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1. INTRODUCTION

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

Lithuania as a European Union member state also has an annual obligations under the Directive 2001/81/EC of the European Parliament and of the Council on national emission ceilings for certain atmospheric pollutants (NEC Directive) which requires to prepare and annually update national emissions inventory of the certain air pollutants (SO_2, NO_X, NMVOC and NH_3).

This Informative Inventory Report (IIR) covering the inventory of air pollutant emissions from Lithuania. The IIR accompanies the emission inventory for 2009.

1.1. Institutional arrangements for inventory preparation

The Environmental Protection Agency (EPA) is subordinated to the Ministry of Environment. Starting from 2011 year, EPA under the Ministry of Environment was nominated as an entity responsible for inventory preparation by the Order of Minister of Environment No D1-1017. The EPA has an overall legal responsibility for the preparation of Lithuanian emission inventory and submits reports to CLRTAP. Until year 2005 emission inventory was compiled by Air Division specialists, Environmental Quality Department at Ministry of Environment. Air emission inventory submission for 1990, 1995, 2000, 2005-2009 was prepared by the expert team from Center for Physical sciences and Technology in co-operation with Air Division specialists, Ministry of Environment and EPA. Air emission inventory is based mainly on statistics published by Lithuanian Statistics Department (Statistical Yearbooks of Lithuania, sectoral yearbooks on energy balance, agriculture, commodities production etc.), Institute of Road Transport, Registry of Transport (State enterprise “Regitra”), emission data collected by Environment Protection Agency and other. The EPA is responsible for the coordination of inventory process, final checking and approval of inventory procedures, checking of consistency of data, documenting, processing, archiving, timely submission of inventory to the European Commission, coordination of the inventory reviews in Lithuania, keeping of archive of official submissions to the European Commission and the European Commission, informing the inventory compilers about relevant requirements for the National system.

1.2. The process of inventory preparation

In the first stage specific responsibilities are defined and allocated. Within the inventory system specific responsibilities for the different emission source categories are defined, as well as for all activities related to the preparation of the inventory, data management and reporting.

In the second stage, the inventory preparation process, were collected activity data, emission factors and all relevant information needed for finally estimating emissions. Activity data were collected from Lithuanian Department of Statistics [1-5], Institute of Road Transport, Registry of Transport, and the emission factors were proposed by the Ministry of Environment and Emission Inventory Guidebook. All data collected together with emission estimates were organised in database, where data sources are well documented for future reconstruction of the inventory.

For the inventory management and reliable data management to fulfil the data collecting and reporting requirements is needed. All emission inventory data are organised in emission inventory database and managed using PostgreSQL database management system; all needed calculations and road transport emission modelling are performed using SQL scripts developed by Centre for Physical sciences and Technology. The EPA annually submits inventory reports to the European Commission secretariat.

1.3. An assessment of completeness

1.3.1 Explanation on the use of Notation Keys

In Table 1-1 definitions and application of the notation keys in our inventory are reported.

Table 1-1. Definition of Notation Keys

Notation Key	Use of notation keys in national inventory
NO	"NO" (Not Occurring) - an activity or process does not exist within a country
NE	"NE" (Not Estimated) - emissions occur but have not been estimated or reported in this submission.
NA	"NA" (Not Applicable) - the process or activity exists but emissions are considered never to occur.
IE	"IE" (Included Elsewhere) - emissions by sources of compounds are estimated but included elsewhere in the inventory.

1.3.2 Completeness analysis

Result of completeness analysis for each pollutant is given in Table 1-2. Values in Table 1-2 are number of cells filled with corresponding notation key or value for each pollutant.

Table 1-2. Completeness analysis for each pollutant.

Pollutant	Number of cells								
	NO	**NE**	**NA**	**IE**	**C**	**NR**	**Zero**	**Value**	**Total**
SO_2	24	13	45	3	0	0	0	24	109
NO_x	23	14	43	3	0	0	0	26	109
NMVOC	23	23	28	4	0	0	0	31	109
CO	21	19	44	3	0	0	0	22	109
NH_3	17	33	37	2	0	0	0	20	109

TSP	25	29	27	3	0	0	0	25	109
PM_{10}	25	33	26	3	0	0	0	22	109
$PM_{2.5}$	25	33	26	3	0	0	0	22	109
As	20	16	60	2	0	0	1	10	109
Cd	20	17	52	2	0	0	0	18	109
Cr	20	16	53	2	0	0	0	18	109
Cu	20	16	53	2	0	0	0	18	109
Hg	20	18	57	2	0	0	0	12	109
Ni	20	16	54	1	0	0	0	18	109
Pb	20	19	51	2	0	0	0	17	109
Se	20	16	54	1	0	0	0	18	109
Zn	20	16	54	1	0	0	0	18	109
DIOX	18	29	44	2	0	0	0	17	109
benzo(a)pyrene	18	24	45	2	0	0	0	17	109
benzo(b)fluoranthene	17	24	45	1	0	0	0	17	109
benzo(k)fluoranthene	17	26	44	1	0	0	0	17	109
ideno(1,2,3-c,d)pyrene	17	26	44	2	0	0	0	17	109
PCB	3	13	90	0	0	0	0	3	109
HCH	4	8	97	0	0	0	0	0	109
HCB	13	16	78	0	0	0	0	0	109
Total									

All major emissions from important sources were estimated and reported. Only minor emissions from few sources were not estimated due to lack of activity data or emission factors.

Aldrin, chlordane, chlordecone, DDT, dieldrin, endrin, HCB, HCH, heptachlor, mirex, pentachlorophenol (PCP) and toxaphene production, import and use is prohibited in Lithuania from 01-04-1997. SCCP and hexabromo-biphenyl are not produced in Lithuania. The data about their usage in Lithuania is not available.

1.4. Key source analysis

The lists of the Key source analysis emission sources that contributed to 95 % of the total national emissions are reported. The Key source analysis was performed for each reported pollutant separately. Memo items were not included in the Key source analysis. The results of the Key source analysis are given in Table 1-3. NFR codes of Key source categories are listed in the second columns of Table 1-3 and sorted by the level descending. Emission from each source category is listed in the third column. Level assessment (relative contribution to total national emission) of each source category is listed in the fourth column (sorted descending).

Table 1-3. Key source analysis for main pollutants.

	Key source analysis								(%)
SOx	1 B 2 a iv (15.9%)	1 A 1 c (14.1%)	1 A 4 b i (10.9%)	1 A 1 a (10.2%)	1 A 4 a i (9.0%)	1 A 1 b (8.3%)	1 A 2 f ii (7.9%)	1 A 3 b iii (6.4%)	82.7
NOx	1 A 3 b iii (33.5%)	1 A 3 b i (20.4%)	1 A 1 a (8.3%)	1 A 3 c (7.8%)	1 A 3 b ii (5.3%)	1 A 1 c (4.5%)	1 A 2 f ii (3.6%)		83.4
NH3	4 B 1 a (40.6%)	4 B 8 (22.2%)	4 B 1 b (19.3%)						82.1

NMVOC	3 A 2 (21.6%)	1 A 4 b i (14.9%)	1 A 3 b i (12.9%)	2 D 2 (12.9%)	1 B 2 a iv (8.4%)	3 D 2 (3.8%)	1 B 2 a v (3.2%)	1 A 2 f i (3.2%)	80.9
CO	1 A 4 b i (44.9%)	1 A 3 b i (36.4%)							81.3
TSP	1 A 4 b i (27.8%)	1 A 1 a (14.1%)	1 A 2 f ii (13.2%)	1 A 1 c (11.2%)	1 A 4 a i (8.6%)	1 A 3 b iii (7.6%)			82.5
PM10	1 A 4 b i (31.5%)	1 A 1 a (15.7%)	1 A 2 f ii (11.4%)	1 A 3 b iii (7.5%)	1 A 1 c (7.3%)	1 A 3 b ii (6.7%)			80.3
PM2.5	1 A 4 b i (36.7%)	1 A 1 a (18.0%)	1 A 2 f ii (9.3%)	1 A 3 b iii (8.8%)	1 A 3 b ii (8.3%)				81.1
Pb	1 A 3 b i (73.3%)	1 A 3 b vi (9.3%)							82.5
Hg	1 A 1 a (87.9%)								87.9
Cd	1 A 1 a (64.1%)	1 A 1 b (20.9%)							85.0
DIOX	1 A 4 b i (80.9%)								80.9
PAH	1 A 4 b i (92.6%)								92.6

Usage of 'NE' and 'IE' notation keys may influence Key sources analysis. Assessment of not estimated emission contribution to National Total was made according to not estimated sources emission statistical contribution to total emission given in the [5] reference. Assessment was made for main pollutants by summing relative contributions of not estimated sources according to CORINAIR90 or CORINAIR94 European countries inventory (Table 1-4). As a result, we assessed usage of notation key 'NE' influence to the key source analysis by main pollutants.

