation (digestive processes) and manure management, where methane is formed under anaerobic conditions.

Nitrous oxide emissions are formed mainly in denitrification processes in soils, mainly under anaerobic conditions. The anthropogenic contribution that is determined in the national inventory of greenhouse gases is caused by nitrogenous substances derived from inorganic nitrogen-containing fertilizers, manure from animal breeding and nitrogen contained in parts of agricultural crops that are returned to the soil.

As shown in Table 6-1, 5 sources of GHG from agriculture are among the key sources of emissions.

Table 6-1. GHG emissions from main sources in agriculture (Gg CO$_2$ equivalent)

Source	GHG	1990	1995	2000	2004	Share in the total emissions % in 2004
4.D.1. Direct soil emissions	N$_2$O	3,118.5	1,452.1	1,437.0	1610,61	7,65
4.A. Enteric fermentation	CH$_4$	3,289.1	1,636.5	1,167.7	1223,58	5,81
4.B. Manure management	N$_2$O	868.1	443.8	316.3	335,27	1,59
4.D.3. Indirect emissions	N$_2$O	877.1	119.3	109.3	247,65	1,18
4.B. Manure management	CH$_4$	465.1	237.0	165.4	190,71	0,91

The reduction of methane and ammonia emissions from inappropriate storage and use of fertilisers and liquid manure is one of the key objectives in implementing the Action programme within the framework of the EU nitrate directive. As the majority of farms lack proper manure storage capacities, methane and ammonia emissions and outdoor pollution are quite common.

6.2.1 Enteric Fermentation

6.2.1.1 Source category description

Enteric fermentation is a source of methane from livestock. In domestic livestock methane is produces in the rumen, by methanogenic bacteria, and emitted to the air through belching.
In Lithuania emissions from cattle (dairy and non-diary cattle), sheep, goats, horses and swine have been calculated. 95% of CH$_4$ emissions from enteric fermentation are produced by cattle. Methane emissions from enteric fermentation were 58,3 Gg and accounted for 87 % of total methane emissions in agriculture sector in 2004.

6.2.1.2 Methodological issues

The number of cattle, sheep, goats, horses and swine was received from the Statistical Yearbook "Agriculture in Lithuania". Emissions from enteric fermentation of domestic livestock have been calculated using IPCC Tier1 methodology:

Methane emission (Gg/year) = emission factor (EF) (kg/animal/year) x number of animals/(10^6 kg/Gg)

IPCC default emission factors were used for calculating CH$_4$ emissions from enteric fermentation for all animal categories (Tier 1 method). Emission factors are presented in Table 6-2.

Table 6-2. Emission factors for each animal category used for calculation of CH$_4$ emission from enteric fermentation.

Animal category	Emission factor (kg CH$_4$/ animal/yr)

Dairy cattle	81
Non-diary cattle	56
Swine	1.50
Sheep	8
Goat	5
Horse	18

6.2.2 Manure Management

6.2.2.1 Source category description

Livestock manure is composed of organic material that produces methane during decomposition in an anaerobic environment and nitrous oxide during the storage of manure before application to land. Methane emissions can be reduced by storage outside the stable in cold environments and by a shorter storage period or to stimulate the fermentation and to capture the methane for energy purposes.

Production of methane from manure management depends on ambient temperature and moisture, residency time and moisture content. Amount of nitrous oxide depends on the composition of manure and urine, a type of bacteria involved and an amount of oxygen and liquid in manure.

Nitrous oxide and methane emissions from manure management were 334.8 Gg and 190.7 Gg CO_2 equivalent in 2004, respectively. Nitrous oxide emissions from manure management were about 12.7 % and methane emissions about 13.4 % of total agricultural emissions in 2004.

6.2.2.2 Methodological issues

For calculation of methane emissions and nitrous oxide emissions from manure management, IPCC Tier 1 methodology was used. Animal numbers used for calculating CH_4 and N2O emissions from manure management are the same used for calculating CH_4 emissions from enteric fermentation (collected from the Lithuanian Statistics Yearbook "Agriculture in Lithuania").

Methane emissions from cattle (dairy and non-dairy), horses, goats, sheep, swine and poultry were calculated. A default IPCC emission values (Table 6-3) for each relevant livestock category are used to calculate emissions from manure. Cattle and swine produced almost equal amounts of CH_4 emissions; this represented 92% of all methane produced by manure management.

Nitrous oxide 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. For calculation of total nitrogen excretion IPCC default annual average nitrogen excretion rates for each animal category were used. Fraction of manure managed in each manure management system was determined using IPCC defaults (Table 6-3). To calculate nitrous oxide emissions the IPCC default emission factors have been used for each manure management system (Table 6-3).

Table 6-3. Emission factors for N$_2$O estimation from manure management

Manure management system	Emission factor (kg N$_2$O-N/kg nitrogen excreted)
Anaerobic lagoons	0.001
Pasture/ range/ paddock	0.02
Solid storage and dry lot	0.02

Liquid system	0.001
Other management systems	0.005

6.2.3   Agricultural soils

6.2.3.1   Source category description

This source category consists of direct and indirect nitrous oxide emissions from agricultural soils. Nitrous oxide emissions from agricultural soils depends directly on an amount of application of synthetic fertilizers and manure, the cultivation of nitrogen fixing crops, the introduction of crop residues into soils and soil nitrogen mineralization due to cultivation of organic soils. The method of estimating direct N_2O emissions from agricultural soils has two parts: 1) estimation of direct N_2O emissions due to N-inputs to soils (excluding N-inputs from animals on pasture, range and paddock) and 2) estimation of direct N_2O emissions from unmanaged animal manure (manure deposited by animals on pasture, range and paddock). As indirect emissions of N_2O, emissions from leaching and runoff of applied/deposited on soils N and atmospheric deposition on soils of NO_x and ammonium (NH_4) were estimated.

6.2.3.2   Methodological issues

Direct nitrous oxide emissions from agricultural soils have been calculated using IPCC methodology. For assessing of direct N_2O emissions from agricultural soils, anthropogenic nitrogen inputs were considered from:
- the application of synthetic fertilizers and animal manure,
- the cultivation of N-fixing crops,
- the incorporation of crop residues into soils,
- soil nitrogen mineralization due to cultivation of organic soils (histosols).

Estimation of direct N_2O emissions from pasture, range and paddock manure was calculated according to the same methodology used for estimation of N_2O emissions from manure management (description in chapter 6.2.2).

Activity data is received from the Statistical Yearbooks "Agriculture in Lithuania" (crop and pulses yields) and "Production of commodities" (annual amount of N fertilisers sold). The estimates of histosols are based on expert judgement: it is assumed that 4% of cultivated agricultural land are cultivated histosols.

Direct and indirect emissions from agricultural soils are calculated using IPCC default emissions factors and default parameters (Table 6-4, Table 6-5, Table 6-6).

Table 6-4. Emission factors used for calculations of direct nitrous oxide emissions from agricultural soils.

Emission source	Emission factor
Synthetic fertilisers	0.0125 kg N_2O-N/kg N
N-fixing crops	0.0125 kg N_2O-N/kg dry biomass
Crop residue	0.0125 kg N_2O-N/kg dry biomass
Cultivation of histosols	5 kg N/ha/yr
Animal wastes applied to soils	0.0125 kg N_2O-N/kg N

Table 6-5. Parameters used for calculation of direct nitrous oxide emissions from agricultural soils.

Parameter	Value
Fraction of crop residue burned	0.1 kg N/kg crop-N
Fraction of N input that volatilises as NH3 and NOx from synthetic fertilizers.	0.1 kg NH_3-N + NOx-N/kg of synthetic fertiliser N applied
Fraction of livestock N excretion that volatilises as NH3 and NOx	0.2 kg NH_3-N + NOx-N/kg of N excreted by livestock
Fraction of livestock N excreted and deposited onto soil during grazing	0.02 kg N_2O-N/kg N excreted
Fraction of total above ground biomass of N-fixing crop that is N	0.03 kg N/kg of dry biomass
Fraction of residue dry biomass that is N	0.015 kg N/kg of dry biomass
Fraction of total above ground crop biomass that is removed from the field as a crop product	0.45 kg N/kg crop-N

Table 6-6. Emission factors used for calculations of indirect nitrous oxide emissions from agricultural soils.

Emission source	Emission factor
Atmospheric deposition of N	0.01 kg N_2O-N/kg NH_4-N & NOx-N deposited
Nitrogen leaching and runoff	0.025 kg N_2O-N/kg N leached and runoff

6.3 Uncertainties

The uncertainty level for emissions from enteric fermentation and manure management are low as there are decent statistical data on a number of livestock since 1990. A number of livestock has been important in Soviet times as well as in the time of independent Lithuanian Republic.

The uncertainty is higher in the calculation of emissions from agricultural soils, e.g. nitrogen estimation from the application of synthetic fertilizers. Due to other activity data is not available, for estimation of emission from the application of N-fertilizers it was assumed that mass of N-fertilizers produced in Lithuania and sold is equal to mass of N-fertilizers used in agriculture. It is very likely, that imported fertilizers are also marketed and used in Lithuania, that means emission from application of synthetic N-fertilizers may be underestimated.

