NATIONAL GREENHOUSE GAS EMISSION INVENTORY REPORT OF THE REPUBLIC OF LITHUANIA

(REPORTED INVENTORY 2002)

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Executive summary

This is the first National Inventory Report (NIR) covering the inventory of greenhouse gas (GHG) emissions from Lithuania. The NIR accompanies the GHG inventory for 2002.

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 from greenhouse gases.

Between 1990 and 2001, 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.

The statistical data for the early years of independence (1990, 1991, 1992) remain imprecise. Statistical Data on Energy Balance have been issued annually since 1990. Moreover, since 1996 all categories of sectors are in line with the requirements of Eurostat .

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) and indirect (CO, NOx, NMVOCs, SO_2) greenhouse gases. It covers the years 1990 (base year), 1998, 2001 and 2002.

An overview of estimated GHG emissions is presented in the table below, which shows GHG emissions by sectors, expressed in CO_2 equivalent and not taking into account GHG emissions/removals from LUCF, based on data for the years 1990, 1998, 2001 and 2002. Such trends as can be established from a relatively sparse time series can be deducted from these figures.

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

GHG sources and categories	1990	1998	2001	2002	2002/1990	2002/2001
1. Energy	37,663.53	14,797.44	11,208.73	11,556.24	-70%	+1%
2. Industrial Processes	2,671.50	2,710.36	1,805.90	1,976.57	-26%	+1%
3. Solvent and Other Product Use	0.00	0.00	0.00	0.00	-	-
4. Agriculture	7,143.87	2,333.41	2,972.27	2,169.66	-70%	-27%
5. Land-Use Change and Forestry (7)	-5,482.36	-7,557.51	-7,335.19	-6,720.60	(22%)	(9%)
6. Waste	2,679.79	1,682.18	1,562.82	1,512.63	-44%	-4%
Total with LUCF	**44,646.32**	**13,978.12**	**10,228.57**	**10,494.50**	**-76%**	**+2,5%**

A number of factors induce a degree of uncertainty in Lithuania's GHG emissions inventory. The data used are gained from statistical yearbooks which have not been established with GHG

emissions in mind. Also, 2002 is only the second year for which an inventory has been established in the (CRF) format prescribed by the International Panel on Climate Change (IPCC) and making full use of the IPCC guidelines wherever possible. National emission factors have only been established for fuel combustion. A Quality Control/ Quality Assurance system still has to be put into place. The necessary improvements will be built into the development of future inventories.

1 Introduction

1.1 Background country information

Lithuania is a Central European country with an area of 65,300 square kilometers, and a Baltic coastline of 90 km. The average temperature is – 4.9º C in winter and + 17º C in summer. Its population was 3 475 586 (1st January 2002 (a decrease of more than 5% comparing with population census data of 1989 January 12), when it stood at 3 674 802).

Lithuania reestablished 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 form 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 (up to 6.8% in 2002). Unemployment rose to a level of 10.9% in 2002.

As is shown in the following Chapters, between 1990 and 2001, 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 % share in the GDP structure are presented in the figure below, 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 in1995. The Kyoto Protocol was ratified in 2002, with a commitment to reduce GHG emissions by 8%.

In May 2004, Lithuania became a member state of the European Union. A major policy priority is now to implement its integration.

1.2 The National Inventory Report

This is the first 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 complies with the *European Union*'s *Council* Decision 280/2004/EC for a Monitoring Mechanism of Community CO_2 and other greenhouse gas emissions.

The NIR accompanies the GHG inventory for 2002, which was submitted to the UNFCCC secretariat in April 2004, together with recalculated inventories in CRF format for 1990, 1998 and 2001. (It should be noted that incomplete greenhouse gas inventories had previously been submitted by Lithuania for the years 1990 to 1998)

1.3 Institutional arrangement and process for inventory preparation

The GHG inventory is prepared by the Air Protection Division of the Department for the Quality of the Environment, Ministry of Environment (Aplinkos Ministerijos, Aplinkos Kokybės Departamentas, Atmosferos Skyrius). It is based on statistics collected from the following sources:

- Statistics of Lithuania (Statistical Yearbooks of Lithuania, Sectoral yearbooks on energy balance, agriculture, good and commodities, natural resources and environmental protection)
- Lithuanian Statistical Yearbook of Forestry, 2003. Ministry of Environment, State Forest Survey Service
- Environmental Protection Agency (data on indirect GHG emissions, and waste water and waste data).

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 Environmental Protection Agency is managing, processing and reporting of information.

So far the development and preparation of the GHG inventory has been the responsibility of a single person with other tasks at the Air Division (mentioned above). Currently discussions are going on about he possibility that the EPA may take over the preparation and the reporting of the GHG inventory from the Ministry of Environment.

1.4 Methodologies and data sources used

The inventory of greenhouse gas emission is performed to the extent possible in accordance to the methodology recommended by the Intergovernmental Panel on Climate Change (IPCC) in its Revised 1996 Guidelines. The UNFCCC guidelines on reporting and review have also been followed wherever this was feasible (*Review of the implementation of commitments and of other provisions of the convention. National communications: greenhouse gas inventories from parties included in annex I to the convention,* FCCC/CP/2002/8, 28 March 2003).

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) and indirect (CO, NOx, NMVOCs, SO_2) greenhouse gases. It covers the years 1990 (base year), 1998, 2001 and 2002. Inventory data for theses years have been recently recalculated to improve figure derived from previous calculations.

This national inventory report 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.

Default emission factors were used for all sectors except Energy, for which national emission factors have been developed.

1.5 Key source categories

The first analysis of the key source categories has been performed on the 2002 GHG data with the assistance of the UNFCCC secretariat, in particular Mr Javier Hanna and Mr Vincent Lalieu

to whom the authors of this report are particularly indebted. The results of this analysis are to be found at Annex 1.

1.6 Uncertainty evaluation

A number of factors induce a degree of uncertainty in Lithuania's GHG emissions inventory. Firstly, there is no dedicated data collection system for this purpose: data from statistical yearbooks are mainly used. Secondly, 2002 is only the second year for which an inventory has been established in the CRF format and making full use of the IPCC guidelines wherever possible. Thirdly, national emission factors have only been established for fuel combustion. Finally, a Quality Control/ Quality Assurance system still has to be put into place. It is expected that the review of the National Inventory Report by the international team of experts under the UNFCC will assist in the process of improvement of future inventories.

2 Trends in Greenhouse Gas Emissions

As GHG emissions inventories have been prepared (and officially submitted) for the years 1990, 1998, 2001 and 2002 only, the possibility for an analysis of trends is limited. However, the main tendencies can be derived.

2.1 Emission trends for aggregated greenhouse gas emissions

Aggregated emissions of GHG expressed in CO_2 equivalent (without CO_2 removals and emissions) from the Land- Use Change and Forestry sector have decreased by 66% during the period 1990 – 2002.

Net CO_2 emissions/removals have decreased by 85 %, and emissions of CH_4 and N_20 have decreased by 50% and 57% respectively. The figure below presents trends of GHG in total CO_2 equivalent emissions without the contribution of the LUCF sector.