Table 1-4. Contribution of not estimated sources emission to national total.

Pollutant	Relative contribution, [%]
SO_2	0.6
NO_x	3.5
NMVOC	1
CO	0.5
NH_3	1.2
TSP	1.7

Usage of 'NE' notation key for SO_2, CO, NMVOC and NH_3 does not influence the Key source analysis. Usage of 'NE' notation key for TSP should not influence the Key source analysis. Not estimated sources of NO_x are not major sources. Most important not estimated sources are direct soil emission (NO_x contribution – 3%) and asphalt roofing (TSP contribution – 1.6 %). Methodology for these sources emission estimation will be prepared in a future.

1.5. Recalculations and other changes

Some renewals in calculations were applied. More detail methodology was applied to the calculation of direct soil NH_3 emission. The biogenic emissions and emissions from fires were calculated. Recalculation of pollutants are presented in Table 1-5.

Table 1-5. Emission recalculation

Pollutant	Sector	2004	2005	2008
NO_x	5E	+0.034182	+0.0068634	
CO	5E	+0.9826692	+0.19731004	
NMVOC	5E	+145.325233	+145.253597	
SO_x	5E	+0.007596	+0.0015252	
SO_x	1 B 2 a iv			+5.503849
NH_3	4D1 i	-3.07295183	-4.7454173	
NH_3	National total	-3.07295183	-4.7454173	
NH_3	5E	+0.007596	+0.0015252	

1.6. Emission Trends for Air Pollutant

The emission ceilings of NECD are designed with the aim of attaining the European Community's interim environmental objectives set out in Article 5 of NECD by 2010. Meeting those objectives is expected to result in reduced acidification, health-and vegetation-related ground-level ozone exposure by 2010 compared with the 1990 situation. National total emissions and trends (1990–2009) as well as emission targets for air pollutants are shown in Figure 1-6 – 1-9.

Accordingly of the global economical crisis Lithuania's economic development has slowed down by the end of 2008. In 2008 GDP growth has decreased to 2.9% and in 2009 GDP contracted by -14.7%.

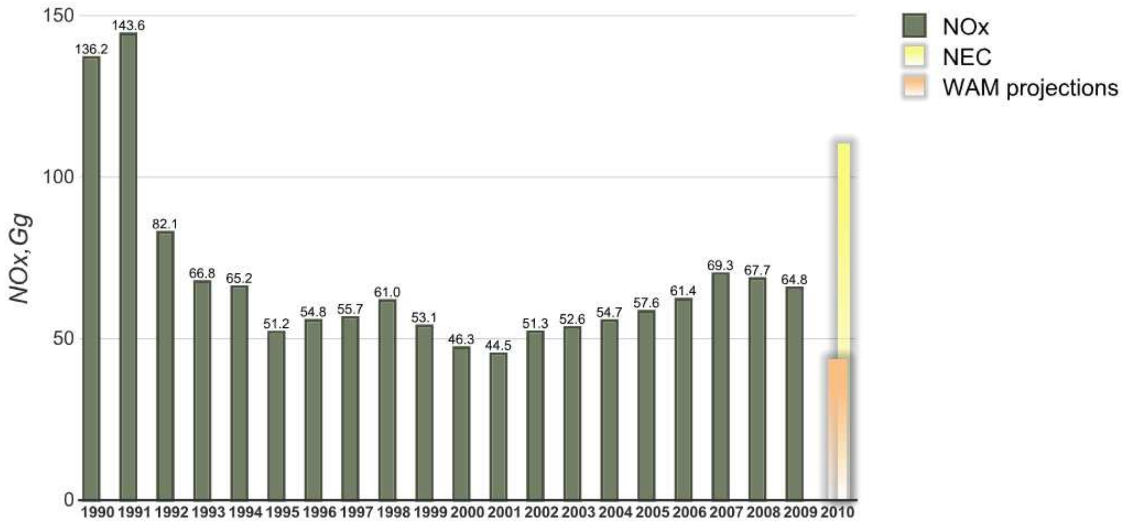
In 2005-2008 GDP increased by 21,7%, but in 2009 decreased by 14,8% comparing with 2008. Energy consumption changed accordingly. During 2005-2007 period final energy consumption increased by 11,7%, but in 2009 decreased by 12,1% comparing with 2007.

The Ignalina Nuclear Power Plant (NPP) played a key role in the Lithuanian energy sector producing up to 70-80% of the electricity until its closure by the end on 2009. It had installed capacity of 3000MW in two RB MK-1500 (large power channel reactor) reactors. The structure of electricity generation in 2005-2009 is shown in (**Error! Reference source not found.**). The share of electricity produced in Ignalina NPP has been taken over mainly by the Lithuanian Thermal Power Plant and the largest combined heat and power plants at Vilnius and Kaunas. Thus, the projected energy demand after the decommissioning of Ignalina NPP has been met by using the existing generating capacities. The country is very dependent on electricity produced from fossil fuels which are imported from the single source.

Fuel consumption in transport sector is dominated by diesel oil (56%) and petrol (27%). Passenger cars are mostly using petrol fuel and gas, whereas buses and heavy duty vehicles run mainly on diesel fuel. The use of liquefied petroleum gas is strongly influenced by the fluctuation of fuel prices. In navigation diesel fuel and fuel oil are used.

1.6.1 NO_x

In 2008, NO_x emissions per GDP (expressed in terms of grams of NOX per EUR of GDP) in the average EU-27 was 0.9 g/EUR and in Lithuania 2.3 g/EUR.



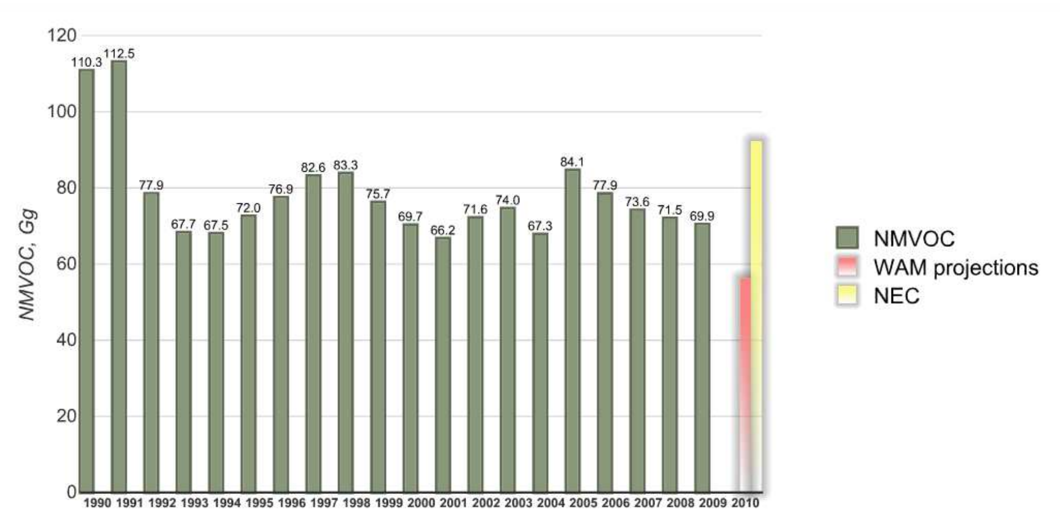
*__A with additional measures (WAM)__ projection is taking into account all currently implemented and adopted plus all planned policies and measures.