7   LAND-USE CHANGE AND FORESTRY (Sector 5)

7.1   Overview

Recorded land use variations in Lithuania (Figure 7.1) show significant fluctuations in 1990-1995. However, these fluctuations are mainly caused not so much by actual land use changes but by modifications of definitions used in statistics, dismantling of Soviet kolkhoz based agriculture system and introduction of private land ownership after the declaration of independence of Lithuania in 1990. From 1995, implementation of new principles of agricultural statistics was finalised and data fluctuations came to an end.
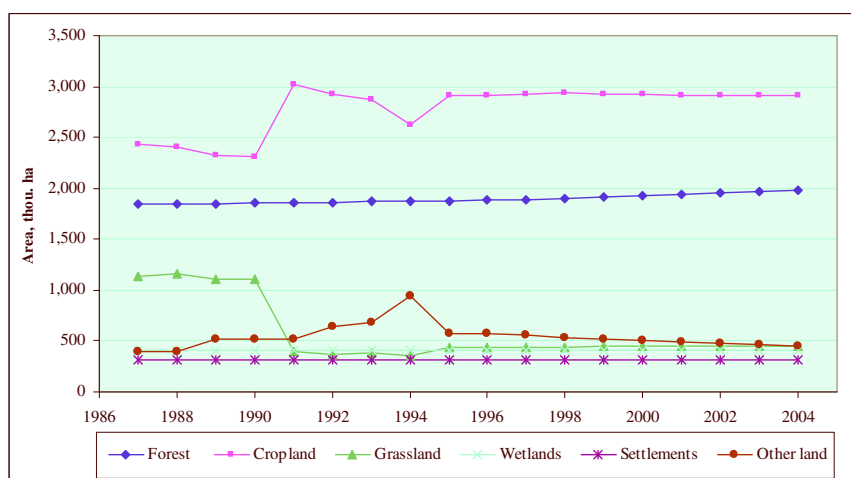
Figure 7.1. Reported land use variations in Lithuania in 1990-2004

The single important land use change in Lithuania was continuous steady expansion of forest area on infertile soils not suitable for intensive agriculture, categorised as "other land".

GHG uptake and release data are reported under IPCC categories 5A (Forestry), 5B (Cropland) and 5D (Wetlands). The IPCC categories 5C (Grassland), 5E (Settlements) and 5F (Other) are not reported as changes within these categories are considered to be not significant or reliable data are not available at the moment. Collection of additional information on these and other categories is continuing.

Changes in carbon stocks in soils (except forest litter) are not included in the calculations assuming that soil carbon stocks remain fairly constant and do not change with time. Nevertheless, data on carbon content in various types of soils in Lithuania are being collected and reports will be amended when more detailed information will be available.

Forest fertilisation is not applied in Lithuania. GHG emissions related to fertilisation of agricultural soils were reported in Agriculture sector.

Changes in carbon stocks in horticultural plantations were not estimated as data on horticultural plantations are not reliable and there are no data on carbon uptake by horticultural plants.

It was assumed that annual carbon stock changes in grasslands are negligible as grassland management activities in Lithuania are not changing. Liming is not applied on grasslands.

Summary of GHG emissions and sinks is provided in Table 7-1.

Table 7-1. Summary of greenhouse gas releases and sinks (Gg CO_2 equivalent per year) in LULUCF sector in Lithuania

	5. LULUCF	5.A Forestry	5.B Cropland	5.C Grassland	5.D Wetlands	5.E Settlements	5.F Other land
1990	-10.681,16	-10.905,26	151,50	NE,NA	72,60	NE,NA	NE
1991	-10.456,30	-10.658,76	129,86	NE,NA	72,60	NE,NA	NE
1992	-10.465,12	-10.645,93	108,21	NE,NA	72,60	NE,NA	NE
1993	-9.213,44	-9.363,44	86,57	NE,NA	63,43	NE,NA	NE
1994	-9.696,16	-9.836,26	64,93	NE,NA	75,17	NE,NA	NE
1995	-7.838,84	-7.956,92	43,29	NE,NA	74,80	NE,NA	NE
1996	-8.360,71	-8.457,15	21,64	NE,NA	74,80	NE,NA	NE
1997	-8.841,96	-8.909,06	0.00	NE,NA	67,10	NE,NA	NE
1998	-9.254,52	-9.322,35	0.00	NE,NA	67,83	NE,NA	NE
1999	-9.288,54	-9.356,37	0.00	NE,NA	67,83	NE,NA	NE
2000	-8.688,53	-8.759,66	0.00	NE,NA	71,13	NE,NA	NE
2001	-8.462,34	-8.533,84	0.00	NE,NA	71,50	NE,NA	NE
2002	-7.907,78	-7.966,08	0.00	NE,NA	58,30	NE,NA	NE
2003	-8.324,61	-8.375,58	0.00	NE,NA	50,97	NE,NA	NE
2004	-8.629,45	-8.682,99	0.00	NE,NA	53,53	NE,NA	NE

7.2 Forest land

7.2.1 Source category description

Data sources

Data on forest land area and its changes may be found in several sources of information. The most comprehensive data are provided in the *Lithuanian Statistical Yearbook of Forestry (2001-2006)* published by the Lithuanian State Forest Survey Service. The first *Yearbook* published in 2001 includes data for 1997 inventory (1 Jan. 1998).

Useful data including some additional information are provided in the *Lithuanian Country Report on Global Forest Resources Assessment 2005* prepared by the Lithuanian State Forest Survey Service. Specifically, the Report provides data of forest assessment in 1987 (1 Jan. 1988).

Detailed data on forest management are provided in the report of the *National Forest Inventory* (NFI) performed in 1998-2003.

The data quoted above may be found on the website of the *Lithuanian State Forest Survey Service*.

The National Land Service under the Ministry of Agriculture provides data on the *Land Fund of the Republic of Lithuania* from 2001 including data on forest land area.

It should be noted that data provided by various information sources are not identical. An example of divergence between the data of the *National Forest Inventory* and forest assessment data provided in the *Statistical Yearbook of Forestry* is shown in Table 7-2.

Table 7-2. **Comparison of forest land areas and their distribution according to National Forest Inventory and forest assessment data of 01 01 2002**

Land use category	National forest inventory	Forest assessment
Forest land, thou. ha	2084.2	2034.3
Covered, %	96.2	95.3
Non-covered, %	1.8	3.0
Nurseries, %	0.1	0.1
Line objects, %	1.8	1.4
Other, %	0.1	0.2

Source: National Forest Inventory 1998-2003

The discrepancy are caused mainly by differences in time of inventories. The difference between the two estimated values of forest land area is 49.9 thou. ha. The difference value is very close to forest area estimation error reported in the *National Forest Inventory* (±45.8 thou. ha with 95% confidence level). Bearing in mind that both inventories were performed not exactly at the same time which should be a natural source of discrepancy between the two sets of data, it was assumed that data inconsistencies are not significant.

Forest area

The most comprehensive information on forest land area is provided in *Lithuanian Statistical Yearbook of Forestry* and it was taken as a basis for calculation of GHG emissions. The *Yearbook* provides data of the regular forest assessments in 1987, 1997 and 2000-2004 which were used directly in calculations. The data for remaining years are interpolations of 1987-1997 and 1997-2000 data.

Forest assessments are based on stand wise forest inventory data base, maintained at the State Forest Survey Service, taking into account changes recorded during forest inventory and afterwards, including forest felling and reforestation activities as well as changes in forest ownership.

Only forested areas (forest stands) including natural and semi-natural forest and plantations were taken for calculation of changes in carbon stocks. Other forestry areas, such as blanks, block lines, forest roads, recreation sites, etc., were included in the 'other land' category.

Data on coniferous and deciduous stands were available in the *Lithuanian Statistical Yearbooks of Forestry* from the year 2000 onwards. For remaining period (1990-1999) it was assumed that percentages of coniferous and deciduous stands were equal to average values in 2000-2004 (59.2% and 40.8% respectively).

Forest coverage in Lithuania was increasing continuously since the 2nd World War (Figure 7.2). Average annual increase of forest area after the war was more than 14 thous. ha. From 1947 to 1960 expansion of forest area reached approximately 20 thous. ha per year. During sixties and seventies forest area was expanding at a slower rate, approximately 10 thou. ha per year.
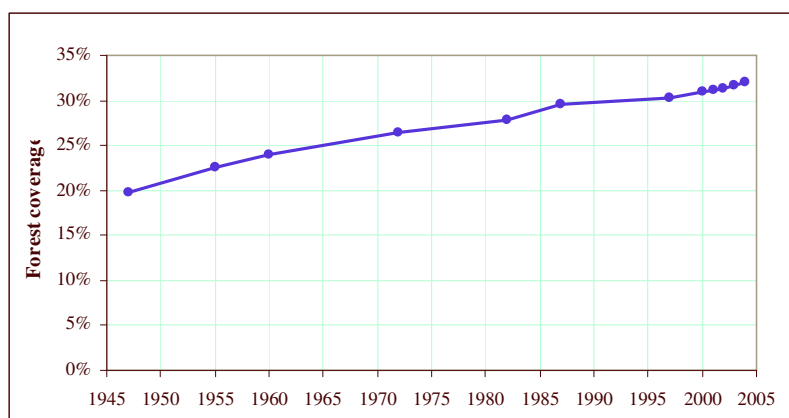
Figure 7.2. **Variation of forest coverage in Lithuania after the 2ⁿᵈ World War**

Forest is planted on infertile soils not suitable for intensive agriculture. As a rule, only "other land" is converted to forest land (seeFigure 7.3).
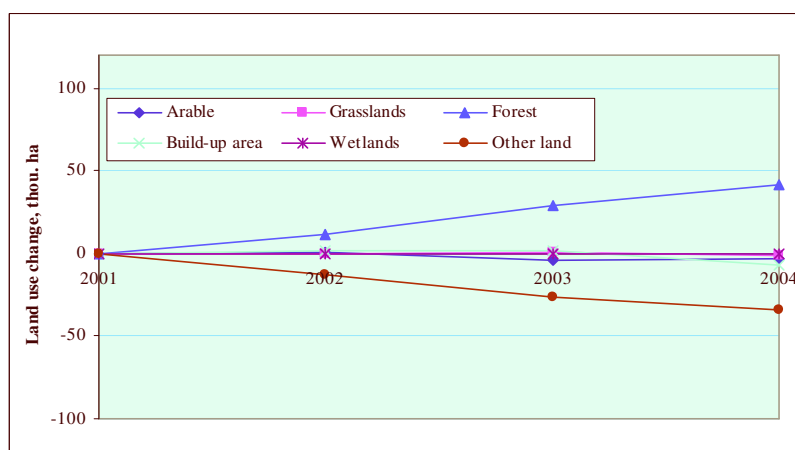
Source: Land fund of the Republic of Lithuania

Figure 7.3. Land use changes in Lithuania from 2001

Time required to reach steady state conditions in land converted to forest land is approximately 20 years (IPCC default value). In order to evaluate the area of land converted to forest land in the base year, historical data are required starting from 1970.