Table 2-1. Emission trends for aggregated GHG (CO_2 equivalent) in 1990, 1998, 2001 and 2002

A rapid decrease of GHG emissions has followed the decline of the national economy in the 1990s. The average annual reduction in GHG emissions from 1990 to 1998 was 3574 Gg CO_2 equivalent per year. Towards the mid 1990s, Lithuania's GDP began to rise and the reduction in emissions slowed down. The annual reduction of GHG emissions in 2001 and 2002 was 349 Gg CO_2 equivalent per year and was achieved mainly through to technological change and energy efficiency measures.

2.2 Emission trends by gas

The decline in the emissions of the main greenhouse gases between 1990 and 2002 is presented in the table below, which shows how these contributed to the overall GHG emissions reduction between 1990 and 2002.

Figure 2-1. Trends of GHG emissions by gas in CO2 equivalent, Gg (based on CRF Summary 2)

	1990	1998	2001	2002
N2O	4050	2214	2598	1793
CH4	7124	3732	3165	3555
CO2	33438	8019	4452	5112

As can be seen form the table CO_2 and CH_4 emissions slightly increased between 2001 and 2002. This increase mainly follows the growth in industrial output as reflected by the growth of GDP. (HFC emissions have also slightly increased but as they make only a minor input to total amount of GHG and where not estimated in 1990 and 1998, they are not shown in the table)
.

2.2.1 Carbon dioxide emissions

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

In 1994, CO_2 emissions from transport increased as the automobile fleet rapidly increased due to the imported second hand passengers cars. In 1995 and 1996 emission dropped as the fleet of passenger cars shifted from Russian cars to Western manufactured, more environmentally sustainable cars.

CO_2 emissions from biomass have increased more than four times since 1990. 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 in as a result of a programme of Activities Implemented Jointly mainly with Scandinavian countries.

Table 2-2 CO_2 emission from biomass in 1990, 1998, 2001 and 2002 (Gg)

Year	1990	1998	2001	2002
CO2 emissions from biomass, Gg	616	2 419	2 790	2 814

As the statistics on marine bunkers have been available only since 2001, the inventory includes year 2001 and year 2002 only. CO_2 emission from international marine bunkers has slightly (38 Gg) increased from 2001 to 2002.

2.2.2 Methane emissions

Methane emissions have been decreasing until 1998 and then have increased again due to the recent increase in coal burning and the more intensive agriculture. During the blockade of the energy resources in 1991-1993, there was a shortage of fuel, and a number of households used wood for heating. This explains the peak in CH_4 emissions in 1992 and 1993.

2.2.3 Nitrogen emissions

Since 1990, N_2O emissions have gradually been decreasing. Within the fuel combustion sector, N_2O emissions originate almost equally from energy industries; manufacturing industries and construction; and transport and other sectors. Residential sector makes about 16% of N_2O emissions from fuel combustion. As regards N_2O emissions from transport, the most important source is road transportation, which is responsible for 26% of emissions from fuel combustion activities.

2.3 Emission trends by source

The trends of GHG emissions by sectors are presented in a table below showing GHG emissions by sectors, expressed in CO_2 equivalent and not taking into account GHG emissions/removals from LUCF, based on data for the years 1990, 1998, 2001 and 2002

Table 2-3 . Trends of GHG emissions by sectors, CO_2 equivalent, Gg

GHG sources and categories	1990	1998	2001	2002	2002/1990	2002/2001
1. Energy	37,663.53	14,797.44	11,208.73	11,556.24	-70%	+1%
2. Industrial Processes	2,671.50	2,710.36	1,805.90	1,976.57	-26%	+1%
3. Solvent and Other Product Use	0.00	0.00	0.00	0.00	-	-
4. Agriculture	7,143.87	2,333.41	2,972.27	2,169.66	-70%	-27%
5. Land-Use Change and Forestry (7)	-5,482.36	-7,557.51	-7,335.19	-6,720.60	(22%)	(9%)
6. Waste	2,679.79	1,682.18	1,562.82	1,512.63	-44%	-4%
Total with LUCF	**44,646.32**	**13,978.12**	**10,228.57**	**10,494.50**	**-76%**	**+2,5%**

The major source of GHG has been energy sector, which is responsible for 67% of all GHG emissions (in CO_2 equivalent.), not taking into account removals/ emissions from LUCF sector.

GHG emissions from all sectors have declined significantly in 1990 – 2002. However, a slight increase of GHG in energy sector and industrial processes sector is visible from 2001 to 2002.

This is in part due to more coal being used in the manufacturing industries as fuel; solid fuel consumption has increased 5 times from 2001 to 2002 (in 2002 the largest cement factory has switched to coal burning). Consequently gaseous fuel consumption in manufacturing has decreased twice in the same period. Solvent and other product use has not been estimated due to a lack of statistical data.

Figure 2-2. Shares of GHG emissions by sector in 1990 and 2002 in CO_2 equivalent

The category Manufacture of Solid Fuels and Other Energy Industries was included in the Lithuanian Statistics only in 2001. Only from that year onwards could the estimates of GHG emissions from those sectors be included in the inventory.

3 Emissions from the 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 (National Energy Strategy, 2002[1]) has focused primarily on its substantial reorganisation and privatisation, 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 3000MW 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 shall close the first reactor by 2005 and the second reactor 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.

The energy industries use 45% of all fuel used in combustion processes. Shares of different fuel types in the total consumption by the energy industries are presented in the figure below.

[1] The main strategic document in energy sector is National Energy Strategy, approved by Resolution No IX-1130 of 10 October 2002 of the Seimas of the Republic of Lithuania.

Figure 3-1 Types of fuel consumed (TJ) by the energy industries

Crude oil and natural gas are mainly imported from Russia. Crude oil and other inputs to refineries constituted over 66% of 2001 energy imports and natural gas accounted for over 25 % 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

The trends of the indices of industrial production (1995 = 100) in the period 1995 – 2000 are shown in the figure below.

Figure 3-2 Trends of indices of industrial production (1995 = 100) in 1995 – 2000

The trends depicted in the figure below show that activity in the construction sector has not been continuous. Since 1991 volume of construction work has been decreasing and since 1994 – increasing. Trend of volume of work done by building companies and enterprises is

presented in a figure below in million Litas at constant prices[2]. Only 2-3% of total construction work has been carried out abroad.

Figure 3-3 Trend of volume of work done by building companies and enterprises is presented in a figure below in million Litas at constant

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 cars younger than 5 years (about 4% of all transport fleet) with petrol engines have catalysers installed.

Passenger cars are mostly using petrol as fuel, whereas busses 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.

54% of fuel consumed in the transport sector is diesel fuel, followed by gasoline and liquefied petroleum gas, as shown in the figure below. In navigation only diesel fuel is used. As regards aviation, aviation gasoline, kerosene type jet fuel and gasoline type jet fuel are used for aviation. Railways use liquid fuel. Fuel used in the transport sector in 2002 is presented in a figure below.

[2] Until 1992 roubles were in use, in 1992 – temporary currency "talonas" was in the market and from 1993 – national currency Litas came to force.

Figure 3-4 Fuel used in the transport sector in 2002

3.1.4 Other sectors

Fuel combustion in residential and institutional/commercial sectors mainly corresponds to fuel combustion for district heating.