Figure 1-6-1. National total emission trend for NO_x

Table 1-6. NOx emissions projections in Lithuania

NOx emissions projections in Lithuania				
	Key data	***Value***	***Unit***	***Rank in EU-27***
NOx emission profile	Total NOx emissions 1990	136	Gg	
	Total NOx emissions 2008	67.7	Gg	21(27)
	NOx emissions in 2008 per capita	20.1	kg/cap	17(27)
	NOx emissions per GDP in 2008 (current prices)	2.3	g/euro	6(27)
	Share of NOx in EU-27 in 2008	0.7	%	
	Current and projected progress toward ceiling	***Value***	***Unit***	
Progress towards ceiling	2010 Emission ceiling	110	Gg	
	2010 projected effect of planned additional measures	43.7	Gg	
		Absolute	***Unit***	***Relative (%)***
	Distance to NOx emission ceiling in 2008	-42.3	Gg	-38.4

1.6.2. **NMVOC**



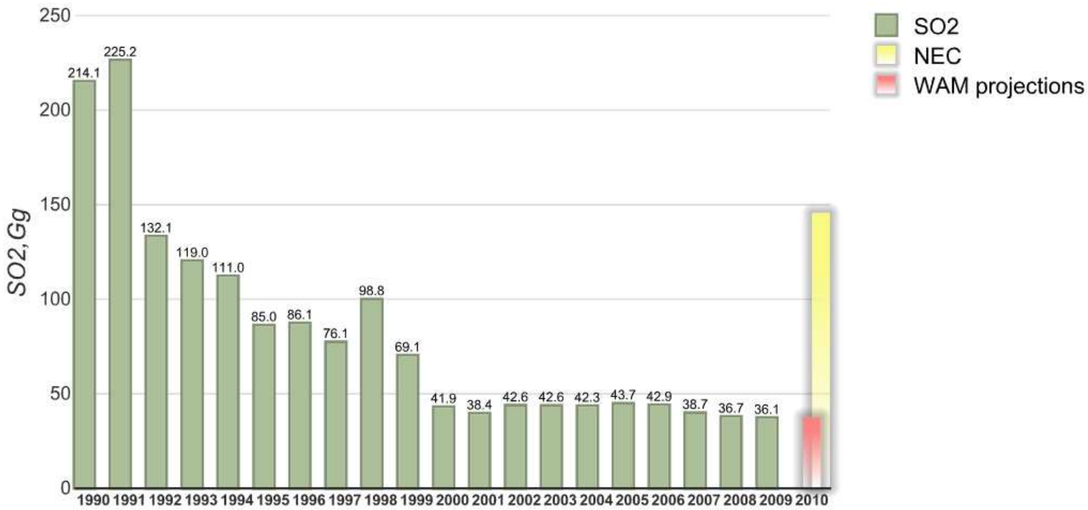
*A **with additional measures (WAM)** projection is taking into account all currently implemented and adopted plus all planned policies and measures.

Figure 1-6-2. National total emission trend for NMVOC

Table 1-7. NMVOC emissions projections in Lithuania

NMVOC emissions projections in Lithuania				
	Key data	***Value***	***Unit***	***Rank in EU-27***
NMVOC emission profile	Total NMVOC emissions 1990	110	Gg	
	Total NMVOC emissions 2008	71.5	Gg	19(27)
	NMVOC emissions in 2008 per capita	21.2	kg/cap	4(27)
	NMVOC emissions per GDP in 2008 (current prices)	1.4	g/euro	5(27)
	Share of NMVOC in EU-27 in 2008	0.9	%	
	Current and projected progress toward ceiling	***Value***	***Unit***	
Progress towards ceiling	2010 Emission ceiling	92	Gg	
	2010 projected effect of planned additional measures	56.2	Gg	
		Absolute	***Unit***	***Relative (%)***
	Distance to NMVOC emission ceiling in 2008	-20.5	Gg	-22.3

1.6.3. SO_2



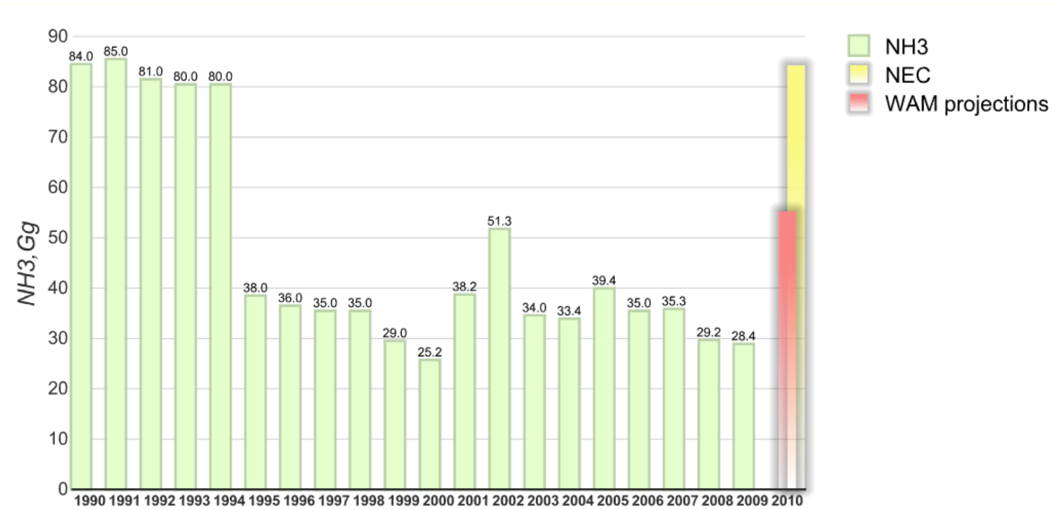
*A **with additional measures (WAM)** projection is taking into account all currently implemented and adopted plus all planned policies and measures.

Figure 1-6-3. National total emission trend for SO_2

Table 1-8. SO_2 emissions projections in Lithuania

SO_2 emissions projections in Lithuania				
	Key data	***Value***	***Unit***	***Rank in EU-27***
SO_2 emission profile	Total SO_2 emissions 1990	214	Gg	
	Total SO_2 emissions 2008	36.7	Gg	19(27)
	SO_2 emissions in 2008 per capita	9.4	kg/cap	15(27)
	SO_2 emissions per GDP in 2008 (current prices)	0.6	g/euro	11(27)
	Share of SO_2 in EU-27 in 2008	0.5	%	
	Current and projected progress toward ceiling	***Value***	***Unit***	
Progress towards ceiling	2010 Emission ceiling	145	Gg	
	2010 projected effect of planned additional measures	37	Gg	
		Absolute	***Unit***	***Relative (%)***
	Distance to SO_2 emission ceiling in 2008	-113.5	Gg	-78.3

1.6.4. **NH_3**



*A **with additional measures (WAM)** projection is taking into account all currently implemented and adopted plus all planned policies and measures.

Figure 1-6-4. National total emission trend for NH_3

Table 1-9. **SO_2 emissions projections in Lithuania**

NH_3 emissions projections in Lithuania				
	Key data	***Value***	***Unit***	***Rank in EU-27***
NH_3 emission profile	Total NH_3 emissions 1990	84	Gg	
	Total NH_3 emissions 2008	38.1	Gg	20(27)
	NH_3 emissions in 2008 per capita	11.3	kg/cap	8(27)
	NH_3 emissions per GDP in 2008 (current prices)	1.3	g/euro	4(27)
	Share of NH_3 in EU-27 in 2008	1	%	
	Current and projected progress toward ceiling	***Value***	***Unit***	
Progress towards ceiling	2010 Emission ceiling	84	Gg	
	2010 projected effect of planned additional measures	55.3	Gg	
		Absolute	***Unit***	***Relative (%)***
	Distance to NH_3 emission ceiling in 2008	-54.8	Gg	-65.3

1.7. Quality Assurance and quality control procedures

Quality Control (QC)

Quality Control (QC) is a system of routine technical activities, to measure and control the quality of the inventory as it is being developed. The QC system is designed to:

- Provide routine and consistent checks to ensure data correctness and completeness;
- Identify and address errors and omissions;
- Document and archive inventory material.

QC activities include general methods such as accuracy checks on data acquisition and calculations and the use of approved standardized procedures for emission calculations, measurements, estimating uncertainties, archiving information and reporting.

Quality assurance (QA)

Quality Assurance (QA) activities include a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. Reviews verify that data quality objectives were met, ensure that the inventory represents the best possible estimates of emissions and sinks given the current state of scientific knowledge and data available, and support the effectiveness of the QC programme. In the inventory preparation process, general quality control procedures have been applied. Some specific quality control procedures related to check of activity data and emission factors were applied in previous submissions with new or updated emission factors and activity data from other sources (Environmental Pollution Register, direct communication with operators).

2. ENERGY

After the collapse of the Soviet Union and the reestablishment of Independence in 1990, Lithuania substantially changed its core economic and institutional values. Lithuania has inherited the economy wherein energy consumption per unit of production was 3 times higher than in analogous West European industries. After Lithuania had succeeded from the Soviet Union, the latter critically curtailed the supplies of energy and other resources. As a result, the economic output of Lithuania decreased by one third in 1992 and by one fourth in 1993.