As discussed above, average annual increase of forest land area from 1973 to 1993 was approximately 12.1 thous. ha. (see Figure 7.2). This figure was used for evaluation of historical data on the area of land converted to forest land from 1970 to 1989.

Variations of forest land area are provided in Table 7-3.

Table 7-3. Forest land area variations in 1990-2004 (thous. ha)

	Nominal forest area	Forest stands	Forest land remaining forest land			Land converted to forest land
			Total	Coniferous	Deciduous	
1990	1,945	1,854	1,612	950	662	242
1991	1,950	1,859	1,624	957	667	234
1992	1,955	1,863	1,636	964	672	227
1993	1,959	1,868	1,649	971	677	219
1994	1,964	1,872	1,661	978	682	212
1995	1,969	1,877	1,673	986	687	204
1996	1,973	1,881	1,685	993	692	196
1997	1,978	1,888	1,697	1,030	667	191
1998	1,992	1,901	1,709	1,007	702	192
1999	2,006	1,914	1,721	1,014	707	193
2000	2,020	1,928	1,733	1,037	696	194
2001	2,034	1,938	1,745	1,045	700	193
2002	2,045	1,951	1,757	1,045	713	194
2003	2,069	1,968	1,770	1,042	727	198
2004	2,091	1,988	1,782	1,035	746	206

Fellings

Data on commercial fellings were provided by the State Forest Survey Service.

Removal of round wood has increased approximately 2.5 times since 1990 (Figure 7.4) and the total volume of removals increased form 3.3 million m^3 on 1990 to the maximum 7.1 million m^3 in 2003.
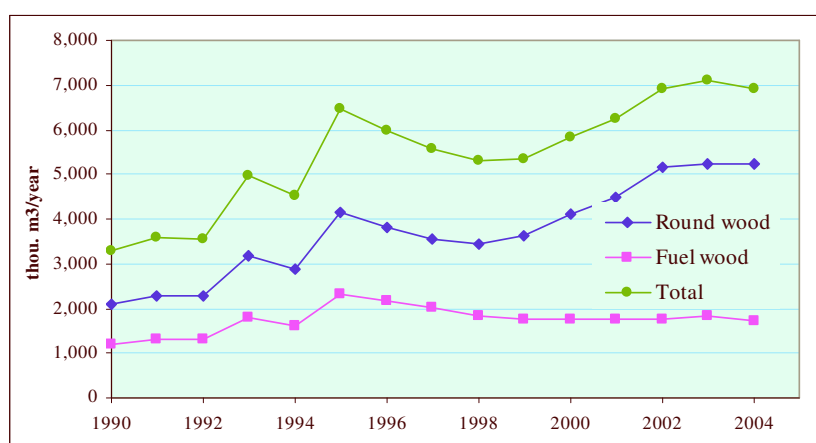
Figure 7.4. Variations of wood removal (over bark) in 1990-2004

Biomass burning

Prescribed burning of forest biomass is not used in Lithuania.

Data on areas affected by forest fires are available from the *Statistical Yearbooks of Forestry* (1999-2005) and from the *Lithuanian Country Report on Global Forest Resources Assessment 2005* (1990-1992 and 1998). Average value of available data were used for calculation of emissions during the remaining period (1993-1997).

Windbreaks and windfalls

Statistical Yearbooks of Forestry provide data on windbreaks and windfalls removals. However, according to the representatives of the State Forest Survey Service responsible for collection and processing of information, 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 calculation of carbon losses due to disturbances.

Forest fertilisation

According to *the State Forest Survey Service*, forest fertilisation is not applied in Lithuania. Therefore, it was assumed that there are no direct emissions of N_2O from forest fertilisation.

7.2.2   Methodological Issues

Changes in carbon stocks in living biomass in forest land remaining forest land including above- and below-ground biomass was estimated as difference in biomass increments and losses according to equation 3.2.2 of the *Good Practice Guidance for LULUCF*.

Annual increase in carbon stocks due to biomass increment in forest land remaining forest was calculated from equations 3.2.4 and 3.2.5 provided in the *Good Practice Guidance for LULUCF*.

Annual carbon loss due to commercial fellings was calculated using equation 3.2.7 of the *Good Practice Guidance for LULUCF*.

Annual carbon loss due to wildfires L_{fires} was estimated using equation 3.2.20 of the *Good Practice Guidance for LULUCF*:

Parameters used in calculation are discussed below.

Annual volume increment

Values of average annual net increment in volume suitable for industrial processing I_V for dominant tree species for 1999 onwards are provided in the *Lithuanian Statistical Yearbooks of Forestry*. Average value of 1999-2004 was used for period 1990-1998. It should be noted that biomass increment value provided in the *National Forest Inventory* is approximately 20% higher than provided in the *Statistical Yearbooks of Forestry*. Data inconsistency may be caused by application of different methodology but it is not discussed in the inventory report. Lower, more conservative values provided in the *Statistical Yearbooks of Forestry* were used for calculation of carbon stock changes.

Annual net increment depends on the age of forest stands (Figure 7.5). Net increment in volume of stands less than 20 years old calculated from the data provided in the *National Forest Inventory* comprise only 37% of the overall increment (22% for coniferous and 48% for deciduous). Net increment of stands more than 20 years old is on average 10% higher than the overall increment (9.5% for coniferous and 10.3% for deciduous). Corresponding corrections of net increment values were made in calculations of changes in carbon stocks in forest land remaining forest land (>20 years) and land converted to forest land (≤20 years). Estimated values

of average annual net increment in volume (m^3 ha^{-1} yr^{-1}) used for calculation of carbon uptake are provided in Table 7-4.
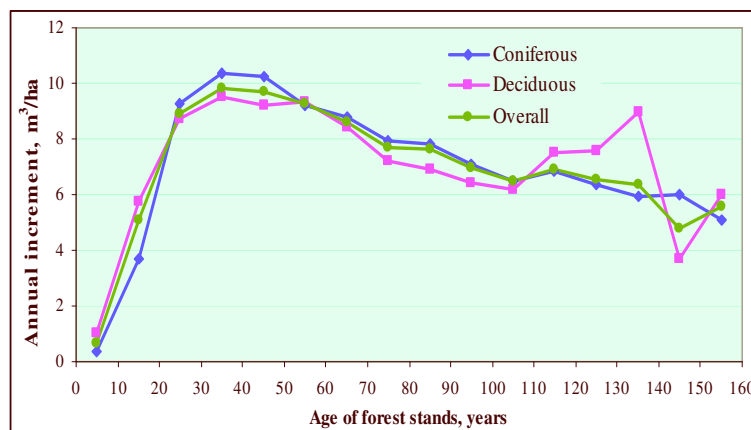
Source: National Forest Inventory 1999-2003

Figure 7.5. Variation of annual net increment of forest stands by age

Table 7-4. Estimated values of average annual net increment in volume (m^3 ha^{-1} yr^{-1}) used for calculation of carbon uptake

	2000	2001	2002	2003	2004
Forest land remaining forest land:					
Coniferous	7.09	7.15	7.15	7.38	7.09
Deciduous	6.32	6.31	6.30	6.48	6.79
Land converted to forest land	2.26	2.26	2.30	2.38	2.38
Overall	6.1	6.1	6.2	6.4	6.4

Wood density

Basic wood density *D* was estimated on the basis of data provided in Table 3A.1.9 of the *Good Practice Guidance for LULUCF*. Density values for coniferous and deciduous were calculated as weighed average values related to growing stock volume (see Table 7-5).

Table 7-5. Calculation of average basic wood density values

Species	Growing stock (mill. m^3), average 2000-2005	Basic wood density, tonnes d.m. m^{-3}	
		Separate species	**Weighed average**
Pine	165.9	0.40	
Spruce	84.0	0.44	
Total coniferous	**250.0**		**0.41**
Birch	67.9	0.51	
Aspen	12.8	0.35	
Black alder	24.5	0.45	

Grey alder	15.4	0.45	
Oak	7.2	0.58	
Ash	8.6	0.57	
Total deciduous	**136.4**		**0.48**
Overall total	**386.4**		**0.44**

Biomass expansion factor for net increment

Default values of biomass expansion factor for conversion of annual net increment to aboveground tree biomass increment, BEF_1, were taken from Table 3A.1.10 of the *Good Practice Guidance for LULUCF* – 1.1 for coniferous and land converted to forest land, and 1.2 for deciduous.

Root-to-shoot ration

Root-to-shoot ratio values provided in the *Lithuanian Country Report on Global Forest Resources Assessment 2005* were used: 0.26 for coniferous, 0.19 for deciduous and 0.23 for all tree species.

Carbon fraction of dry matter

Default value 0.5 tonne C (tonne d.m.)$^{-1}$ provided in the *Good Practice Guidance for LULUCF* was used for carbon fraction of dry matter *CF*.

Biomass expansion factor for removals

Biomass expansion factors for converting volumes of extracted round wood to total aboveground biomass BEF_2 for coniferous and broadleaf were obtained from Table 3A.1.10 of the *Good Practice Guidance for LULUCF*. Overall biomass expansion factor was estimated as weighted average equal to 1.34.

Biomass left to decay

Default value of fraction of biomass left to decay in forest (transferred to dead organic matter) (F_{BL}) provided in Table 3A.1.11 was used (0.15 – temperate semi natural forests).

Dead organic matter

It was assumed that carbon inputs and losses in dead wood and litter in forest land remaining forest land balance one another and net changes are close to zero. 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 in 20 years at the end of conversion period.