Consumption of different types of fuel (TJ) in these other sectors is presented in the figure below.

Figure 3-5 Fuel used (TJ) in other sectors in 2002

3.2 Greenhouse gas emission sources in energy sector

GHG emissions from the energy sector – fuel combustion and fugitive – constitute 64% of the total GHG emissions. Out of Lithuania's 17 215 Gg CO2 eq. total GHG emissions in 2002, 11 556 Gg CO2 eq. originated from the energy sector. As the key source analyses has revealed, energy sector – fuel combustion activities are responsible for 4 key source categories of GHG emissions (CO_2) and fugitive emissions from oil and gas operations (CH_4) for 1 key source.

Figure 3-6. Key GHG sources in energy sector fuel combustion and fugitive emissions

No.	Name of a source	Key source	Share of total GHG emissions , %
1.	CO2 from stationary combustion -gas	Key source	25.2%
2.	CO2 from mobile combustion – road vehicles	Key source	19.0%
3.	CO2 from stationary combustion -oil	Key source	13.7%
4.	CO2 from stationary combustion - coal	Key source	3.4%
5.	CH_4 fugitive emissions from oil and gas operations	Key source	2.4%

3.2.1 Greenhouse gas emissions sources in the energy sector

3.2.1.1 Energy industries

The energy industries were responsible for 47% of the total CO_2 emissions inform the energy sector in 2002 (5,086 Gg out of 10,783 Gg). 77 % of CO_2 emissions 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 almost 23% 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 a figure below. There are no CH_4, N_2O emissions from manufacture of solid fuels and other energy industries and are less than CO_2 emission from those are very small (20.63Gg).

Due to the economic recession and changes in the balance of consumed fuel as well as some energy efficiency measures CO_2 emissions from fuel combustions in energy industries has dropped down by 69% in 12 years since 1990. (16 352 Gg of CO_2 in 1990 and 5 086 Gg of CO_2 in 2002).

Figure 3-7 CO_2, CH_4 and N_2O emissions (Gg) from fuel combustion in energy industry

3.2.1.2 Manufacture and construction

For the totality of this sector, only aggregated data per type of fuel consumed are available in the statistical data.

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 the figure below.

Figure 3-8. CO_2 emissions (Gg) from different types of fuel consumed in manufacture and construction

Manufacturing and construction activity also emit CH_4 and N_2O in small quantities - 0,26 Gg and 0,04 Gg respectively.

3.2.1.3 Transport

CO_2 emissions from mobile combustion road vehicles were the second largest key source of GHG in the Lithuanian GHG inventory for 2002. Road transport is responsible for the major part (94)% of all CO_2 emissions from transport (3 278 Gg CO_2 out of 3 501 Gg CO_2). Of that, 17% originate from gasoline and 26% from diesel oil consumption as shown in the figure below.

Figure 3-9. Share (%) of CO_2 Gg emissions from road transportation per type of fuel

CH_4 emissions in the transport sector are caused mainly by road transport and by the use of gasoline in particular (86%) (1.36 Gg out of 1.38 Gg CH_4 is emitted by road transportation and 1.17 Gg due to gasoline consumption). N_2O emissions from diesel fuel oil and gasoline account for 93% of all N_2O emissions from transport sector. The table below represents transport activity and corresponding emissions.

Table 3-1 Tansport activity and corresponding emissions in Gg

Transport activity and type of fuel	CO_2	CH_4	N_2O
a. Civil Aviation	1.58	0.00	0.00
Aviation Gasoline	1.58	0.00	0.00
b. Road Transportation	3,278.20	1.36	0.14
Gasoline	1,146.83	1.17	0.03
Diesel Oil	1,716.80	0.08	0.09
LPG	414.57	0.12	0.01
c. Railways	209.86	0.01	0.01
Liquid Fuels	209.86	0.01	0.01
d. Navigation	12.06	0.00	0.00
Diesel Oil	12.06	0.00	0.00
Total Transport	**3,501.70**	**1.38**	**0.15**

3.2.1.4 Other sectors

The commercial/industrial; residential; and the agriculture/forestry/ fishery sectors fall under 'other sectors' in the inventory of emissions from fuel combustion. The largest part (28,369.00 TJ out of 37,337.00 TJ) of emissions originates from residential fuel combustion. As shown in the figure below, this represents more than half of the CO_2 emissions from the 'other sectors'. Within the residential sector, emissions mainly stem from district heating. 2002 CO_2 emissions (Gg) from 'other sectors' are presented in the table below.

Figure 3-10 CO_2 emissions (Gg) in other sectors in 2002

The major part of the CH_4 emissions comes from the burning of biomass. (88%). The same tendency applies for N_2O emissions (55%). This is due to a fact that biomass (wood fuel) is consumed for heating purposes in many rural areas.

3.2.2 Methodological issues

The Sectorial (national) approach has been used for calculating GHG emissions in the energy sector. 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 emission factors.

National emission factors have been developed on the basis of international experience, to which local circumstances have been applied, by scientist Prof. B. Jaskelevičius and consultant P.

Liuga who based themselves on emission factors developed by Danish, German and Slovak experts[3].The emission factors calculated apply to CO_2 and SO_2, NOx, CO, CH4, N_2O, non-methane volatile organic compounds and solid particles, 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.

Table 3-2. CH_4 and N_2O emissions (Gg) in other sectors in 2002

Activity category	CH_4	N2O
1.A.4 Other Sectors	**8.75**	**0.11**
Liquid Fuels	0.03	0.01
Solid Fuels	0.71	0.03
Gaseous Fuels	0.04	0.01
Biomass	7.97	0.06
Other Fuels	NO	NO
a. Commercial/Institutional	0.42	0.01
Liquid Fuels	0.01	0.00
Solid Fuels	0.25	0.01
Gaseous Fuels	0.01	0.00
Biomass	0.16	0.00
b. Residential	8.20	0.09
Liquid Fuels	0.00	0.00
Solid Fuels	0.46	0.02
Gaseous Fuels	0.02	0.00
Biomass	7.71	0.06
c. Agriculture/Forestry/Fisheries	0.14	0.01
Liquid Fuels	0.03	0.00
Solid Fuels	0.00	0.00
Gaseous Fuels	0.01	0.00
Biomass	0.11	0.00

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.

[3] (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. 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 Categories of energy generating facilities in national fuel and energy balance and national emission factors sheets (Prof. B. Jaskeliavicius, P. Liuga, 1997)

Fuel combustion sector	Categories of the national energy and fuel balance
1. Power plants 2. Heat boiler houses	Production of electricity and thermal energy 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

The means of determining methane emissions are similar in many respects to the method of the individual consumption categories for carbon dioxide emissions. The simplest level (Tier 1) includes only summary fuel categories: liquid fuels, solid fuels, gaseous fuels, biomass. CH_4 emissions were calculated on the basis of national emission factors. Annex 2 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, cerosine, other processed fuel, combustible auxiliary energy resources, other products of refinery and shale oil.

The Reference Approach has been used in addition to the Sectorial Approach as a way of checking results. It is based on the national balance of consumption of fuels. i.e extraction + imports – exports – change in stocks and corrected by subtracting non-energy production.