A very sharp increase in primary energy prices and loss of the former Eastern markets brought about a noticeable decline of national energy industry and energy exports. Energy demand and its production decreased almost by half.

By now, however, the declining trend has been successfully reversed. In 2009-2010 the national emission decreased due to the world economical crisis which slightly reflected in the country's emissions.

2.1. Stationary combustion

This chapter covers fuel combustion emissions from boilers, gas turbines, stationary engines and other stationary equipments in energy, industry, commercial/institutional, household and agriculture sectors (stationary sources in NFR sector 1A). Emissions from large point sources were reported separately in Excel template Table IV 3C. The sources provided in inventory as large point sources are:

- 7 power stations
- 6 regional boiler houses
- 2 chemical plants
- 1 oil refinery
- 1 cement plant

Data on direct emissions from large point sources was obtained from their annual emission questionnaires submitted to the Ministry of Environment. Emissions from area sources are estimated according to statistical fuel consumption data.

Emission factors for SOx, NOx, CO, NMVOC, NH3, TSP, PM10, PM2.5, heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn) and POP's are described in this chapter. Emissions were estimated by multiplying heat value of combusted fuel by corresponding emission factor.

2.1.1. Main pollutants

Emission factors for sulphur dioxide (SO_2) and particulate matter (PM) were calculated using the national methodology given in [8] reference. In this methodology are prescribed multipliers, which multiplied by the fuel sulphur and ash contents gives the emission factors. These calculated emission factors are equal for all fuel consuming objects (Tables 2-1 and 2-2).

Table 2-1. Emission factors for SO_2, [kg/GJ].

Fuel	Fuel sulphur content,	Multiplier	Emission factor
Hard coal	1.82	0.714	1.29
Crude oil	0.24	0.488	0.12

Residual oil	2.2	0.488	1.05
Gas oil	0.8	0.468	0.37

Table 2-2. Emission factors for PM, [kg/GJ].

Fuel	Fuel ash content, □	Multiplier	Emission factor
Hard coal	10	0.04365	0.4365
Peat	5	0.164	0.82
Crude oil	0.03	0.249	0.007
Residual oil	0.08	0.249	0.0199

National emission factors of other pollutants, i.e. CO, NOx, NMVOC, SO2 and PM, were taken from [8] reference. Emissions from coke combustion were estimated using hard coal's emission factors, emissions from charcoal and agriculture waste combustion were estimated using wood's emission factors. Particle size distribution was taken from [7] reference (Table 2-3).

Table 2-3. Particle size distribution, [%].

Fuel	PM10	PM2.5
Coal, coke	52	13
Wood, peat	96	93
Heavy fuel oil (energy, industry)	85	60
Heavy fuel oil (domestic)	65	25
Light fuel oil (energy)	50	19
Light fuel oil (industry)	50	14
Light fuel oil (domestic)	53	47

National emission factors have been developed on the basis of international experience, to which local circumstances have been applied, by scientist Prof. B. Jaskelevicius and consultant P. Liuga who based themselves on emission factors developed by Danish, German and Slovak experts[1]. 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 (Table 2-4). Moreover, different transport means are distinguished: motor cars, railways, water transport, air transport and agricultural machines.

[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 Rahmenũbereinkommen der Vereinten Nationen ũber Klimaänderungen. Bundesumweltminiisterium. Bundesumweltministerium fũr Umwelt, Naturschutz und Reaktorsicherheit.
1997; (2) Jiri Balajka. Estimating CO2 Emissions from Energy in Slovakia using the IPCC Reference Method. JDOJARAS, Vol. 99, No. 3-4, July-December, 1995).

Table 2-4. Correspondence between NFR sectors and national energy sector classification.

NFR sectors	National energy sector classification
1A1a	Power plants
1A1a	Heat boiler houses
1A1b	Industry
1A1c	Industry
1A2	Industry
1A3a i (ii)	Air transport
1A3a ii (ii)	Air transport
1A3c	Railway transport
1A3d i	Water transport
1A3d ii	Water transport
1A4a	Small companies
1A4b i	Households
1A4c i	Small companies
1A5c ii	Agricultural machines

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

2.1.2. Heavy metals

Most of the heavy metals considered (As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn) are normally released as compounds (e.g. oxides, chlorides) in association with particulates. Only Hg and Se are at least partly present in the vapour phase. Less volatile elements tend to condense onto the surface of smaller particles in the flue gas stream. Therefore, enrichment in the finest particle fractions is observed. The content of heavy metals in coal is normally several orders of magnitude higher than in oil (except occasionally for Ni in heavy fuel oil) and in natural gas. For natural gas only emissions of mercury are relevant. During the combustion of coal, particles undergo complex changes, which lead to evaporation of volatile elements. The rate of volatility of heavy metal compounds depends on fuel characteristics (e.g. concentrations in coal, fraction of inorganic components, such as calcium) and on technology characteristics (e.g. type of boiler, operation mode).

Due to there is no national data about concentrations of heavy metals in the fuel the emission factors for heavy metals were taken from the CORINAIR database, which was installed with CollectER II (Table 2-5).

Table 2-5. Fuel combustion emission factors for heavy metals, [mg/GJ].

Material	Emission factors			
	Residual oil	Natural gas	Hard coal	Lignite
As	12.20	0	5.61	2.90

Cd	24.40	0	0.22	0.25
Cr	61.00	0	4.09	3.02
Cu	24.40	0	7.00	0.99
Hg	24.40	0.1	4.27	10.33
Ni	853.66	0	7.34	2.49
Pb	31.71	0	19.11	2.60
Se	0	0	0.68	0
Zn	24.39	0	22.7	8.68

2.1.3. PAH and other POP's

Emission factors for PAH were derived from [10] reference, resulting emission factors are reported in Table 2-6. Emission factors for dioxins/furans were taken from [6] reference and emission factors for PCB's were taken from [9] reference (Table 2-7).

Table 2-6. PAH emission factors, [mg/GJ].

Source	Fuel	BaP*	BbF*	BkF*	I_P*
Electricity plants	Coal	3.870	1.381	1.381	1.238
Electricity plants	Wood	0.326	0.256	0.256	0.140
Electricity plants	Heavy fuel oil	0.003	0.009	0.009	0.015
Electricity plants	Gas-oil	0.003	0.009	0.009	0.009
Electricity plants	Diesel	0.081	0.043	0.067	0.161
Electricity plants	Lignite	0.023	0.014	0.010	0.022
Heat plants	Coal	0.006	6.171	6.171	0.112
Heat plants	Wood	0.326	0.256	0.256	0.140
Heat plants	Heavy fuel oil	0.003	0.009	0.009	0.015
Heat plants	Gas-oil	0.003	0.009	0.009	0.009
Heat plants	Diesel	0.081	0.043	0.067	0.161
Heat plants	Lignite	0.023	0.014	0.010	0.022
Industry	Coal	0.006	6.171	6.171	0.112
Industry	Wood	0.326	0.256	0.256	0.140
Industry	Heavy fuel oil	0.003	0.009	0.009	0.015
Industry	Gas-oil	0.081	0.043	0.067	0.161
Industry	Diesel	0.023	0.014	0.010	0.022
Industry	Lignite	119.40	79.620	79.620	79.620
Comm./Inst. plants	Coal	0.009	0.698	0.698	0.016
Comm./Inst. plants	Wood	0.003	0.009	0.009	0.015
Comm./Inst. plants	Heavy fuel oil	0.003	0.009	0.009	0.009
Comm./Inst. plants	Gas-oil	0.023	0.014	0.010	0.022
Comm./Inst. plants	Diesel	119.40	79.620	79.620	79.620
Comm./Inst. plants	Lignite	179.80	207.00	114.00	279.10
Domestic plants	Coal	0.058	0.058	0.058	0.058
Domestic plants	Wood	0.036	0.052	0.052	0.028
Domestic plants	Heavy fuel oil	0.058	0.058	0.058	0.058
Domestic plants	Natural gas	204.90	136.60	136.60	136.60
Domestic plants	Gas-oil	0.326	0.256	0.256	0.140
Domestic plants	Lignite	0.003	0.009	0.009	0.015

*Abbreviations: BaP – benzo(a)pyrene, BbF – benzo(b)fluoranthene, BkF - benzo(k)fluoranthene, I_P - indeno(1,2,3-c,d)pyrene.

Table 2-7. PCB and dioxin/furan emission factors.