The total amount of dead wood and litter in Lithuanian forests was evaluated in the *Lithuanian Country Report on Global Forest Resources Assessment 2005* (Table 7-6)

Table 7-6. Estimated carbon content in dead wood and litter (million tonne)

	1990	**2000**	**2005**
Dead wood	9.8	10.2	10.5
Litter	46.7	48.5	50.4

Source: Lithuanian Country Report on Global Forest Resources Assessment 2005

It was calculated from these data that dead wood amount in forest land remaining forest land on average is approximately 5.3 tonne C per ha and litter amount is approximately 25.1 tonne C per ha. Assuming that this amount is accumulating in 20 years, annual carbon stock increment in land converted to forest land is approximately 0.26 tonne per ha in dead wood and 1.26 tonne per ha in litter.

Soils

Classification of forest land according to soil type is provided in the *Statistical Yearbooks of Forestry 2006*. According to the statistics, the total area of organic forest soil (peat land) is 257.1 thou. ha from which 125.1 thou. ha is drained peat land. As drainage activities actually have stopped after independence, it was assumed that the area of drained forest peat lend was not changing since 1990.

It was assumed that soil carbon stocks in organic not drained soil in forest land remaining forest land remain stable and do not change with time.

In a long-term experiment conducted by the Lithuanian Institute of Agriculture (Armolaitis, K., et al., 2005) it was established that organic carbon pool in upper 10 cm layer in pine plantation was approximately 6 times higher than in non-cultivated land. However, the major part of carbon is accumulated in litter while the difference of carbon content in mineral topsoil layer is far less significant. As carbon accumulation in litter in land converted to forest land was assessed separately, accumulation in mineral soil was not included in calculations.

Average growing stocks

Data on average growing stocks required for calculation of carbon loss due to wildfires are available from the *Statistical Yearbooks of Forestry* (1997, 2000-2004) and from the *Lithuanian Country Report on Global Forest Resources Assessment 2005* (1987 and 1992). Values of biomass stocks for remaining years were interpolated from the regression line (Figure 7.6).

y = 171 + 2.0735 (x - 1990)

r = 0.98
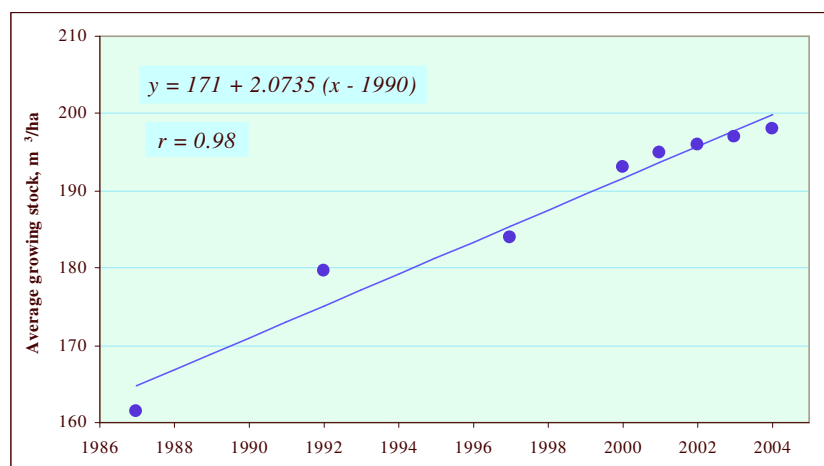
Figure 7.6. Regression analysis of variations of average growing stocks

Combustion efficiency

Combustion efficiency *C* is taken from Table 3A.1.12 of the *Good Practice Guidance for LULUCF* (0.45).

Emission factors for forest fires

Emission factors D_{em} are taken from Table 3A.1.12 of the *Good Practice Guidance for LULUCF* as average of two values provided for forest fires (tonne per tonne dry matter combusted):

CO_2 1.56
C   0.42
CO   1.21
CH_4 0.008
NO_x 0.0007
N_2O 0.00011

7.3   Cropland

7.3.1   Source category description

Data on land use covering all area of Lithuania are provided in the *Statistical Yearbook: Agriculture in Lithuania*. Variations of agricultural land use from 1986 as reported in the *Yearbook* are shown in Figure 7.7. As may be seen from the diagram, substantial changes in land use were recorded from 1990 to 1995 while very insignificant variations occurred before and after this period.
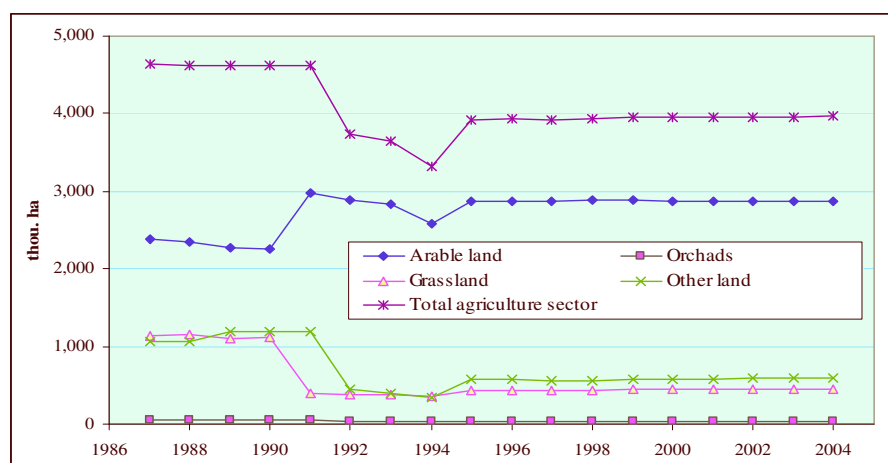
Source: Agriculture in Lithuania. Statistics Lithuania, 1990-2004

Figure 7.7. Land use in Lithuanian agriculture sector

Recorded variations in 1990-1995 are mainly related not so much to actual changes of land use but to modifications of definitions used in statistics, dismantling of Soviet kolkhoz based agriculture system and introduction of private land ownership after the declaration of independence of Lithuania. Land reform started immediately after the proclamation of

independence in 1990 and the most important features of land reform were restitution of land ownership and, as a result of this, break up of kolkhoz farms to smaller private farms.

Substantial reduction of recorded grassland and corresponding increase of recorded cropland in 1991 was caused by change of definition of arable land which, from 1991 onwards, included sown perennial grasses assigned to meadows and pastures in the Soviet statistics. Further, following break up of kolkhoz farms, significant part of non-arable land formerly owned by kolkhozes and categorised as "other land" was assigned to specific land use categories, e.g. settlements, wetlands, etc. Other consequence of kolkhoz break-up was that some arable land became ownerless and temporary "disappeared" from the statistics. This phenomenon caused gradual reduction of recorded arable land from 1991 to the minimum level in 1994. From 1995, implementation of new principles of agricultural statistics was finalised and data fluctuations came to an end.

Therefore, though statistical data show substantial fluctuations, it was assumed that no significant conversion of cropland to other uses and conversion of land from other uses to cropland has taken place from 1990 onwards and cropland area was quite stable.

7.3.2   Methodological Issues

Changes in biomass stocks

As stated in the *Good Practice Guidance for LULUCF,* for annual crops, increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year and there is no net accumulation of biomass carbon stocks. Further, changes in dead organic matter and inorganic carbon were also assumed to be zero and were not included in calculations.

Carbon can be stored in the biomass of croplands that contain perennial woody vegetation which, in Lithuanian conditions, are horticultural plantations. Statistical data on areas of horticultural plantations in Lithuania are provided in the statistical database of the Statistics Lithuania (http://db.stat.gov.lt/sips/Database/sipsen/s4en/p401en/g413en/g413en.asp).

According to the data collected by the Statistics Lithuania, the total area of orchards and berry plantations in Lithuania was gradually decreasing from 45 thou. ha in 1990 to 32 thou. ha in 2004. However, it seems that major part of horticultural area reported in the statistics is taken by private gardens and small land plots at the summer houses containing fruit trees, mainly apple trees which, according to the *Good Practice Guidance for LULUCF*, should be classified as settlements (Section 3.6).

On the other hand, according to the data provided by the Lithuanian Institute of Horticulture, the total area of horticultural plantations in Lithuania is approximately 40.5 thou. ha including private gardens and it has not changed substantially during the last 15 years. The area of industrial horticultural plantations was approximately 6.5 thou. ha in 1990 and has increased to more than 9 thou. ha during the last 15 years.

Bearing in mind inconsistency of available data as well as lack of data on biomass accumulation and losses, changes in carbon stocks in horticultural plantations were not estimated.

It was assumed that land use and management have not changed and overall change in carbon content in soils was negligible.

Liming

Statistical data on liming of agricultural land in Lithuania are not available. There are approximately 800 thous. ha agricultural land that need liming. According to the Lithuanian Agrochemical Research Centre, approximately 200 thous. tonne dolomite powder were used annually in Lithuania for soil liming up to 1990. Since then, liming was gradually decreasing to almost zero in 1996. This information was confirmed by two dolomite quarries which are the main suppliers of dolomite products in Lithuania. Both companies are not producing dolomite for soil liming for the last 10 years. Therefore, it was assumed that dolomite consumption was decreasing linearly from 200 thous. tonne in 1990 to zero in 1996.

7.4   Grassland

Data on grassland area are provided in the *Statistical Yearbook: Agriculture in Lithuania* (see Figure 7.7). Variations of grassland area are discussed in Section 7.3.

Changes in carbon stocks in grassland were not estimated. As grassland management activities in Lithuania are not changing, it was assumed that annual carbon stock changes are close to zero. Liming is not applied on grasslands.

7.5   Wetland

Data on wetland area were taken from the *Land Fund of the Republic of Lithuania*. The area includes two categories reported in the statistics – water bodies and swamps (bogs). CO_2 emissions associated with peat extraction were evaluated.