The comparison of energy consumption and CO_2 emissions from fuel combustion calculated using sectorial and reference approaches are presented in a table below (based on Table 1.A (c)).

Table 3-4. Comparison of C02 emissions calculated by reference and by national approaches from fuel combustion in 2002.

FUEL TYPES	Reference approach		National approach (1)		Difference (2)	
	Energy consumption (PJ)	CO_2 emissions (Gg)	Energy Consumption (PJ)	CO_2 emissions (Gg)	Energy Consumption (%)	CO_2 emissions (%)
Liquid Fuels (excluding international bunkers)	103.12	7,728.06	73.70	5,441.96	37.60	39.60
Solid Fuels (excluding international bunkers)	6.31	590.00	6.02	592.86	-30.40	-27.80
Gaseous Fuels	91.90	3,674.09	76.15	4,332.82	20.70	-15.20
Other (3)			6.38	414.57	-100.00	-100.00
Total (3)	**201.33**	**11,992.14**	**162.25**	**10,782.20**	**20.90**	**8.00**

Difference of CO_2 emissions between reference approach and sectorial approach is 8 %.

Emissions of Precursor Gases

The inventory of ozone precursors (CO, NOx 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 to CORINAIR and used as a data source for GHG inventories.

3.2.3 Uncertainties

There is a certain level of uncertainty for the fuel combustion sector. Data on fuel consumption are collected by the Lithuanian Statistical Department (www.std.lt) 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.

As regards biomass, data are available for firewood and wood waste and biogas. However, statistical data on biogas are only available since 2002.

3.2.4 Source specific QA/AC and verification

Not applicable for 2002, as this was not performed for the time being. It is envisaged for future inventories.

There are a number of areas where improvements are needed.

The comparison of CO_2 emissions from fuel combustion calculated using sectorial and reference approaches should yield results which are no more that 2% apart- in the present inventory, the results differ by 8%. The reason for the difference may be (1) the amount of crude oil refined at the oil refinery (which is included in the reference approach but not in the sectorial approach) and (2) relatively big losses of natural gas that are not estimated in reference method. This needs to be looked into in future years.

3.2.5 Source specific recalculations

Changes to the 2002 inventory and NIR were made in response to the inventory part of the In-Depth Review carried out by international team of experts under the UNFCCC, 17-21 may 2004. Recalculations were made for international aviation bunkers

3.2.6 International bunkers fuels

The Lithuanian Statistical Yearbook provides data on marine bunkers. Data on gas/diesel oil and residual fuel oil are available, where the later makes about 80% of total GHG emissions from marine bunkers. Default emissions factors are used to estimate CO_2 and CH_4 emissions.

Since 2001, three types of aviation fuel are distinguished: gasoline type aviation fuel, kerosene type aviation fuel and kerosene. No data are available for 1990 and 1998.

Following advice from experts[4] it was decided to distinguish GHG emissions from aviation bunkers in such a way that all gasoline is used for domestic purposes and thus all the rest is used for international flights – the latter could therefore be considered as aviation bunkers. GHG emissions due to multilateral operations are not available.

3.2.7 Fugitive emissions from fuels

Treatment and all handling of fossil fuels are sources of fugitive emissions. They consist mainly of emissions of methane and volatile organic compounds NMVOCs. There are no mining activities in Lithuania, thus no fugitive emissions from solid fuels exists. The only data estimated is CH_4 and minor CO_2 emissions due to the distribution of natural gas (constituting the major part) and minor CH_4 emissions due to oil transportation. Emissions are calculated using

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

implied emission factor, and based on 500 km of pipeline as well as amount of natural gas consumed in TJ. Emissions from oil transportation are calculated using amount of oil (Mg) loaded in tankers combined with the implied emission factors.

A key source analysis on 2002 emissions shows that fugitive emissions from oil&gas operations CH_4 are one of a key source. There are no CO_2 capture from flue gases and subsequent CO_2 storage for the moment in Lithuania.

A summary table of GHG emissions in energy sector is presented in Annex 3.

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 the figure below.

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)

The figure below presents cement production in 1990 and in 1995 – 2002[5]. Since 1990 cement production has decreased almost 6 times due to restructuring of economy and changes of markets (until 1991 the majority of the production was exported to the Soviet Union). In 2002 a slow increase is visible that is expected to continue.

[5] Data of 2001 and 2002 are taken from National statistics and company data are used for the other years

Figure 4-2 Production of cement and nitrogen fertilizers in Lithuania in 1990 and in 1995 – 2002.

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, 2 of which fall within the key source categories. GHG sources from industrial processes are provided in a table below.

Table 4-1. GHG sources from industrial processes and their share in total amount of GHG

No.	Name of a source	Key source	Share of total GHG emissions, %
1.	N2O from Nitric Acid production	Key source	5.2%
2.	Ammonia production CO2	Key source	4.1 %

4.2.1 Mineral industry

Cement and lime industry are present in Lithuania. 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.

4.2.2 Chemical industry

CO_2 emissions occur during the production of ammonia, a chemical used as a feedstock for the production of several other chemicals. Anhydrous ammonia is produced by catalytic steam reforming of natural gas or other fossil fuels. CO_2 at plants using this process is released

primarily during regeneration of the CO_2 scrubbing solution, with additional but relatively minor emissions resulting from condense stripping.

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 main producer of nitric acid is JSC Achema.

4.2.3 Sources of HFC's, PFC's and SF6

Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6) 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 HFC's, PFC's and SF6 occur as leakage from use of equipment and form the destruction of such equipment after use.

These substances, monitored under the UNFCCC, are not produced in Lithuania and national consumption is covered only by import. They are used in different industrial activities. HFCs are currently used in refrigeration technologies as a cooling medium, where they substitute banned CFCs and partially regulated halogenated chlorofluorohydrocarbons. To some degree, they are used as expanding agents for the production of foamed insulating materials, as aerosol (mostly pharmaceutical), cleaning agents in electro technical industries and as fire extinguishers. PFCs are used in limited amounts in the refrigeration and electro technical industries. 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 or for windowpanes insulation.

The estimation of quantities, and therefore emissions, is made difficult due to lack of data. The only local producer of refrigerators "Alytaus Snaige" has shifted to non-GHG reagents in their production. Electric equipment manufactures need an environmental permit from the Regional Environmental Protection Departments (REPD); for this, they must report on the materials are used and in which quantities. However, no aggregated data are available about the quantities of HFC's, PFC's and SF6 used.

4.2.4 Methodological issues

Data on annual production of nitric acid, ammonia, cement and lime is provided by companies to the Lithuanian Statistics report on "Production of Goods".

Emissions from ammonia, nitric acid and methanol production are estimated, as are those of CO_2 from cement and lime production. The general methodology described in the IPCC Guidelines is used.

Emissions from food and drink are taken from COLECTOR Data base that is reported to ECE Long Range Trans-boundary Air Pollution Convention (LRTAP).

As regards HFC's, PFC's and SF6, consumption is estimated following IPCC Guidelines Tier 1. As there is a lack of data on each consumer group a aggregated data on emissions of those GHG is estimated according to potential emissions. Potential emissions are calculated from

consumption, which is defined as import minus expert. 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 HFC's and PFC's that fall under Montreal Protocol. Those data are then sent to the Ministry of Environment, Division of Chemical Substances and forwarded to the Division of Air Protection. Then amounts of HFC's, PFC's and SF6 are calculated using default shares on the amount of certain chemical in a mixture.