Fuel	*PCB [µg/GJ]*	*DIOX [ng I-Teq/GJ]*
Coal	144	2.4
Wood	350	90
Heavy fuel oil	90	25
Light fuel oil	90	25
Lignite	257	4.5

2.2. TRANSPORT

Since 1990, the Government of Lithuania has adopted a number of important decisions on the reduction of transport pollution, i.e. national programmes like "Transport and the Protection of Environment", "Measures for the Implementation of the National Transport Development Programme", and other programmes aimed at reducing the negative impact of transport on the environment and on people's health. Due to a difficult economic situation, the implementation of these programmes is slower than expected.

Please note that emissions from mobile sources are calculated based on fuel sold in Lithuania, thus national total emissions include.

2.2.1. Road transport

Calculations of emissions from road transport (NFR sector 1A3b) are based on:

- statistical fuel consumption data from Energy balance
- traffic intensity, estimated by Institute of Transport
- road transport fleet data, taken from Registry of Transport (State Enterprise "Regitra"). Emission factors and fuel consumption factors for NO_X, NMVOC, CO, TSP and NH3 emission estimations were calculated using COPERT IV model. Road transport was differentiated into the passenger cars, light duty vehicles, heavy duty vehicles, buses and motorcycles categories.

2.2.1.1. Main pollutant emissions

The emissions of SO_2 are estimated by assuming that all sulphur in the fuel is transformed completely into SO_2 using the equation [5]:

$$E^{CALC}_{SO_2,j} = 2 \cdot k_{S,m} \cdot FC^{CALC}_{jm}, \tag{1}$$

where, $k_{S,m}$ - weight related sulphur content in fuel of type m [kg/kg fuel]. Calculation results are listed in Table 2-8.

Table 2-8. Emission factors for SO_2, [g/kg].

Fuel	k	Emission factor
Gasoline	0.0005	1
Diesel oil	0.002	4

CO, NMVOC, NO_x, NH_3, TSP emission factors and fuel consumption factors were calculated using COPERT IV model. Emission factors were calculated for urban, rural and highway modes from average speed of transport at these modes (Table 2-9).

Table 2-9. Average speed of transport categories at different driving modes, [km/h].

Transport category/ Driving modes	Urban	Rural	Highway

Passenger cars	30	70	100
Light duty vehicles	25	65	100
Heavy duty vehicles	25	65	90
Buses	20	65	85
Motorcycles	30	70	90

Fuel was distributed to transport categories, types, ecology standards and driving modes according to mileage data taken from Institute of Transport and transport fleet data taken from Transport Registry. Following particle size distributions were taken from [7] reference: PM_{10} – 96 % of TSP, $PM_{2.5}$ – 86.5 % of TSP. Result of emission factors estimation are listed in Tables 2-10 - 2-14.

Table 2-10. Emission factors for passenger cars [g/GJ].

Engine type	Ecology standard	CO	NO_x	NMVOC	NH_3	TSP	PM_{10}	$PM_{2.5}$
Highway								
Gasoline < 1.4 l	PRE ECE	5647.45	736.13	453.76	0.73	0	0	0
	ECE 15/00-01	8747.2	950.35	526.78	0.94	0	0	0
	ECE 15/02	3683.29	1297.18	423.62	0.89	0	0	0
	ECE 15/03	3397.9	1460.83	423.62	0.89	0	0	0
	ECE 15/04	2054.12	1274.14	334.09	0.96	0	0	0
	Euro I	1650.39	307.89	53.52	51.9	0	0	0
	Euro II	1122.26	110.84	11.24	51.9	0	0	0
	Euro III	924.22	73.89	8.03	51.9	0	0	0
	Euro IV	561.13	40.03	1.61	51.96	0	0	0
Gasoline 1.4 – 2.0 l	PRE ECE	4638.78	935.53	372.72	0.6	0	0	0
	ECE 15/00-01	7049.99	1185.09	424.57	0.76	0	0	0
	ECE 15/02	3159.93	1255.94	363.43	0.77	0	0	0
	ECE 15/03	2915.09	1328.12	363.43	0.77	0	0	0
	ECE 15/04	1882.38	1545.7	306.16	0.88	0	0	0
	Euro I	1141.55	251.88	39.16	47.5	0	0	0
	Euro II	776.26	90.68	8.22	47.5	0	0	0
	Euro III	639.27	60.45	5.48	47.5	0	0	0
	Euro IV	388.13	32.74	1.17	47.53	0	0	0
Gasoline > 2.0 l	PRE ECE	4014.39	1422.62	322.55	0.52	0	0	0
	ECE 15/00-01	6411.98	1893.98	386.15	0.69	0	0	0
	ECE 15/02	2667.39	1188.38	306.78	0.65	0	0	0
	ECE 15/03	2460.71	1486.76	306.78	0.65	0	0	0
	ECE 15/04	1401.74	1204.26	227.98	0.65	0	0	0
	Euro I	436.5	233.01	51.7	44.7	0	0	0
	Euro II	296.82	83.88	12.41	44.7	0	0	0
	Euro III	244.44	55.92	8.27	44.7	0	0	0
	Euro IV	152.77	30.29	2.58	44.72	0	0	0
Diesel < 2.0 l	Conventional	179.7	246.87	28.81	0.47	79.4	76.3	68.75
	Euro I	81.36	305.55	14.47	0.49	35.5	34.1	30.72
	Euro II	81.36	305.55	14.47	0.49	35.5	34.1	30.72
	Euro III	81.36	235.27	12.3	0.49	25.5	24.55	22.12
	Euro IV	81.36	161.94	9.99	0.49	15.98	15.34	13.83
Diesel > 2.0 l	Conventional	179.7	402.56	28.81	0.47	79.4	76.3	68.75

	Euro I	81.36	305.55	14.47	0.49	35.5	34.1	30.72
	Euro II	81.36	305.55	14.47	0.49	35.5	34.1	30.72
	Euro III	81.36	235.27	12.3	0.49	25.5	24.55	22.12
	Euro IV	81.36	161.94	9.99	0.49	15.98	15.34	13.83
LPG	Conventional	3914.25	1151.7	197.15	0	0	0	0
	Euro I	1429.78	119.61	33.38	0	0	0	0
	Euro II	972.25	43.06	7.01	0	0	0	0
	Euro III	800.68	28.71	5.01	0	0	0	0
	Euro IV	486.13	15.55	1	0	0	0	0
Rural								
Gasoline < 1.4 l	PRE ECE	8025.24	855.96	663.02	0.83	0	0	0
	ECE 15/00-01	7435.75	1058.88	645	1.03	0	0	0
	ECE 15/02	4144.67	1062.45	536.28	1.01	0	0	0
	ECE 15/03	4444.4	1138.77	536.28	1.01	0	0	0
	ECE 15/04	2604.71	1098.09	470.44	1.05	0	0	0
	Euro I	334.69	213.79	49.02	60.0	0	0	0
	Euro II	227.59	76.97	10.29	60.0	0	0	0
	Euro III	187.43	51.31	7.35	60.0	0	0	0
	Euro IV	113.79	27.79	1.47	60.09	0	0	0
Gasoline 1.4 – 2.0 l	PRE ECE	6587.88	914.26	544.27	0.68	0	0	0
	ECE 15/00-01	6470.81	1198.98	561.29	0.89	0	0	0
	ECE 15/02	3693.62	1070.7	477.92	0.9	0	0	0
	ECE 15/03	3960.73	1161.97	477.92	0.9	0	0	0
	ECE 15/04	2303.89	1281.48	416.11	0.93	0	0	0
	Euro I	485.79	181.25	43.09	51.8	0	0	0
	Euro II	330.34	65.25	9.05	51.8	0	0	0
	Euro III	272.05	43.5	6.03	51.8	0	0	0
	Euro IV	165.17	23.56	1.29	51.87	0	0	0
Gasoline > 2.0 l	PRE ECE	5517.35	1167.24	455.83	0.57	0	0	0
	ECE 15/00-01	5790.74	1635.65	502.3	0.8	0	0	0
	ECE 15/02	2959.45	965.43	382.92	0.72	0	0	0
	ECE 15/03	3173.46	1241.74	382.92	0.72	0	0	0
	ECE 15/04	1948.15	1081.17	351.86	0.79	0	0	0
	Euro I	400.53	199.75	80.79	49.2	0	0	0
	Euro II	272.36	71.91	19.39	49.2	0	0	0
	Euro III	224.3	47.94	12.93	49.2	0	0	0
	Euro IV	140.18	25.97	4.04	49.2	0	0	0
Diesel < 2.0 l	Conventional	268.08	246.02	48.91	0.57	75.1	72.12	64.99
	Euro I	60.57	270.74	18.2	0.55	19.1	18.38	16.56
	Euro II	60.57	270.74	18.2	0.55	19.1	18.38	16.56
	Euro III	60.57	208.47	15.47	0.55	13.7	13.23	11.92
	Euro IV	60.57	143.49	12.56	0.55	8.62	8.27	7.45
Diesel > 2.0 l	Conventional	268.08	410.71	48.91	0.57	75.1	72.12	64.99
	Euro I	60.57	270.74	18.2	0.55	19.1	18.38	16.56
	Euro II	60.57	270.74	18.2	0.55	19.1	18.38	16.56
	Euro III	60.57	208.47	15.47	0.55	13.7	13.23	11.92
	Euro IV	60.57	143.49	12.56	0.55	8.62	8.27	7.45
LPG	Conventional	1146.38	1248.46	322.09	0	0	0	0
	Euro I	695.58	136.15	34.23	0	0	0	0
	Euro II	472.99	49.01	7.19	0	0	0	0
	Euro III	389.52	32.68	5.13	0	0	0	0
	Euro IV	236.5	17.7	1.03	0	0	0	0