7.5.1   Source category description

Peat extraction areas are recorded by the Lithuanian Geological Survey from 1992. Extraction area was fairly stable from 1992 to 2001 fluctuating in approximately 12% range (Figure 7.8). 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 2002.
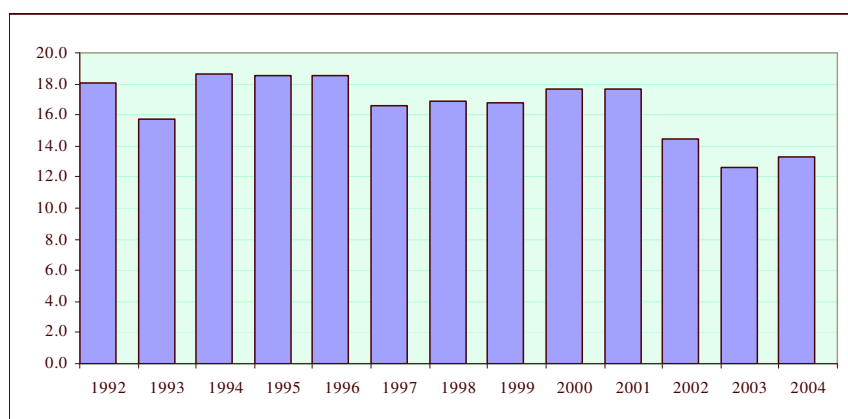
Source: Lithuanian Geological Survey

Figure 7.8. Variation of peat extraction areas

7.5.2 Methodological Issues

The method provided in the *Good Practice Guidance for LULUCF* addresses emissions from removal of vegetation 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 shows slightly decreasing trend, it was assumed that emissions from removal of vegetation for peat extraction are negligible and were not taken into account. CO_2 emissions due to oxidation of peat were calculated using modified equation 3.5.5 of the *Good Practice Guidance for LULUCF*.

As data on areas of nutrient rich and nutrient poor organic soils were not available, emission factor for changes of carbon stocks in soils converted to peat extraction *EF* for nutrient rich peat land from Table 3.5.2 of the *Good Practice Guidance for LULUCF* was used.

7.6 Settlements

Area of settlements is defined in the *Land Fund of the Republic of Lithuania* (urban territory and roads).

Carbon stock changes in settlements were not estimated and assumed to be close to zero.

7.7 Other land

Carbon stock changes in other land were not estimated and assumed to be close to zero.

8   WASTE (Sector 6)

8.1 Overview of the waste sector

Waste and wastewater treatment are among the highest national priorities in environmental management in Lithuania. The National Strategic Waste Management Plan was adopted in 2002. The annual total non-hazardous waste production is about 2.5 million ton. About 44% of this waste is stored in landfills.

Municipal waste accounts for about 1 million ton in 2004. Since 2000 the amount of municipal waste produced has declined and should reach 750 000 tons per year. About 300 kg of municipal waste per capita is generated in large Lithuanian cities, about 220 kg in smaller towns and 70 kg in rural areas. A sizeable amount of non-hazardous waste of other categories such as street and road sweepings, biodegradable waste from the food processing and catering sector, construction and destruction waste is also disposed. Continuing efforts are put towards data improvement in order to obtain more reliable trends in waste generation.

The present situation is that about 800 landfills of municipal waste have been registered in Lithuania, but only 300 of them are being used. The majority of landfills currently in use do not comply with environmental and sanitary requirements because of poorly chosen sites, poor engineering equipment and improper use of it, and insufficient control of waste taken to the landfills. Currently only 3 landfills of the biggest cities partly comply with the requirements, i.e. treat leachate and have monitoring systems installed.

A number of recent improvements in the Lithuanian waste sector were driven by the process of accession to the EU. A regional waste management system is currently under implementation. It will include 10 regional landfills that will match the EU environmental standards by 2009. Unmanaged waste disposal sites will be eliminated. Moreover, there are plans to construct a waste incineration plant in Siauliai region and a feasibility study has already been prepared.

Directive 1999/31/EC on landfill of waste requires a 50% reduction in bio-degradable waste by 2005 and a further reduction of 25% by 2010 (as compared to the level of biodegradable waste in 1993). In addition, two packaging waste recovery organizations ("Zaliasis taskas" and "Ateities ekologija") have been created for the collection and recycling of packaging waste.

There are three the most commonly used wastewater treatment methods in Lithuania: mechanical treatment, biological treatment and biological treatment with phosphorus and nitrogen removal. In 2004 Lithuania had 1124 operating wastewater treatment facilities.
In 2004 the total discharge of wastewater amounted 5470.9 million m^3 – that is 10% less than in 2003. From this amount 5427 million m^3 did not require any treatment, due to it was used by Ignalina nuclear plant and Kruonis electric power plant. The amount of wastewater in 2004 treated according to the standards (106.4 million m^3) increased by 14 % comparing with year 2003. Comparing with 2003, approximately six times decreased partly treated discharged water amount and four times - untreated wastewater discharge. Construction and reconstruction of wastewater treatment plants is supported by the EU funding.

Wastewater treatment sludge makes about one third of all non-hazardous waste. As there is no sludge management system in Lithuania established yet, wastewater treatment sludge is stored at the production places. Some is also used for agricultural purposes, if quality standards are met. The amount of sludge has slightly decreased recently. In 2000 about 244 thousand tons were collected, in 2001 – 240 thousand tons and in 2002 – 230 thousand tons.

8.2 Greenhouse gas sources in waste sector

Emissions of greenhouse gases from the waste sector in Lithuania originate from following sources:
- solid waste disposal on land;
- wastewater handling (industrial and domestic/commercial wastewater);
- human sewage;
- waste incineration.

Two of assessed categories fall under the key sources of GHG. Key sources from waste sector and its contribution to total amount of GHG emissions are presented in Table 8-1.

Table 8-1. Key sources of GHG in waste sector

Source	GHG	1990	1995	2000	2004	Share in the total emissions % in 2004
6.A. Solid waste disposal on land	CH_4	1,076.8	1,165.6	1,072.9	951,76	4,52
6.B. Wastewater handling	CH_4	839.6	387.2	421.4	508,52	2,42

8.2.1 Solid Waste

Methane emissions from municipal solid waste landfills were estimated using IPCC Tier 2 methodology. Calculations were performed using IPCC Spreadsheet for Estimating Methane emissions from Solid Waste Disposal Sites.

8.2.1.1 Source category description

Disposal of MSW

Data on disposal of municipal solid waste in landfills in 1991-2004 were provided by the Lithuanian Environmental Protection Agency (EPA) which is responsible for environmental statistics in Lithuania.

Disposal of MSW in landfills in 1991-2004, Gg per year

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1,976	2,019	1,383	1,836	1,954	1,513	1,421	1,415	1,473	1,044	1,084	1,046	1,000	909	1,032

Source: Lithuanian EPA

Data provided by the EPA describe specifically the fraction of MSW sent to SWDS, therefore factor MSW_F was taken as 100%.

Data on waste generation and disposal were collected in Lithuania only from 1991, data on disposal before 1991 are not available. It was assumed that in the period from 1950 to 1990 all generated waste was disposed in landfills and waste generation was increasing by 2% annually to reach 1991 level.

Waste composition

Average composition of MSW is provided in the MoE report "Status of the Environment" (2004):

Plastics	9 %
Paper/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 following composition of waste going to solid waste disposal sites was assumed for IPCC model:

Food	42%
Paper	14%
Wood	2%
Textile	4%
Other non-degradable	38%

8.2.1.2   Methodological issues

Methane correction factor

Lithuanian landfills can be divided into three categories: 1) landfills of major cities (county centres), 2) landfills of smaller towns, and 3) 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 with methane correction factor = 1.

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 methane correction factor = 0.8.

Small landfills and dumps in rural areas were assigned to unmanaged shallow landfills (<5 m waste) with methane correction factor = 0.4.

According to the Lithuanian Department of Statistics, rural population in Lithuania is approximately 33%. Bearing in mind that waste generation per capita in rural areas is lower than in cities and towns, it was assumed that approximately 30% of waste was disposed in small rural landfills and dumps.

Population of major Lithuanian cities is given in the table below.

Population of major Lithuanian cities (thousands)

Alytus	71.6
Kaunas	376.6
Klaipėda	192.5
Marijampolė	48.7
Panevėžys	119.4
Šiauliai	133.5
Tauragė	31.2
Telšiai	32.8
Utena	33.9
Visaginas	29
Vilnius	553.2
Total	**1622.4**

Source: Counties of Lithuania. Statistics Lithuania, Vilnius, 2003.

Total population of the major cities (1.6 million) is about 47% of the total population of Lithuania. Bearing in mind that waste generation per capita in major cities is higher than average, it was assumed that approximately 50% of waste was disposed in deep managed landfills.

Remaining 20% of waste was disposed in deep unmanaged landfills.

Other parameters

Other parameters were taken as IPCC default values:

DOC (Degradable organic carbon) (weight fraction, wet basis)

Food waste	0.15
Paper	0.4
Wood	0.43
Textiles	0.24

Methane generation rate constant (years^{-1})

Food waste	0.185
Paper	0.06
Wood	0.03
Textile	0.06

DOC_f (fraction of DOC dissimilated)	0.5
Delay time (months)	6
Fraction of methane in developed gas	0.5
Conversion factor, C to CH_4	1.33
Methane recovery	0
Methane oxidation	0

8.2.2 Wastewater

8.2.2.1 Source category description

The emission sources in this subsector cover domestic and industrial wastewater handling systems for CH_4 emissions and indirect N_2O emissions from human sewage. CH_4 emissions from domestic and industrial wastewater handling systems are considered separately.