4.2.5 Uncertainties

There is a certain level of uncertainty in the activity data for cement production and for the chemical industry. As mentioned before, the data are collected from the pool of available national statistical data and these are not always the most appropriate. At the moment there are no data included on food processing, paper production and other industrial activities. However, data not directly reported in statistics could be obtained from environmental permits or statistics made available by companies. Thus, there are possibilities for improvement.

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 inventorisation 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 a 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[6]. 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

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

- 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.

5.2 Greenhouse gas sources in solvent and other products use sector

5.2.1 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.

5.2.2 Methodological issues

Direct emissions of GHG from solvent and other products were not estimated until 2002.

In the future there is a potential to complement the inventory. using the outcomes of the implementation of the EU Directive 99/13/EC, that would require preparation of an annual inventory of emissions from solvent use.

The *IPCC Guideline* 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. In 2003, forests cover was 30.8 per cent of that area. The other uses of land are shown in the table below. The reclaimed area equalled 3.05 million hectares, 85 per cent of which has been drained. More than 1 million hectares of soil are acid, and therefore must be permanently chalked.

Table 6-1. Land use by categories [5]

Land-use categories	1998.01.01		2002.01.01		2003.01.01	
	Area		Area		Area	
	1000 ha	%	1000 ha	%	1000 ha	%
Agricultural land	3495,7	53,5	3487,1	53,4	3487,4	53,4
Forest land	1979,4	30,3	1996,9	30,6	2008,5	30,8
Other wooded land (bushes)	84,1	1,3	84,7	1,3	80,1	1,2
Roads	131,7	2,0	131,6	2,0	131,0	2,0
Urban territory	185,0	2,9	188,0	2,9	189,2	2,9
Water	262,4	4,0	262,2	4,0	262,2	4,0
Swamps (Bogs)	149,4	2,3	147,1	2,2	146,1	2,2
Other land	242,3	3,7	232,4	3,6	225,5	3,5
Total	**6530,0**	**100**	**6530,0**	**100**	**6530,0**	**100**

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 km2 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.

[5] Source: Land fund of the Republic of Lithuania

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 (from 14.5 % of GDP in 1998 to 12 % in 2000).

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 2000; crop production took a leading position at 61.9 %.

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 48% of all methane and 82 % 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.

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 the table below, 5 sources of GHG from agriculture are among the key sources of emissions.

Emissions are calculated using default emission factor from IPPC.

Table 6-2. Sources of GHG in agricultural sector and their share in total amount of GHG

No.	Name of a source	Key source	Share of total GHG emissions , %
1.	CH_4 from Enteric Fermentation in Domestic Livestock	Key source	6.8%
2.	Direct N2O emissions from Agricultural soils	Key source	2.6%
3.	CH_4 from Enteric Fermentation in Domestic Livestock	Key source	6.8%
4.	N2O from Manure Management	Key source	1.2%
5.	CH_4 from Manure Management	Key source	1%

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

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, sheep, goats, horses and swine have been calculated. 95% of CH_4 emissions from enteric fermentation is produced by cattle. The data on domestic livestock are available in the Lithuanian Statistical Yearbook:

6.2.2 Manure Management

Livestock manure is composed of organic material that produces methane during decomposition in an anaerobic environment and nitrous oxide during the storage of 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. A pilot project for production of biogas from manure is already implemented in Lithuania, Kaunas region, Rokai.

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.

6.2.3 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. Agricultural soils are calculated while adding arable land and orchards and berry plantation land. The statistics yearbook Natural resources and environment protection (Lithuanian Statistics) is used as a reference.

6.3 Methodological issues

Tier 1 of the Revised 1996 IPCC Guidelines is used for calculation of GHG emissions in agricultural sector.

6.3.1 Emissions from livestock

A default IPCC emission value for each relevant livestock population is used to calculate emissions from manure. A number of livestock population is collected from the Lithuanian

Statistics Yearbook. Agriculture statistics also contains data on the amount of manure spread to arable land.

Emissions from cattle (dairy and non-dairy), horses, swine and poultry were calculated. Cattle and swine produced almost equal amounts of CH_4 emissions; this represented 92% of all methane produces by manure management. As regards nitrous oxide emissions – only the total emissions from manure management could be calculated.

6.3.2 Emissions from agricultural soils

Direct emissions from agricultural soils are calculated using default emissions factors found in the Revised 1996 IPCC guidelines. N_2O emissions from agricultural soils are calculated using data on nitrogen fertilizers used per hectare, and default emission factors given in the CORINE Guidebook, as well as emissions factors from the IPPC workbook. The IPCC Guidelines suggest to use a *default* mean emission factor of 0.0036 kg N-N_2O/kg N. The annual amount of nitrogen fertilizers as well as the annual harvest is taken from Lithuanian Statistics.

Data on consumption of mineral fertilisers in agricultural land companies and enterprises are given in the Statistical Yearbook. The assumption has been made that private farmers scatter the same amount per hectare.

The total N2O emissions from agricultural soils are calculated as the sum of direct emissions, emissions from animal waste and indirect emissions.

6.4 Uncertainty

The uncertainty level for emissions from enteric fermentation and manure management are very 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. The assumption is made that synthetic fertilizers and manure are applied on all arable land and orchards and berry plantations, as there are no data about the proportion of arable land on which no synthetic fertilisers are applied.

7 Land – use Change and Forestry (Sector 5)

7.1 Overview of land-use change and forestry sector

Forests cover one-third of the country. According to data from the Lithuanian Statistical Yearbook of Forestry, 2003, during 1998-2002, forest coverage increased from 30,3% to 31,3%. Forest coverage trends are presented in a figure below.

Figure 7-1. Forest coverage trends in Lithuania 1938 – 2003

The total growing stock volume augmented from 347 600 m³ to 382 600 m³ during the past five years. The development has been influenced by an increasing area of stands and average growing stock per hectare. The area of mature stands has expanded from 238.500 ha to 308.500 ha, and growing stock volume has increased from 59,4 million m³ to 77,4 million m³. The average forest area per capita increased from 0,53 ha to 0,59 ha, and average growing stock volume – from 93 to 110 m³. Average age of stands increased from 51 to 53 years during 1998-2002. Coniferous stands, covering 1.160.000 ha, prevail (59,5%), followed by soft - broadleaves (698 000 ha; 35,8%) and hard broadleaved (93 000 ha; 4,7%) stands. A trend of growing stock volume is presented in a figure below.

Figure 7-2. Growing stock volume 1938 – 2003[2]

The volume of annual fellings has been increasing during the past 4 years. In 2002 felled volumes comprised 5.9 mill. m³ or 8% more than a year ago. In 2002 in these forests 3.9 mill.m³ of wood were removed. A trend of fellings is presented in a figure below.