Urban								
Gasoline < 1.4 l	PRE ECE	9508.97	496.65	828.67	0.58	0	0	0
	ECE 15/00-01	7718.4	563.16	745.54	0.65	0	0	0
	ECE 15/02	7134.59	547.27	812.13	0.72	0	0	0
	ECE 15/03	7480.48	568.38	812.13	0.72	0	0	0
	ECE 15/04	4745.53	642.04	726.25	0.8	0	0	0
	Euro I	1232.18	130.9	111.4	26.74	0	0	0
	Euro II	837.88	47.12	23.39	26.74	0	0	0
	Euro III	690.02	31.42	16.71	26.74	0	0	0
	Euro IV	418.94	17.02	3.34	26.74	0	0	0
Gasoline 1.4 – 2.0 l	PRE ECE	8028.98	480.96	699.7	0.49	0	0	0
	ECE 15/00-01	6518.66	545.5	629.65	0.55	0	0	0
	ECE 15/02	5996.81	519.83	682.62	0.6	0	0	0
	ECE 15/03	6287.54	521.96	682.62	0.6	0	0	0
	ECE 15/04	3891.13	639.59	595.5	0.66	0	0	0
	Euro I	1105.03	100.56	66.46	20.24	0	0	0
	Euro II	751.42	36.2	13.96	20.24	0	0	0
	Euro III	618.82	24.13	9.3	20.24	0	0	0
	Euro IV	375.71	13.07	1.99	20.24	0	0	0
Gasoline > 2.0 l	PRE ECE	6508.72	491.56	567.21	0.39	0	0	0
	ECE 15/00-01	5860.85	618.34	566.11	0.5	0	0	0
	ECE 15/02	4867.48	476.11	554.07	0.49	0	0	0
	ECE 15/03	5103.46	661.96	554.07	0.49	0	0	0
	ECE 15/04	3134.75	596.46	479.74	0.53	0	0	0
	Euro I	1284.48	107.3	74.33	16.19	0	0	0
	Euro II	873.44	38.63	17.84	16.19	0	0	0
	Euro III	719.31	25.75	11.89	16.19	0	0	0
	Euro IV	449.57	13.95	3.72	16.19	0	0	0
Diesel < 2.0 l	Conventional	262.11	201.13	65.03	0.34	83.4	80.07	72.14
	Euro I	244.45	319.35	39.31	0.39	30.56	29.34	26.44
	Euro II	244.45	319.35	39.31	0.39	30.56	29.34	26.44
	Euro III	244.45	245.9	33.41	0.39	22.01	21.13	19.04
	Euro IV	244.45	169.26	27.12	0.39	13.75	13.2	11.9
Diesel > 2.0 l	Conventional	262.11	311.04	65.03	0.34	83.4	80.07	72.14
	Euro I	244.45	319.35	39.31	0.39	30.56	29.34	26.44
	Euro II	244.45	319.35	39.31	0.39	30.56	29.34	26.44
	Euro III	244.45	245.9	33.41	0.39	22.01	21.13	19.04
	Euro IV	244.45	169.26	27.12	0.39	13.75	13.2	11.9
LPG	Conventional	1287.03	747.93	511.25	0	0	0	0
	Euro I	694.61	152.71	136.53	0	0	0	0
	Euro II	472.33	54.98	28.67	0	0	0	0
	Euro III	388.98	36.65	20.48	0	0	0	0
	Euro IV	236.17	19.85	4.1	0	0	0	0

Table 2-11. Emission factors for light duty vehicles [g/GJ].

Engine type	Ecology standard	CO	NO_x	NMVOC	NH_3	TSP	PM_{10}	$PM_{2.5}$
Highway								
Gasoline	Conventional	6054.66	1344.06	195.04	0.72	0	0	0

	Euro I	1213.08	158.92	23.24	30.5	0	0	0
	Euro II	739.98	54.03	5.58	30.5	0	0	0
	Euro III	630.8	33.37	3.25	30.5	0	0	0
	Euro IV	339.66	15.89	1.39	30.5	0	0	0
Diesel	Conventional	311.92	342.74	26.37	0.25	87.39	83.9	75.6
	Euro I	194.93	346.15	29.6	0.28	42.71	41	36.9
	Euro II	194.93	346.15	29.6	0.28	42.71	41	36.9
	Euro III	159.84	290.77	18.35	0.28	28.62	27.47	24.7
	Euro IV	126.7	235.38	6.81	0.28	14.95	14.35	12.9
Rural								
Gasoline	Conventional	2316.18	1188.86	277.84	0.76	0	0	0
	Euro I	279.6	129.74	35.5	32.44	0	0	0
	Euro II	170.56	44.11	8.52	32.44	0	0	0
	Euro III	145.39	27.25	4.97	32.44	0	0	0
	Euro IV	78.29	12.97	2.13	32.44	0	0	0
Diesel	Conventional	358.42	299.25	37.49	0.36	107.73	103.42	93.19
	Euro I	132.09	392.54	42.48	0.4	26.48	25.42	22.91
	Euro II	132.09	392.54	42.48	0.4	26.48	25.42	22.91
	Euro III	108.31	329.74	26.34	0.4	17.74	17.03	15.35
	Euro IV	85.86	266.93	9.77	0.4	9.27	8.9	8.02
Urban								
Gasoline	Conventional	5800.27	518.76	641.71	0.43	0	0	0
	Euro I	1549.64	90.04	59.11	12.91	0	0	0
	Euro II	945.28	30.61	14.19	12.91	0	0	0
	Euro III	805.81	18.91	8.28	12.91	0	0	0
	Euro IV	433.9	9	3.55	12.91	0	0	0
Diesel	Conventional	320.78	650.03	38.14	0.24	68.74	65.99	59.46
	Euro I	151.94	370.88	41.96	0.27	26.66	25.59	23.06
	Euro II	151.94	370.88	41.96	0.27	26.66	25.59	23.06
	Euro III	124.59	311.54	26.02	0.27	17.86	17.15	15.45
	Euro IV	98.76	252.2	9.65	0.27	9.33	8.96	8.07

Table 2-12. Emission factors for heavy-duty vehicles [g/GJ].