8.2.2.2   Methodological issues

Wastewater handling

For the calculation of GHG emissions IPCC Tier 1 method has been followed.
All industries that have at their disposal waste water treatment facilities and all wastewater treatment plants once per year report to the Environment Protection Agency. On the basis of these data the EPA calculates the total COD for industrial wastewater and BOD for domestic wastewater. Then EPA sends it to Statistical department.
The emissions from municipal/commercial wastewater treatment are based on the BOD_5 load (Biochemical Oxygen Demand, 5-day test) of the wastewaters and emissions from industrial wastewater treatment are based on the COD load (Chemical Oxygen Demand). These Degradable Organic Component values of wastewaters with shared methane conversion factors have been used for both wastewater and sludge handling.
Maximum methane producing capacity factors for domestic/commercial and industrial wastewaters are IPCC default factors: Bo=0.6 kg CH_4/kg BOD and Bo=0.25 kg CH_4/kg COD. Methane conversion factors are country-specific, based on expert knowledge: MCF=0.5.
Methane recovery from wastewater handling data was obtained from Statistics Lithuania publication "Energy balance".

Emissions from human sewage

The emissions of N_2O from human sewage are calculated according to IPCC methodology, by multiplying annual per capita protein intake by number of people in country and default 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). The data about per capita protein intake (78 g per capita per day) was obtained from Nutrition Centre under the Ministry of Health.

8.2.3   Waste incineration

8.2.3.1   Source category description

No managed municipal waste incineration is taking place at present. Some types of waste (hospital, waste oils etc.) in minor amounts take place at industrial companies or within hospitals without energy production.

8.2.3.2   Methodological issues

Carbon dioxide emissions from waste incineration were calculated according to IPCC methodology. Default values, provided in IPCC Good Practice Guidance were used: fraction of carbon content, fraction of fossil carbon and burn out efficiency of combustion of incinerators.
Activity data on incinerated amounts of hazardous and clinical waste were obtained from Environment Protection Agency waste database.

8.3 Uncertainties

It must be noted that the current system of statistical data collection was established in 1991 only, when statistical forms on Water and on Waste have been approved. As 1991 year was the first year of a new system and no data were available for the year 1990 (base year for the inventory), the data of 1991 were used for 1990. Thus, the baseline data could bear certain level of uncertainty. According to the Environmental Protection Agency expert in charge of emission

management, the assessed amounts of waste produced in 1991 and 1990 were similar as no changes were made in the waste management system during that period. Moreover, as Lithuania's GNP had fallen by 5 % between 1990 and 1991 (due to the beginning of restructuring of the economy), using the same amount for 1990 as it was in 1991 slightly underestimates GHG emissions.

9   Main references

Agriculture in Lithuania, 2004, Statistics Lithuania, Vilnius, 2005.

Agriculture in Lithuania, 2003, Statistics Lithuania, Vilnius, 2004

Agriculture in Lithuania, 2002, Statistics Lithuania, Vilnius, 2003.

Agriculture in Lithuania, 2001, Statistics Lithuania, Vilnius, 2002.

Agriculture in Lithuania, 2000, Statistics Lithuania, Vilnius, 2001.

Agriculture in Lithuania, 1996, Statistics Lithuania, Vilnius, 1997.

Agriculture in Lithuania, 1994, Statistics Lithuania, Vilnius, 1995.

Agriculture in Lithuania, Statistics Lithuania, Vilnius, 1991.

Armolaitis, K., Aleinikovienė, J., Baniūnienė, A., Žėkaitė, V.. Chemical and biological properties of arenosols in abandoned and afforested arable land (in Lith.). Agriculture. Scientific Articles. Lithuanian Institute of Agriculture, 2005, 4, 92, 3-19.

Atmospheric emission inventory guidebook (3rd edition), Volumes 1-3, Joint EMEP/CORINAIR , 2002.

Energy Balance, 2004, Statistics Lithuania, Vilnius, 2005

Energy Balance, 1990-2003, Statistics Lithuania, Vilnius, 2004.

Energy Balance, 2002, Statistics Lithuania, Vilnius, 2003.

Energy Balance, 2001, Statistics Lithuania, Vilnius, 2002.

Energy Balance, 2000, Statistics Lithuania, Vilnius, 2001.

Energy Balance, 1996-1997, Statistics Lithuania, Vilnius, 1998.

Energy Balance, 1994-1995, Statistics Lithuania, Vilnius, 1996.

Energy Balance, 1994, Statistics Lithuania, Vilnius, 1995.

Energy Balance, 1993, Statistics Lithuania, Vilnius, 1994.

Energy Balance, 1992, Statistics Lithuania, Vilnius, 1993.

Energy Balance, 1990-1992, Statistics Lithuania, Vilnius, 1992.

Forestry Law of the Republic of Lithuania, 22 November 1994 No. I-671, as amended. Žin., 2001, Nr. 35-1161, http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=101682

Global Forest Resources Assessment, 2000, FAO 2001.

Global Forest Resources Assessment 2005: Lithuanian Country Report. Forestry Department, Food and Agriculture Organisation of the United Nations.
http://www.fao.org/forestry/foris/webview/forestry2/index.jsp?siteId=6773&sitetreeId=28699&langId=1&geoId=0

Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories (following the incorporation of the provisions of decision 13/CP.9 (FCCC/SBSTA/2004/8).

Inventory of Trade Names of Chemical Products Containing Ozone Depleting Substances and their Alternatives, 2001, UNEP.

IPCC Good Practice Guidance for Land use, Land-Use Change and Forestry, IGES, 2003.

IPCC Good Practice Guidance and Uncertainty Management in National greenhouse gas Inventories, IPCC/OECD/IEA, 2000.

Land Fund of the Republic of Lithuania. National Land Service under the Ministry of Agriculture,2002-2006.
http://www.nzt.lt/index.cfm?fuseaction=displayHTML&attributes.file=File_483.cfm&langparam=LT

Lithuanian Forest Expansion Programme. Approved by the Order of the Minister of Environment and Minister of Agriculture No. 616/471 from 2 December 2002, Valstybės žinios, 2003 01 04, Nr. 1-10. http://www3.lrs.lt/pls/inter2/dokpaieska.showdoc_l?p_id=198062&p_query=&p_tr2=

Lithuanian National Forest Inventory 1998-2002. Sampling Design, Methods, Results. Ministry of Environment, State Forest Survey Service. Kaunas, 2003. http://www.lvmi.lt/vmt/index.php

Lithuanian Statistical Yearbook of Forestry. Ministry of Environment, State Forest Survey Service, 2001-2006. http://www.lvmi.lt/vmt/index.php

Lithuanian Statistical Yearbook of Forestry, 2004. Ministry of Environment, State Forest Survey Service. Kaunas, 2004.

Lithuanian Statistical Yearbook of Forestry, 2003. Ministry of Environment, State Forest Survey Service. Kaunas, 2003.

Lithuanian Statistical Yearbook, 2005, Statistics Lithuania, Vilnius, 2005

Lithuanian Statistical Yearbook, 2004, Statistics Lithuania, Vilnius, 2004

Lithuanian Statistical Yearbook, 2003, Statistics Lithuania, Vilnius, 2003

Lithuanian Statistical Yearbook, 2002, Statistics Lithuania, Vilnius, 2002

Lithuanian Statistical Yearbook, 2001, Statistics Lithuania, Vilnius, 2001

Lithuanian Statistical Yearbook, 2000, Statistics Lithuania, Vilnius, 2000

Lithuanian Statistical Yearbook, 1997, Statistics Lithuania, Vilnius, 1997

Lithuanian Statistical Yearbook, 1994-1995, Statistics Lithuania, Vilnius, 1995

Lithuanian Statistical Yearbook, 1993, Statistics Lithuania, Vilnius, 1994

Lithuanian Statistical Yearbook, 1980. (Lietuvos TSR liaudies ūkis per 40 metų. Statistikos metraštis, 1980).

Material resources, 1992, Statistics Lithuania, Vilnius, 1993.

Material resources, 1994, Statistics Lithuania, Vilnius, 1995.

Natural resources and environmental protection 2000, Statistics Lithuania, 2001.

Natural resources and environmental protection 2001, Statistics Lithuania, 2002.

Natural Resources and Environment Protection 2003. Statistics Lithuania, 2003.

Natural Resources and Environment Protection 2004. Statistics Lithuania, 2004.

Order of the Minister of Environment No. 686 of 31 December 2002 on approval of methodology for establishment of norm of the main forest cuttings. Žin., 2003, Nr. 4-160, http://www3.lrs.lt/pls/inter2/dokpaieska.showdoc_l?p_id=198591

Production of commodities 2004, Statistics Lithuania, Vilnius, 2005.

Production of commodities 2003, Statistics Lithuania, Vilnius, 2004.

Production of commodities 2002, Statistics Lithuania, Vilnius, 2003.

Production of commodities 2001, Statistics Lithuania, Vilnius, 2002.

Raw materials, 2005. Statistics Lithuania, Vilnius, 2006.

Raw materials, 2004. Statistics Lithuania, Vilnius, 2004.

State of Environment 2005, Lithuanian Ministry of Environment, 2006.

State of Environment 2004, Lithuanian Ministry of Environment, 2005.

State of Environment 2003, Lithuanian Ministry of Environment, 2004.

State of Environment 2002, Lithuanian Ministry of Environment, 2003.

State of Environment 2001, Lithuanian Ministry of Environment, 2002.

Statistical Yearbook: Agriculture in Lithuania. Statistics Lithuania, Vilnius, 1990-2006. Statistics Lithuania. Statistics database. Agriculture. Crop production.
http://db.stat.gov.lt/sips/Database/sipsen/s4en/p401en/g413en/g413en.asp

The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 1-3, IPCC/OECD/IEA, 1997.

Transport and communications, 2005, Statistics Lithuania, Vilnius, 2006.