Figure 7-3. Fellings [3] **in Lithuania, 1921-2002**

Lithuanian statistics present following definition of forest area, forest land and forest. ***Forestry area*** includes all forest land as well as agricultural and other land (swamps, sands) owned by

[2] Source: State Forest Survey Service

[3] Fellings in private forests evaluated by permissions by fellings, source: General Forest Enterprise, Ministry of Environment

state forest enterprise or national park. ***Forest land*** is defined as the land covered by forest (stands), forest meadows, nurseries, seed plots, seed orchards and raw shrubbery and plantations). Also, rated as forest land are forest roads and draining ditches, forest compartment lines, technological and fire-prevention strips, pilling places and areas taken up by facilities related to forest, rest spots, game feeding points, swamps, sands, as well as land appropriated for afforestation. Forest land may be forestry or conservation designated. ***Forest*** is defined as a ratio of forest land area to the total land area. According to the land stock assessment forest land (land fund by land-use categories) in 2002 in Lithuania occupies 2008.5 thousand ha (forest coverage is 30.8%) and according to the state forest records forest land occupies 2045.3 thousand ha (forest coverage is 31.3%).

Keeping to the FAO recommendations forest coverage is calculated as the ratio of forest land to the dry land area. Land with scrubs etc. is considered as forest land as well. Inland waters including Curronian lagoon occupy 263 thousand ha (dry land area 6267 thousand ha). Shrubberies occupy 80.1 thousand ha. Therefore, according to the ratio of forest land area to the area of dry land of Lithuania, share of forest land in total land area total 31.3%, and including the area of shrubberies it might total 32.5%. Forest area and land coverage by land –use category are presented in tables below.

Table 7-1. Forest area by land –use categories [4]

Category of forest area	1998.01.01		2002.01.01		2003.01.01	
	ha	%	ha	%	ha	%
Total forestry area	2149622	100	2183435	100	2183613	100
Forest land area	1978435	92	2034329	93.2	2045287	93.7
Forested area	1887974	87.8	1938219	88.8	1950980	89.4
Non forested area	56615	2.6	61708	2.8	59521	2.7
Special-purpose forest land	2877	0.1	2710	0.1	2584	0.1
Linear objects	26988	1.3	27165	1.3	27676	1.3
Other forest land	3981	0.2	4527	0.2	4526	0.2
Non forest area	171187	8	149106	6.8	138326	6.3

The Law on Forests stipulates the afforestation of cleared spaces within two years. Over the last few years, between 9.000 and 11.000 ha have been reforested annually. About 25% felled forest area is left for natural regeneration.

The regulation of forest utilisation takes into account the distribution of forests according to their purpose, the age of felling, areas of mature trees and the volume of the timber stock in mature stands. The most intensive felling of forests occurred between the wars and in the post-war period. The volume of timber currently available in forests is three times higher than the period between the wars. According to experts, the permissible annual volume of felled timber in the next decade comprises 6.2 million m^3, and up to 7 million m^3 in 20 to 30 years.

[4] Source: State Forest Survey Service

Table 7-2. Land use categories (land fund) in Lithuania by land – use categories [5]

Land-use categories	1998.01.01		2002.01.01		2003.01.01	
	Area		Area		Area	
	1000 ha	%	1000 ha	%	1000 ha	%
Agricultural land	3495,7	53,5	3487,1	53,4	3487,4	53,4
Forest land	1979,4	30,3	1996,9	30,6	2008,5	30,8
Other wooded land (bushes)	84,1	1,3	84,7	1,3	80,1	1,2
Roads	131,7	2,0	131,6	2,0	131,0	2,0
Urban territory	185,0	2,9	188,0	2,9	189,2	2,9
Water	262,4	4,0	262,2	4,0	262,2	4,0
Swamps (Bogs)	149,4	2,3	147,1	2,2	146,1	2,2
Other land	242,3	3,7	232,4	3,6	225,5	3,5
Total	**6530,0**	**100**	**6530,0**	**100**	**6530,0**	**100**

Recent trend of natural and artificial reforestation, afforestation and clear fellings is presented in a figure below.

Figure 7-4. Clear fellings, natural and artificial reforestation and afforestation in state forests 2000 - 2002[6]

[5] Source: Land fund of the Republic of Lithuania
[6] Source: General Forest Enterprise

Table 7-3. Reforestation, afforestation and natural forest regeneration in state forest enterprises and national parks

State forest enterprise, national park	Artificial reforestation and afforestation		Natural forest regeneration
	Total	Afforestation (from the total area)	
Total 1991, ha	6125.0	-	-
Total 2001, ha	6932.1	159.3	2875.5
Total 2002, ha	7611.4	916.9	3061.5

7.2 Emissions and removals from the forestry sector

The inventory of CO_2 from the land-use change and forestry was calculated using country activity data and IPCC defaults. Overview of data is given in Table 7.6. CO_2 removals (changes in biomass stocks and abandonment of managed lands) accounted for – 12 685,75 Gg CO_2 in 2002. CO_2 emissions (changes in biomass stocks and soils accounted for 5 965,15 Gg CO2. In 2002 net emissions/removals – 6 720,6 Gg CO_2 and comparing to 1990 it increases to 1.238,24 Gg CO_2. During 1998-2002 forest area expanded 66 900 ha that increase in sink strength. Over the last few years, between 9.000 and 11.000 ha have been reforested annually that increase in sink strength as well. Total Net CO_2 emissions/removals are shown in the below.

Table 7-4. Total net CO_2 emissions/removals in 1990 – 2002

7.2.1 Methodological issues

LUCF category is exceptional, as methodical approaches are currently been analyzed internationally, based on The report on Good Practice Guidance for Land Use, Land-Use Change and Forestry, IPCC. This document should serve as scientific basis for preparation of new IPCC methodology for LULUCF sector. As CO_2 emissions and removals in LUCF category in Lithuania have small contribution to total GHG emission balance, national experts do not

consider being rational to include premature changes at this point in time. After approval of new IPCC methodology for LULUCF sector inventory will be recalculated.

For calculation of carbon stocks, emissions and removals of green house gases from land-use change and forestry the Revised 1996 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories[7], referred to below as the IPCC Guidelines, were used. The calculations are based on statistical forestry data and supported by expert judgments and analysis given by national forest experts from the State Forest Survey Service, the General Forest Enterprise of Ministry of Environment. In principle, the calculation follows an idea of first tier and conversion and expansion of the factors recommended by IPCC.

The activity data and related information from the changes in forest and other woody biomass stocks, forest and grassland conversion, abandonment of managed lands, which result in CO_2 emissions and uptake were taken into account. Statistical data are given in the table below.

The immediate release of non-CO_2 trace gases from the burning associated with forest/grassland conversion was not calculated. The non-CO_2 trace gases emissions from biomass fuel combustion were reported in the Energy module.

There is no official statistical data on the total biomass burned *on-site* and with reference to forestry expert opinion and assumption to estimate CO_2 emissions from burning during forest/grassland conversion is not worth because burning *on-site* for that purpose is not occurred in Lithuania.