Weight	Ecology standard	CO	NO_x	NMVOC	NH_3	TSP	PM_{10}	$PM_{2.5}$
Highway								
3.5 – 7.5 t	Conventional	312.67	621.92	147.76	0.57	36.12	34.68	31.25
	Euro I	171.97	559.72	110.82	0.57	23.48	22.54	20.31
	Euro II	156.34	404.25	103.43	0.57	14.45	13.87	12.5
	Euro III	109.43	282.97	72.4	0.57	10.11	9.71	8.75
	Euro IV	79.73	197.77	50.68	0.57	1.91	1.84	1.66
7.5 – 16 t	Conventional	208.52	530.86	98.54	0.38	46.64	44.77	40.34
	Euro I	114.69	477.78	73.9	0.38	30.32	29.1	26.22
	Euro II	104.26	345.06	68.98	0.38	18.66	17.91	16.14
	Euro III	72.98	241.54	48.28	0.38	13.06	12.54	11.3
	Euro IV	53.17	168.81	33.8	0.38	2.47	2.37	2.14
16 – 32 t	Conventional	157.16	679.98	74.27	0.29	42.72	41.01	36.95
	Euro I	102.16	373.99	55.7	0.29	27.77	26.66	24.02
	Euro II	102.16	305.99	48.27	0.29	10.68	10.25	9.24
	Euro III	71.51	214.19	33.79	0.29	7.48	7.18	6.47
	Euro IV	52.18	149.6	23.62	0.29	1.41	1.35	1.22

> 32 t	Conventional	122.43	806.16	57.85	0.22	35.97	34.53	31.12
	Euro I	79.58	443.39	43.39	0.22	23.38	22.45	20.23
	Euro II	79.58	362.77	37.61	0.22	8.99	8.63	7.78
	Euro III	55.7	253.94	26.32	0.22	6.3	6.04	5.45
	Euro IV	40.65	177.36	18.4	0.22	1.19	1.14	1.03
Rural								
3.5 – 7.5 t	Conventional	522.8	553.87	262.2	0.76	60.65	58.22	52.46
	Euro I	313.68	387.71	196.65	0.76	39.42	37.84	34.1
	Euro II	287.54	304.63	183.54	0.76	24.26	23.29	20.98
	Euro III	201.28	213.24	128.48	0.76	16.98	16.3	14.69
	Euro IV	146.91	148.99	89.94	0.76	3.21	3.09	2.78
7.5 – 16 t	Conventional	317.19	648.41	159.08	0.46	71.67	68.81	62
	Euro I	190.31	453.89	119.31	0.46	46.59	44.72	40.3
	Euro II	174.45	356.63	111.36	0.46	28.67	27.52	24.8
	Euro III	122.12	249.64	77.95	0.46	20.07	19.27	17.36
	Euro IV	89.13	174.42	54.57	0.46	3.8	3.65	3.29
16 – 32 t	Conventional	213.6	897.96	107.13	0.31	58.36	56.03	50.49
	Euro I	128.16	538.78	69.63	0.31	37.94	36.42	32.82
	Euro II	106.8	404.08	64.28	0.31	14.59	14.01	12.62
	Euro III	74.76	282.86	44.99	0.31	10.21	9.81	8.83
	Euro IV	54.47	197.55	31.5	0.31	1.93	1.85	1.67
> 32 t	Conventional	159.1	1002.18	79.8	0.23	46.77	44.9	40.46
	Euro I	95.46	601.31	51.87	0.23	30.4	29.19	26.3
	Euro II	79.55	450.98	47.88	0.23	11.69	11.23	10.11
	Euro III	55.69	315.69	33.51	0.23	8.19	7.86	7.08
	Euro IV	40.57	220.48	23.46	0.23	1.54	1.48	1.34
Urban								
3.5 – 7.5 t	Conventional	754.67	796.58	450.78	0.57	88.6	85.05	76.64
	Euro I	377.34	557.61	338.08	0.57	57.59	55.28	49.81
	Euro II	301.87	398.29	315.54	0.57	35.44	34.02	30.65
	Euro III	211.31	278.8	220.88	0.57	24.81	23.81	21.46
	Euro IV	153.95	195.16	154.62	0.57	4.7	4.51	4.06
7.5 – 16 t	Conventional	423.77	911.1	253.13	0.32	98.67	94.73	85.35
	Euro I	211.89	637.77	189.84	0.32	64.14	61.57	55.48
	Euro II	169.51	455.55	177.19	0.32	39.47	37.89	34.14
	Euro III	118.66	318.89	124.03	0.32	27.63	26.52	23.9
	Euro IV	86.45	223.22	86.82	0.32	5.23	5.02	4.52
16 – 32 t	Conventional	269.51	1041.22	160.98	0.2	74.78	71.78	64.68
	Euro I	148.23	572.67	80.49	0.2	48.6	46.66	42.04
	Euro II	121.28	416.49	72.44	0.2	18.69	17.95	16.17
	Euro III	84.9	291.54	50.71	0.2	13.09	12.56	11.32
	Euro IV	61.99	204.08	35.42	0.2	2.47	2.37	2.13
> 32 t	Conventional	205.19	1134.53	122.56	0.15	60.41	57.99	52.25
	Euro I	112.85	623.99	61.28	0.15	39.26	37.69	33.96
	Euro II	92.33	453.81	55.15	0.15	15.1	14.5	13.06
	Euro III	64.63	317.67	38.61	0.15	10.57	10.15	9.14
	Euro IV	47.19	222.37	26.96	0.15	1.99	1.91	1.72

Table 2-13. Emission factors for buses [g/GJ].

Bus type	Ecology standard	CO	NO_x	NMVOC	NH_3	TSP	PM_{10}	$PM_{2.5}$
Highway								
Coaches	Conventional	179.59	921.71	100.71	0.35	41.16	39.52	35.61

	Euro I	116.74	506.94	75.54	0.35	26.76	25.69	23.14
	Euro II	116.74	414.77	65.46	0.35	10.29	9.88	8.9
	Euro III	81.72	290.34	45.82	0.35	7.2	6.92	6.23
	Euro IV	59.63	202.78	32.03	0.35	1.36	1.3	1.18
Rural								
Coaches	Conventional	216.98	913.47	123.24	0.34	48.39	46.45	41.86
	Euro I	130.19	548.08	80.11	0.34	31.45	30.19	27.21
	Euro II	108.49	411.06	73.95	0.34	12.1	11.61	10.46
	Euro III	75.94	287.74	51.76	0.34	8.47	8.13	7.32
	Euro IV	55.33	200.96	36.23	0.34	1.6	1.53	1.38
Urban								
Urban buses	Conventional	394.57	1174.31	124.13	0.19	53.96	51.8	46.67
	Euro I	197.29	822.02	93.1	0.19	35.07	33.67	30.34
	Euro II	157.83	587.16	86.89	0.19	21.58	20.72	18.67
	Euro III	110.48	411.01	60.83	0.19	15.11	14.5	13.07
	Euro IV	80.49	287.71	42.58	0.19	2.86	2.75	2.47
Coaches	Conventional	317.2	1083.23	190.59	0.18	62.73	60.22	54.26
	Euro I	174.46	595.77	95.3	0.18	40.77	39.14	35.27
	Euro II	142.74	433.29	85.77	0.18	15.68	15.05	13.56
	Euro III	99.92	303.3	60.04	0.18	10.98	10.54	9.5
	Euro IV	72.96	212.31	41.93	0.18	2.07	1.99	1.79

Table 2-14. Emission factors for motorcycles [g/GJ].

Engine type	Ecology standard	CO	NO_x	NMVOC	NH_3	TSP	PM_{10}	$PM_{2.5}$
Highway								
2-stroke > 50 cm³	Conventional	17230.13	78.41	5343.2	1.29	0	0	0
	97/24/EC	20795.8	44.33	4590.39	1.61	0	0	0
4-stroke < 250 cm³	Conventional	23992.76	223.35	716.41	1.4	0	0	0
	97/24/EC	10094.42	295.57	291.08	1.5	0	0	0
4-stroke 250 – 750 cm³	Conventional	17126.12	232.84	697.81	1.42	0	0	0
	97/24/EC	10094.42	295.57	291.08	1.5	0	0	0
4-stroke > 750 cm³	Conventional	13703.09	214.44	811.9	1.24	0	0	0
	97/24/EC	10094.42	295.57	291.08	1.5	0	0	0
Rural								
2-stroke > 50 cm³	Conventional	17975.71	62.06	5925.14	1.41	0	0	0
	97/24/EC	17477.41	31.67	5139.66	1.71	0	0	0
4-stroke < 250 cm³	Conventional	22473.86	206.79	820.34	1.71	0	0	0
	97/24/EC	7800.24	261.69	394.64	1.68	0	0	0
4-stroke 250 – 750 cm³	Conventional	17152.78	200.09	752.53	1.59	0	0	0
	97/24/EC	7800.24	261.69	394.64	1.68	0	0	0
4-stroke > 750 cm³	Conventional	11982.41	176.78	1069.98	1.33	0	0	0
	97/24/EC	7800.24	261.69	394.64	1.68	0	0	0
Urban								
2-stroke > 50 cm³	Conventional	17975.71	62.06	5925.14	1.41	0	0	0
	97/24/EC	17477.41	31.67	5139.66	1.71	0	0	0
4-stroke < 250 cm³	Conventional	22473.86	206.79	820.34	1.71	0	0	0
	97/24/EC	7800.24	261.69	394.64	1.68	0	0	0
4-stroke 250 – 750 cm³	Conventional	17152.78	200.09	752.53	1.59	0	0	0
	97/24/EC	7800.24	261.69	394.64	1.68	0	0	0
4-stroke > 750 cm³	Conventional	11982.41	176.78	1069.98	1.33	0	0	0
	97/24/EC	7800.24	261.69	394.64	1.68	0	0	0

2.2.1.2. Lead (Pb) and other heavy metals emissions

Emissions of lead are estimated by assuming that 75 % of lead contained in the fuel is emitted into air [5]. Then the equation is:

$$E_{Pb,j}^{CALC} = 0.75 \cdot k_{Pb,m} \cdot FC_{jm}^{CALC}, \qquad (2)$$

where, $k_{Pb,m}$ – weight related lead content of gasoline (type m) in [kg/kg fuel]. The emission factor for lead is given in the Table 2-15.