ANNEX 1. National emission factors for Energy sector

No.	Fuel use category	Fuel type: **COAL** Emission factor, kg/GJ							
		CO2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SD*
1.	Power plants	95	0.714xS%	0.36	0.097	0.015	0.002	0.015	0.04365xAs%
2.	Heat boiler houses	95	0.714xS%	0.36	0.097	0.015	0.003	0.015	0.04365xAs%
3.	Industry	95	0.714xS%	0.20	0.367	0.015	0.003	0.015	0.04365xAs%
4.	Small companies	95	0.714xS%	0.20	2.6	0.114	0.004	0.085	0.04365xAs%
5.	Households	95	0.714Xs%	0.15	4.8	0.300	0.040	0.114	0.04365xAs%

No.	Fuel use category	Fuel type: **FUEL WOOD** Emission factor, kg/GJ							
		CO2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
1.	Power plants	102	0.13	0.13	0.16	0.032	0.004	0.048	0.205
2.	Heat boiler houses	102	0.13	0.13	0.16	0.032	0.004	0.048	0.205
3.	Industry	102	0.13	0.13	0.16	0.032	0.004	0.048	0.205
4.	Small companies	102	0.13	0.10	2.5	0.196	0.003	0.230	0.205
5.	Households	102	0.13	0.05	5	0.400	0.003	0.600	0.205

No.	Fuel use category	Fuel type: **NATURAL GAS** Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
1.	Power plants	56.9	0.0003	0.160	0.020	0.0025	0.001	0.0025	0.0015
2.	Heat boiler houses	56.9	0.0003	0.160	0.025	0.0040	0.001	0.0040	0.0015
3.	Industry	56.9	0.0003	0.080	0.050	0.0040	0.001	0.0040	0.0015
4.	Small companies	56.9	0.0003	0.080	0.050	0.0050	0.001	0.0050	0.0015
5.	Households	56.9	0.0003	0.050	0.050	0.0050	0.001	0.0050	0.0015
6.	Transport								
6.1.	Road transport	56.9	0.0003	0.439	3.313	0.0192	0.001	0.5680	0.0020

No.	Fuel use category	Fuel type: **ORIMULSION** Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
1.	Power plants	81	1.93	0.24	0.13	0.003	0.0025	0.003	0.0919

No.	Fuel use category	Fuel type: **GAS OIL** Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
1.	Power plants	74	0.468xS%	0.150	0.130	0.0015	0.002	0.0015	0.0237
2.	Heat boiler houses	74	0.468xS%	0.150	0.150	0.0015	0.002	0.0015	0.0237
3.	Industry	74	0.468xS%	0.100	0.190	0.0015	0.002	0.0015	0.0237
4.	Small companies	74	0.468xS%	0.050	0.200	0.0015	0.002	0.0015	0.0237
5.	Households	74	0.468xS%	0.050	0.300	0.0015	0.002	0.0015	0.0237

No.	Fuel use category	Fuel type: **PETROL** Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
6.	Transport		S = 0.05%						
6.1.	Road transport	73	0.022	0.666	7.4	0.0743	0.002	1.2562	0.0014

No.	Fuel use category	Fuel type: **CEROSINE** Emission factor, kg/GJ							
		CO2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
1.	Power plants								
2.	Heat boiler houses			0.1	0.1				
3.	Industry	74	0.022	0.100	0.100	0.0020	0.0015	0.002	0.011
4.	Small companies	74	0.022	0.050	0.190	0.0020	0.0015	0.002	0.011
5.	Households	74	0.022	0.050	0.190	0.0020	0.0015	0.002	0.011
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport	74	0.022	0.326	0.326	0.0010	0.0015	0.059	0.016
6.5.	Agricultural machines								

No.	Fuel use category	Fuel type: **OTHER PROCESSED FUEL** Emission factor, kg/GJ							
		CO2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
1.	Power plants	95	0.714xS%	0.36	0.097	0.015	0.002	0.015	0.04365xAs%
2.	Heat boiler houses	95	0.714xS%	0.36	0.097	0.015	0.003	0.015	0.04365xAs%
3.	Industry	95	0.714xS%	0.20	0.367	0.015	0.003	0.015	0.04365xAs%
4.	Small companies	95	0.714xS%	0.20	3.650	0.114	0.004	0.085	0.04365xAs%
5.	Households	95	0.714xS%	0.15	4.8	0.300	0.004	0.114	0.04365xAs%

No.	Fuel use category	Fuel type: **COMBUSTIBLE AUXILIARY ENERGY RESOURCES** Emission factor, kg/GJ							
		CO2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
1.	Power plants	78	0.468xS%	0.24	0.13	0.0035	0.0025	0.0035	0.25xAs%
2.	Heat boiler houses	78	0.468xS%	0.19	0.17	0.0035	0.0025	0.0035	0.25xAs%

3.	Industry	78	0.468xS%	0.15	0.20	0.0032	0.0025	0.0032	0.25xAs%
4.	Small companies	78	0.468xS%	0.15	0.20	0.0032	0.0025	0.0032	0.25xAs%
5.	Households	78	0.468xS%	0.15	0.30	0.0030	0.0025	0.0030	0.25xAs%

No.	Fuel use category	Fuel type: **CRUDE OIL** Emission factor, kg/GJ							
		CO2	SO$_2$	NO$_x$	CO	CH$_4$	N$_2$O	NMVOC	SP*
1.	Power plants	78	0,488xS%	0,150	0,13	0,0015	0,002	0,0015	0,249xAs%
2.	Heat boiler houses	78	0,488xS%	0,150	0,15	0,0015	0,002	0,0015	0,249xAs%
3.	Industry	78	0,488xS%	0,100	0,19	0,0015	0,002	0,0015	0,249xAs%
4.	Small companies	78	0,488xS%	0,050	0,20	0,0015	0,002	0,0015	0,249xAs%
5.	Households	78	0,488xS%	0,050	0,30	0,0015	0,002	0,0015	0,249xAs%
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines	78	0,488xS%	1,171	0,468	0,0094	0,002	0,178	0,249xAs%

No.	Fuel use category	Fuel type: **PEAT** Emission factor, kg/GJ							
		CO2	SO$_2$	NO$_x$	CO	CH$_4$	N$_2$O	NMVOC	SP*
1.	Power plants	102	0,3	0,30	0,032	0,032	0,004	0,048	0,164xAs%
2.	Heat boiler houses	102	0,3	0,30	0,032	0,032	0,004	0,048	0,164xAs%
3.	Industry	102	0,3	0,21	0,12	0,032	0,004	0,048	0,164xAs%
4.	Small companies	102	0,3	0,141	0,18	0,140	0,004	0,130	0,164xAs%
5.	Households	102	0,3	0,141	4,30	0,389	0,004	0,225	0,164xAs%

No.	Fuel use category	Fuel type: **OTHER NATURAL FUEL** Emission factor, kg/GJ							
		CO2	SO$_2$	NO$_x$	CO	CH$_4$	N$_2$O	NMVOC	SP*
1.	Power plants	102	0,18	0,13	0,16	0,032	0,004	0,048	0,17xAs%
2.	Heat boiler houses	102	0,18	0,13	0,16	0,032	0,004	0,048	0,17xAs%
3.	Industry	102	0,18	0,13	0,16	0,032	0,004	0,048	0,17xAs%

No.	Fuel use category								
4.	Small companies	102	0,18	0,10	2,5	0,196	0,003	0,230	0,17xAs%
5.	Households	102	0,18	0,05	5,0	0,400	0,003	0,600	0,17xAs%

No.	Fuel use category	Fuel type: **HEAVY FUEL OIL** Emission factor, kg/GJ							
		CO2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
1.	Power plants	78	0,488xS%	0,24	0,130	0,0035	0,0025	0,0035	0,249xAs%
2.	Heat boiler houses	78	0,488xS%	0,19	0,170	0,0035	0,0025	0,0035	0,249xAs%
3.	Industry	78	0,488xS%	0,15	0,200	0,0032	0,0020	0,0032	0,249xAs%
4.	Small companies	78	0,488xS%	0,15	0,200	0,0032	0,0025	0,0032	0,249xAs%
5.	Households	78	0,488xS%	0,15	0,300	0,0030	0,0025	0,0030	0,249xAs%
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport	78	0,488xS%	1,46		0,0020		0,0648	0,260xAs%
6.4.	Air transport								
6.5.	Agricultural machines								

No.	Fuel use category	Fuel type: **DIESEL FUEL OIL** Emission factor, kg/GJ							
		CO2	SO_2 S=0,2% S=0,05%	NO_x	CO	CH_4	N_2O	NMVOC	SP*
1.	Power plants	74	0,094/0,023	0,150	0,130	0,0015	0,002	0,0015	0,0237
2.	Heat boiler houses	74	0,094/0,023	0,150	0,150	0,0015	0,002	0,0015	0,0237
3.	Industry	74	0,094/0,023	0,100	0,150	0,0015	0,002	0,0015	0,0237
4.	Small companies	74	0,094/0,023	0,050	0,200	0,0015	0,002	0,0015	0,0237
5.	Households	74	0,094/0,023	0,050	0,300	0,0015	0,002	0,0015	0,0237
6.	Transport								
6.1.	Road transport	74	0,094/0,023	0,534	0,570	0,0033	0,004	0,1130	0,1012
6.2.	Railway transport	74	0,094/0,023	1,100	0,470	0,0050	0,003	0,2250	0,1012
6.3.	Water transport	74	0,094/0,023	1,160	0,258	0,0030	0,003	0,1110	0,1012
6.4.	Air transport								
6.5.	Agricultural machines	74	0,094/0,023	1,171	0,468	0,0094	0,002	0,1780	0,1012

No.	Fuel use category	Fuel type: **AVIATION GASOLINE** Emission factor, kg/GJ							
		CO2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
1.	Power plants								
2.	Heat boiler houses								
3.	Industry								
4.	Small companies								
5.	Households								
6.	Transport		S=0,01%						
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport	72	0,005	0,196	1,268	0,0869	0,002	0,8182	0,0116
6.5.	Agricultural machines								

No.	Fuel use category	Fuel type: **LIQUIFIED PETROLEUM GAS** Emission factor, kg/GJ							
		CO2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
1.	Power plants								
2.	Heat boiler houses	65		0,160	0,010	0,0025	0,0015	0,0025	
3.	Industry	65		0,160	0,010	0,0025	0,0015	0,0025	
4.	Small companies	65		0,100	0,041	0,0025	0,0015	0,0025	
5.	Households	65		0,100	0,050	0,0010	0,0010	0,0021	
6.	Transport								
6.1.	Road transport	65		0,898	1,610	0,0192	0,0020	0,3585	