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

Table 7-5. Total CO_2 emissions and removals from LUCF in 1990, 1998, 2001 and 2002 ($GgCO_2$)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2emissions				CO_2 removals				Net CO_2 emissions/ removals			
	1990	1998	2001	2002	1990	1998	2001	2002	1990	1998	2001	2002
Total Land-Use Change and Forestry	**5.647,97**	**4.733,88**	**5.226,62**	**5.965,15**	**-11.130,33**	**-12.291,39**	**-12.561,81**	**-12.685,75**	**-5.482,36**	**-7.557,51**	**-7.335,19**	**-6.720,60**
A. Changes in Forest and Other Woody Biomass Stocks Temperate Forests	2.935,17	4.493,50	5.016,00	5.775,00	-10.199,93	-10.742,23	-11.012,65	-11.077,00	-7.264,76	-6.248,73	-5.996,65	-5.302,00
C. Abandonment of Managed Lands Temperate Forests					-930,40	-1.549,16	-1.549,16	-1.608,75	-930,40	-1.549,16	-1.549,16	-1.608,75
D. CO2 Emissions and Removals from Soil Cultivation of Organic Soils	2.712,80	240,38	210,62	190,15					2.712,80	240,38	210,62	190,15

Table 7-6. Basic statistical data for carbon balance calculation in 1990, 1998, 2001, 2002

Category	Unit	1990	1998	2001	2002
Productive forest area (stands)	thous. Ha	1 797	1 888	1 938	1 951
Gross annual increment (over bark)	mil. m^3		11.6	11.9	12.0
Fellings in forests	thous. m^3	3 200	4 900	5 472	6 300
Mean current annual increment	m^3/ha				
evergreen		6.6	6.6	6.6	6.6
deciduous		5.6	5.6	5.6	5.6
Forest stands area by dominant tree species	%				
evergreen		59.2	60.7	59.9	59.5
deciduous		40.8	39.3	40.1	40.5
Total fuelwood consumed[8]	thous. m^3	851	2 519	3 336	3 368
Destroyed by forest fires	Ha	43[9]	93	111	746[10]
Reforestation and afforestation	Ha	6125.0	10918.0	6932.1	7611.4
Natural forest regeneration	Ha	-	-	2875.5	3061.5

[8] Source: Energy Balance
[9] Source: FAO
[10] In 2002 hot and dry weather conditions were exceptionally favourable to forest fires, so the area affected by forest fires in Lithuania was maximum, usually this annually affected area is much lower. Hence, biomass losses and emissions of other GHGs by forest fires are negligible.

7.2.2 CO_2 emission and removals based on total annual biomass timber harvest and augmentation from forest management

Basic data for CO_2 production calculation from major harvest is total timber removal (mil.m^3). Default conversion coefficient has been used for total wood biomass calculations. Looses during timber harvest were not evaluated. Calculation of carbon dioxide sink by biomass augmentation was based on detailed national inventory of wood-biomass reserve.

7.2.3 CO_2 emission and removals from forest and grassland conversion

CO2 emission/removals and trace gas emissions from forest and grassland conversion were not estimated because this source is not occurring.

7.2.4 CO_2 emission and removals from abandonment of managed land

The calculation was based on the difference in forest area at two points in time. Available forest land data for the inventory year 2002 and year 1966 and 1978 was used. Statistical data are given in table 7.5.

Table 7-7. Uncertainty of forest land data

Year and data in statistics	**1978**	**2002**	**Difference**
Forest land, thous. ha	1800	1951	151
	1978	**1966**	**Difference**
Forest land, thous. ha	1800	1600	200

The period between 1978 and 2002 was considered as abandoned lands regrowing during the 20 years and the period between 1978 and 1966 was considered for more than 20 years. For the annual rate of aboveground biomass growth the mean default value for temperate forest (2.5 t dm/ha) was used. Estimated total carbon dioxide uptake – 1608.75 Gg.

7.2.5 CO_2 emission and removals from soils

The calculations for CO_2 emissions from organic soils are performed using the forest land use data – agricultural land and pasture - from the State Forest Survey Service. The land area in inventory year for crops - 49 181 ha and pasture - 10 715 ha for cool temperate climate zone was multiplied by the annual loss rate default values to get carbon loss from organic soils. The annual CO2 emissions – 190,15 Gg. CO_2 emissions from liming has not been calculated due to lime were not applied in the forest management.

8 Waste (Sector 6)

8.1 Overview of the waste sector

Waste and waste water 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 1 million ton. 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 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 organisations ("Zaliasis taskas" and "Ateities ekologija") have been created for the collection and recycling of packaging waste.

Statistics for 2003 show that 38% of all waste water was treated fully with phosphorus and nitrogen removal; 47% were treated with mechanical and biological treatment; 14,4% were treated mechanically and only 0,6 % was discharged without any treatment. Comparing with 2001, the amount of treated waste water in the total balance has increased twofold. Construction and reconstruction of waste water treatment plants is supported by the EU funding.

Waste water treatment sludge makes about one third of all non-hazardous waste. As there is no sludge management system in Lithuania established yet, waste water 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 Green house gas sources in waste sector

8.2.1 Description of sources in the waste sector

Emissions of greenhouse gases from the waste sector in Lithuania originate from two major source categories: solid waste disposal on land and wastewater handling (for industrial wastewater and domestic and commercial wastewater).

8.2.1.1 Solid Waste

The quantity of available carbon contained in waste is a key parameter for estimating GHG emissions from the waste sector. Most solid waste contains a mixture of biologically degradable and non-biodegradable components. The latter do not produce any emissions. The relevant parameters for solid waste are therefore the amount of biodegradable organic carbon and the fraction of degradable organic carbon that is actually degraded

Data on solid waste are collected from waste management utilities The utilities ultimately report (via a number of steps) to the Environmental Protection Agency, that submits the data to the Lithuanian Statistical Department.

.A minor part of disposal sites have already have waste weights in there disposal. However majority of landfills and damping sites are considered as unmanaged sites (have no waste weights and do not meet waste management requirements). Waste amounts are evaluating by visual assessment and calculated following certain methodology. Moreover, so far the data on waste does not distinguish between waste flows from managed and unmanaged disposal sites..

In the solid waste category, only emissions from unmanaged waste disposal sites have been reported , as all waste disposal sites, that have not met the EU requirements until 2003 were considered as unmanaged waste disposal sites. Once the distinction between unmanaged and managed sites can be made, data in the CRF will be reported accordingly.. ..

No (managed) municipal waste incineration is taking place at present. No emissions from other sources have been estimated. Some types of waste (hospital, plastic, waste oils) in minor amounts take place at industrial companies or within hospitals without energy production. However there are no official statistical data in Statistical Yearbooks on the amounts.

8.2.1.2 Waste Water

CH_4 emissions from wastewater handling depend on the organic load of pollution in the wastewater. The Revised 1996 IPCC Guidelines recommend that these should be measured as BOD (biological oxygen demand) for municipal waste water and COD (chemical oxygen demand) for industrial wastewater. Sludge that are the products of wastewater treatment produce CH_4 under anaerobic conditions and therefore emission from these sludge should also be estimated.

8.2.2 Methodological issues

For the calculation of GHG emissions, the default IPPC emission factors have been used and a Tier 1 method has been followed.

For calculation of methane in waste water handling A maximum methane potential of the organic component of wastewater and a methane correction factor (that is relevant to the adjustment to emissions from solid waste disposal sites dependent on waste management practices) is used. Default emission factors and actual BOD and COD are used for calculation of CH_4 emissions.