No.	Fuel use category	Fuel type: **OTHER PRODUCTS OF REFINERY** Emission factor, kg/GJ							
		CO2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
1.	Power plants	74	0,468xS%	0,150	0,130	0,0015	0,002	0,0015	0,024

No.	Fuel use category								
2.	Heat boiler houses	74	0,468xS%	0,150	0,150	0,0015	0,002	0,0015	0,024
3.	Industry	74	0,468xS%	0,100	0,190	0,0015	0,002	0,0015	0,024
4.	Small companies	74	0,468xS%	0,050	0,200	0,0015	0,002	0,0015	0,024
5.	Households	74	0,468xS%	0,050	0,300	0,0015	0,002	0,0015	0,024

No.	Fuel use category	Fuel type: **SHALE OIL** Emission factor, kg/GJ							
		CO2	SO2	NOx	CO	CH4	N2O	NMVOC	SP*
1.	Power plants	74	0,37	0,150	0,130	0,0015	0,002	0,0015	0,024
2.	Heat boiler houses	74	0,37	0,150	0,150	0,0015	0,002	0,0015	0,024
3.	Industry	74	0,37	0,100	0,190	0,0015	0,002	0,0015	0,024
4.	Small companies	74	0,37	0,050	0,200	0,0015	0,002	0,0015	0,024
5.	Households	74	0,37	0,050	0,300	0,0015	0,002	0,0015	0,024

Here: S% - sulphur content of fuel %

As% - ash content of fuel %

SD* - solid particles

ANNEX 2. Tier I uncertainty evaluation

IPCC Source category	Gas	Base year (1990) emissions*	Emissions in 2004	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in 2004	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	6.732,42	1.531,55	2	5	5	0,39	-0,029	0,032	-0,15	0,09	0,17
1A1 Energy Industries: solid fuel	CO_2	417,78	66,54	2	5	5	0,02	-0,002	0,001	-0,01	0,00	0,01
1A1 Energy Industries: gaseous fuel	CO_2	6.698,69	4.065,86	2	5	5	1,04	0,024	0,084	0,12	0,24	0,27
1A2 Manufacturing Industries	CO_2	6.196,92	1.247,36	3	5	6	0,35	-0,030	0,026	-0,15	0,11	0,19
1A3 Mobile combustion: road transport	CO_2	5.280,54	3.639,35	5	5	7	1,22	0,028	0,075	0,14	0,53	0,55
1A3 Mobile combustion: other transport	CO_2	371,68	248,02	3	5	6	0,07	0,002	0,005	0,01	0,02	0,02
1A4 Commercial/Institutional	CO_2	3.090,19	340,62	5	5	7	0,11	-0,021	0,007	-0,10	0,05	0,12
1A4 Residential	CO_2	2.379,86	607,65	5	5	7	0,20	-0,009	0,013	-0,04	0,09	0,10
1A4 Agriculture/Forestry/Fishing	CO_2	1.503,66	200,05	5	5	7	0,07	-0,009	0,004	-0,05	0,03	0,06
2A1 Cement Production	CO_2	1.570,73	330,36	2	2	3	0,04	-0,007	0,007	-0,01	0,02	0,02
2A2 Lime Production	CO_2	222,87	46,63	5	3	6	0,01	-0,001	0,001	0,00	0,01	0,01
2A4 Soda ash use	CO_2	10,38	6,46	10	5	11	0,00	0,000	0,000	0,00	0,00	0,00
2B1 Ammonia production	CO_2	1.189,56	1.072,78	2	10	10	0,52	0,011	0,022	0,11	0,06	0,13
6C Waste incineration	CO_2	4,00	3,10	25	30	39	0,01	0,000	0,000	0,00	0,00	0,00
1A1, 1A2 Energy: stationary combustion	CH_4	22,76	15,15	3	50	50	0,04	0,000	0,000	0,01	0,00	0,01
1A3 Energy: mobile combustion	CH_4	68,22	29,16	5	50	50	0,07	0,000	0,001	0,00	0,00	0,00
1A4 Energy: other sectors	CH_4	219,28	174,91	5	50	50	0,42	0,002	0,004	0,08	0,03	0,09
1B Fugitive Emissions	CH_4	153,87	236,06	5	15	16	0,18	0,004	0,005	0,05	0,03	0,06
4A Enteric Fermentation	CH_4	3.289,11	1.223,58	5	30	30	1,77	-0,004	0,025	-0,13	0,18	0,22

4B Manure Management	CH$_4$	465,10	190,71	5	40	40	0,37	0,000	0,004	-0,01	0,03	0,03
6A Solid Waste	CH$_4$	1.195,38	951,76	25	50	56	2,53	0,009	0,020	0,45	0,70	0,83
6B Wastewater Handling	CH$_4$	839,62	508,52	30	50	58	1,41	0,003	0,011	0,15	0,45	0,47
1A1, 1A2, 1A4 Energy: stationary combustion	N$_2$O	230,36	87,26	3	80	80	0,33	0,000	0,002	-0,02	0,01	0,02
1A3 Energy: mobile combustion	N$_2$O	67,48	50,91	5	80	80	0,19	0,000	0,001	0,04	0,01	0,04
2B2 Nitric Acid Production	N$_2$O	771,30	1.723,60	2	30	30	2,46	0,029	0,036	0,86	0,10	0,87
4B Manure Management	N$_2$O	868,10	335,27	15	70	72	1,14	-0,001	0,007	-0,06	0,15	0,16
4D1 Direct Soil Emissions	N$_2$O	3118,49	1.610,61	20	100	102	7,80	0,005	0,033	0,52	0,94	1,08
4D2 Pasture Range and Paddock	N$_2$O	229,29	118,22	15	70	72	0,40	0,000	0,002	0,03	0,05	0,06
4D3 Indirect Soil Emissions	N$_2$O	877,11	247,65	20	100	102	1,20	-0,003	0,005	-0,28	0,15	0,32
6B Wastewater Handling	N$_2$O	80,04	76,22	25	50	56	0,20	0,001	0,002	0,04	0,06	0,07
2F Potential HFC emissions	HFC	44,61	36,83	20	20	28	0,05	0,000	0,001	0,01	0,02	0,02
SF$_6$ in Electrical Equipment	SF$_6$	0,05	0,86	10	10	14	0,00	0,000	0,000	0,00	0,00	0,00
Other emission sources		4,88	26,71	10	20	22	0,03	0,001	0,001	0,01	0,01	0,01
T o t a l		**48214,33**	**21050,31**		**Level Uncertainty**		**9,22**			**Trend Uncertainty**		**1,87**

* Base year for F-gases is 1995

ANNEX 3. Summary table of GHG emissions in 2004

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO₂	CH₄	N₂O	HFCs	PFCs	SF₆	Total
	CO₂ equivalent (Gg)						
Total (Net Emissions)	**4.781,49**	**3.333,11**	**4.268,57**	**36,83**	**NA,NO**	**0,86**	**12.420,86**
1. Energy	**11.971,85**	**455,28**	**138,24**				**12.565,36**
A. Fuel Combustion (Sectoral Approach)	11.947,00	219,22	138,16				12.304,38
1. Energy Industries	5.663,94	9,86	45,49				5.719,29
2. Manufacturing Industries and Construction	1.247,36	5,29	14,28				1.266,93
3. Transport	3.887,37	29,16	50,91				3.967,44
4. Other Sectors	1.148,33	174,91	27,48				1.350,72
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	24,85	236,06	0,07				260,98
1. Solid Fuels	NO	NO	NO				NO
2. Oil and Natural Gas	24,85	236,06	0,07				260,98
2. Industrial Processes	**1.456,23**	**1,79**	**1.723,60**	**36,83**	**NA,NO**	**0,86**	**3.219,30**
A. Mineral Products	383,45	NE,NO	NE,NO				383,45
B. Chemical Industry	1.072,78	1,79	1.723,60	NO	NO	NO	2.798,17
C. Metal Production	NO	NO	NO	NO	NO	NO	NO
D. Other Production	NE						NE
E. Production of Halocarbons and SF₆				NO	NO	NO	NO
F. Consumption of Halocarbons and SF₆				36,83	NO	0,86	37,69
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**NE**		**NE**				**NE**
4. Agriculture		**1.414,29**	**2.311,76**				**3.726,05**
A. Enteric Fermentation		1.223,58					1.223,58
B. Manure Management		190,71	335,27				525,99
C. Rice Cultivation		NO					NO
D. Agricultural Soils		NA,NE	1.976,49				1.976,49
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	**-8.649,68**	**1,47**	**18,76**				**-8.629,45**
A. Forest Land	-8.703,21	1,47	18,76				-8.682,99
B. Cropland	0,00	NA,NE	NA,NE				0,00
C. Grassland	NA,NE	NA,NE	NA,NE				NA,NE
D. Wetlands	53,53	NA,NE	NA,NE				53,53
E. Settlements	NA,NE	NE	NE				NA,NE
F. Other Land	NE	NE	NE				NE
G. Other	NE	NE	NE				NE
6. Waste	**3,10**	**1.460,28**	**76,22**				**1.539,60**
A. Solid Waste Disposal on Land	NA,NE	951,76					951,76
B. Waste-water Handling		508,52	76,22				584,74
C. Waste Incineration	3,10	NE	NE				3,10
D. Other	NA	NA	NA				NA
7. Other	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Memo Items:							
International Bunkers	470,11	2,03	5,14				477,28
Aviation	118,57	1,82	0,91				121,30
Marine	351,54	0,21	4,23				355,98
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO₂ Emissions from Biomass	**3.114,85**						**3.114,85**
Total CO₂ Equivalent Emissions without Land Use, Land-Use Change and Forestry							21.050,31
Total CO₂ Equivalent Emissions with Land Use, Land-Use Change and Forestry							12.420,86