All industries that have at their disposal waste water treatment facilities and all waste water treatment plants once per year report to the EPA On the basis of these data the EPA calculates the total COD for industrial waste water and BOD for domestic waste water. Then EPS sends it to statistical department. The total amount of wastewater is available from the Lithuanian Statistical Yearbook. It should be noted that water used for cooling in nuclear power plant falls under this category, although chemical characteristics of water are not changed by these processes. Therefore this amount of water is not included into the total amount.

There are no data on amount of sludge available in the Lithuanian Statistics. However, some data are available in Environmental Protection Agency, which could be used for GHG inventory for upcoming years. It is not clear at the moment how sludge will be managed in the future. It is clear that at least part of it could not be used as a fertiliser, as contains heavy metals left as a residue from industrial wastewater treatment.

Both assessed categories fall under key sources of GHG. Sources from waste sector and its contribution to total amount of GHG emissions are presented in a table below.

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

No.	Name of a source	Share of total GHG emissions , %
1.	CH_4 from Solid Waste Disposal Sites	6,3 %
2.	Wastewater handling CH_4	2,4%

8.2.3 Uncertainties

It must 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.

8.2.4 Source specific planned improvements

There are no data on amount of sludge available in the Lithuanian Statistics. However, some data are available in Environmental Protection Agency, which could be used for GHG inventory for upcoming years.

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ANNEX 1. Key source analysis

Key source description	Level assessment	Cumulative level assessment
CO2 Stationary combustion-gas	0.251687108	
Mobile combustion-Road vehicles CO2	0.19042588	0.442112988
CH4 from Solid Waste Disposal Sites	0.063432695	0.505545683
CO2 Stationary combustion-oil	0.136788192	0.642333875
CH4 from Enteric Fermentation in Domestic Livestock	0.068397523	0.710731398
N2O from Nitric Acid production	0.051861456	0.762592854
Ammonia production CO2	0.040822308	0.803415162
CO2 Stationary combustion-coal	0.034438203	0.837853365
Fugitive emissions: oil&gas operations CH4	0.024463063	0.862316428
CH4 from Manure Management	0.010838452	0.87315488
Direct N2O emissions from Agricultural soils	0.025966743	0.899121622
Wastewater handling CH4	0.024433786	0.923555409
CO2 from Cement production	0.017595021	0.94115043
N2O from Manure Management	0.011884917	0.953035347

ANNEX 2. National emission factors

No.	Fuel use category	**Fuel type: COAL** Emission factor, kg/GJ							
		CO_2	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	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%
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines								

No.	Fuel use category	**Fuel type: FUEL WOOD** Emission factor, kg/GJ							
		CO_2	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
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines								

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
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines								

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
2.	Heat boiler houses								
3.	Industry								
4.	Small companies								
5.	Households								
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines								

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
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines								

No.	Fuel use category	Fuel type: ***PETROL*** Emission factor, kg/GJ							
		CO_2	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 = 0.05%						
6.1.	Road transport	73	0.022	0.666	7.4	0.0743	0.002	1.2562	0.0014
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines								

No.	Fuel use category	Fuel type: ***CEROSINE*** Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
1.	Power plants								
2.	Heat boiler houses								
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							
		CO_2	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%
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines								

Eil. Nr.	Fuel use category	Fuel type: PEAT Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	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%
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines								

Eil. Nr.	Fuel use category	Fuel type: OTHER NATURAL FUEL Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	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%
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%
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines								

Eil. Nr.	Fuel use category	Fuel type: HEAVY FUEL OIL Emission factor, kg/GJ							
		CO_2	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								

Eil. Nr.	Fuel use category	Fuel type: DIESEL FUEL OIL Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	SP*
			S=0,2% S=0,05%						
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

Eil. Nr.	Fuel use category	Fuel type: AVIATION GASOLINE Emission factor, kg/GJ							
		CO_2	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								

Eil. Nr.	Fuel use category	Fuel type: LIQUIFIED PETROLEUM GAS Emission factor, kg/GJ							
		CO_2	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	
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines								

Eil. Nr.	Fuel use category	Fuel type: OTHER PRODUCTS OF REFINERY 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	0,024
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
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines								

Eil. Nr.	Fuel use category	Fuel type: SHALE OIL Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	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
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines								

Here: S% - sulphur content of fuel %
As% - ash content of fuel %
SP* - solid particles

ANNEX 3 Summary table of GHG emissions in energy sector

GREENHOUSE GAS SOURCE AND SINK CATEGORIES CO2 equivalent (Gg)	CO_2	CH_4	N_2O	HFCs	PFCs	SF6	Total
Total (Net Emissions) (1)	**5,112.16**	**3,554.98**	**1,792.86**	**34.50**	**NE**	**NE**	**10,494.50**
1. Energy	**10,783.49**	**645.83**	**126.92**				**11,556.24**
A. Fuel Combustion (Sectoral Approach)	10,782.20	224.69	126.92				11,133.82
1. Energy Industries	5,086.13	6.42	36.13				5,128.68
2. Manufacturing Industries and Construction	1,086.25	5.46	12.40				1,104.11
3. Transport	3,501.70	28.99	45.27				3,575.96
4. Other Sectors	1,108.12	183.83	33.12				1,325.06
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	1.29	421.13	0.00				422.42
1. Solid Fuels	NO	NO	NO				NO
2. Oil and Natural Gas	1.29	421.13	NE				422.42
2. Industrial Processes	**1,049.27**	**NE**	**892.80**	**34.50**	**NE**	**NE**	**1,976.57**
A. Mineral Products	346.51	NE	NE				346.51
B. Chemical Industry	702.76	NE	892.80	NE	NE	NE	1,595.56
C. Metal Production	NO	NO	NO		NO	NO	NO
D. Other Production	NE						NE
E. Production of HFC's, PFC's and SF6				NO	NO	NO	NO
F. Consumption of HFC's, PFC's, SF6				34.50	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE	0.00
3. Solvent and Other Product Use	**NE**		**NE**				**NE**
4. Agriculture	**NE**	**1,396.52**	**773.14**				**2,169.66**
A. Enteric Fermentation		1,209.94					1,209.94
B. Manure Management		186.59	210.80				397.39
C. Rice Cultivation		NO					NO
D. Agricultural Soils(2)	NE	NE	562.34				2,060.26
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other							
5. Land-Use Change and Forestry(1)	**-6,720.60**	**NE**	**NE**				**-6,720.60**
6. Waste	**NE**	**1,512.63**	**NE**				1,512.63
A. Solid Waste Disposal on Land	NE	1,092.00					1,092.00
B. Wastewater Handling		420.63	NE				420.63
C. Waste Incineration	NE	NE	NE				NE
D. Other	NE	NE	NE				NE
7. Other *(please specify)*	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**
Memo Items:							
International Bunkers	**442.51**	**0.48**	**NE**				**351.02**
Aviation	91.97	NE	NE				NE
Marine	350.54	0.48	NE				351.02
Multilateral Operations	**NE**	**NE**	**NE**				**NE**
CO_2 Emissions from Biomass	**2,813.71**						**2,813.71**