Table 2-15. Emission factor for lead (Pb).

Fuel	k	Emission factor, mg/kg
Gasoline	$1.73 \cdot 10^{-5}$	13

With regard to the emission of other heavy metal species, emission factors provided correspond both to fuel content and engine wear. Therefore it is considered that the total quantity is emitted to the atmosphere (no losses in the engine). Heavy metal emissions depends on metal content in fuel, therefore emissions were calculated according to consumed fuel (Table 2-16). LPG doesn't contain heavy metal; therefore there are no heavy metals emissions from road transport using LPG.

Table 2-16. Heavy metal emission factors for all vehicle categories in [mg/kg fuel] [5].

Category	Cadmium	Copper	Chromium	Nickel	Selenium	Zinc
Road transport	0.01	1.7	0.05	0.07	0.01	1

2.2.1.3. PAH's and other POP's emissions

PAH and dioxins/furans emission factors were taken from [5] reference, PCB – from [6] reference and listed in the Table 2-17. Emission factors were converted to mass per heat value units according to the fuel consumption factors estimated with COPERT IV and inserted into CORINAIR database.

Table 2-17. PAH's and other POP's bulk (hot + cold) emission factors [5].

Species	Emission factors (μg/km)					
	Gasoline PC & LDV		Diesel PC & LDV		HDV	LPG
	Pre Euro I	Euro I & on	DI	IDI	DI	
indeno(1,2,3-c,d)pyrene	1.03	0.39	0.70	2.54	1.40	0.01
benzo(k)fluoranthene	0.30	0.26	0.19	2.87	6.09	0.01
benzo(b)fluoranthene	0.88	0.36	0.60	3.30	5.45	0
benzo(ghi)perylene	2.90	0.56	0.95	6.00	0.77	0.02
fluoranthene	18.22	2.80	18.003	38.32	21.39	1.36
benzo(a)pyrene	0.48	0.32	0.63	2.85	0.90	0.01
PCB's	0.0012	0.0012	0.05	0.05	5.39	0

Dioxins/furans, [ng I-Teq/km]	0.0315	0.0315	0.0015	0.0015	0.0109	0

2.2.1.4. Gasoline evaporation

Gasoline evaporation emissions are estimated according to mileage of separate road transport categories consuming gasoline and number of vehicles consuming gasoline. Mileage of road transport categories was estimated according to statistical fuel consumption data, fuel consumption factors calculated by COPERT III and mileage data estimated by Institute of Transport. NMVOC emission factors were taken from [18] literature (Table 2-18).

Table 2-18. NMVOC emission factors for gasoline evaporation [18].

	NMVOC emission factors	Units
Passenger cars		
Diurnal and hot soak emissions in summer	3642.00	g/vehicle
Diurnal and hot soak emissions in winter	4807.00	g/vehicle
Running losses in summer	0.022	g/km
Running losses in winter	0.006	g/km
Light duty vehicle		
Diurnal and hot soak emissions in summer	3642.00	g/vehicle
Diurnal and hot soak emissions in winter	4807.00	g/vehicle
Running losses in summer	0.022	g/km
Running losses in winter	0.006	g/km
Motorcycles		
Diurnal and hot soak emissions in summer	1457.00	g/vehicle
Diurnal and hot soak emissions in winter	1923.00	g/vehicle
Running losses in summer	0.009	g/km
Running losses in winter	0.002	g/km

2.2.1.5. Tyre, brake wear and road abrasion emissions

Tyre, brake wear and road abrasion emissions are estimated according to mileage of separate road transport categories. Mileage of road transport categories was estimated according to statistical fuel consumption data, fuel consumption factors calculated by COPERT IV and mileage data estimated by Institute of Transport. The resulting mileage data (Table 2-19) is used as activity rates for estimating tyre, brake wear and road abrasion emissions.

Table 2-19. Road transport mileage by categories, [km].

Category	Mileage
Passenger cars	13 008 209 253
Light duty vehicle	3 081 711 323
Heavy duty vehicle and buses	3 120 526 744
Motorcycles	15 511 407
Total	19 225 958 728

TSP, PM_{10} and heavy metal emission factors for tyre, brake wear and road abrasion were taken from [18] literature and reported in Tables 2-20, 2-21, 2-23. $PM_{2.5}$ emission factors were taken from [7] reference and reported in Table 2-22.

Table 2-20. TSP emission factors for tyre, brake wear and road abrasion [18].

Transport category	Emission factor (g/km)		
	Tyre wear	Brake wear	Road abrasion
Motorcycles	0.0028	0.0037	0.0030
Passenger cars	0.0064	0.0073	0.0075
Light duty vehicles	0.0101	0.0115	0.0075
Heavy duty vehicles and buses	0.0270	0.0320	0.0380

Table 2-21. PM_{10} emission factors for tyre, brake wear and road abrasion [18].

Transport category	Emission factor (g/km)		
	Tyre wear	Brake wear	Road abrasion
Motorcycles	0.0028	0.0020	0.0030
Passenger cars	0.0064	0.0033	0.0075
Light duty vehicles	0.0101	0.0052	0.0075
Heavy duty vehicles and buses	0.0270	0.0130	0.0380

Table 2-22. $PM_{2.5}$ emission factors for tyre, brake wear and road abrasion [7].

Transport category	Emission factor (g/km)		
	Tyre wear	Brake wear	Road abrasion
Motorcycles	0.0001	0.0003	0.0016
Passenger cars	0.0003	0.0022	0.0042
Light duty vehicles	0.0003	0.0022	0.0042
Heavy duty vehicles and buses	0.0020	0.0071	0.0209

Table 2-23. Heavy metal fraction of tyre, brake wear and road abrasion TSP emission [18].

Heavy metal	Tyre wear [mg/kg TSP]	Brake wear [mg/kg TSP]	Road abrasion [mg/kg TSP]
As	0.8	10.0	0
Cd	2.6	13.2	1
Cr	12.4	669	40
Cu	174	51112	12
Ni	33.6	463	20
Pb	107	3126	15
Zn	7434	8676	35

2.2.2. Off-road transport

This chapter includes estimation methodology for emissions of off-road transport (mobiles in NFR sectors 1A2f, 1A3a, 1A3c, 1A3d, 1A4c), i.e. railway, air and water transport, also agriculture and constructional machines. Emissions from off-road transport were estimated according to statistical fuel consumption and some statistical transport activity data (i.e. airplane's landing and taking-off number).

A simple methodology for estimating emissions is based on total fuel consumption data, which have to be multiplied by appropriate bulk emission factors. Therefore, the equation to be applied in this case is:

$$E_i = FC \cdot EF_i \tag{3}$$

were E_i - mass of emissions of pollutant i during inventory period; FC - fuel consumption; EF_i - average emissions of pollutant i per unit of fuel used.

SO_2 emission factors were calculating using multiplier proposed in [9] methodology and multiplying it by the fuel sulphur content. The calculation results are listed in Table 2-24.

Table 2-24. Emission factors for SO_2, [kg/GJ].

Fuel	Fuel sulphur content, □	Multiplier	Emission factor
Aviation gasoline	0.01	0.5	0.005
Residual oil	2.2	0.488	1.073

TSP, PM_{10} and $PM_{2.5}$ emission factors of navigation were taken from [8] reference and reported in Table 2-25. Emission factors of other main pollutants were inserted into the emission inventory database directly from the national emission factors database, which was compiled using emission factors proposed in [8] methodology. Emission factors for PM_{10} and $PM_{2.5}$ were calculated according to particle size distribution given in [7] reference (Table 2-26).

Table 2-25. TSP, PM_{10} and $PM_{2.5}$ emission factors for navigation, [g/GJ].

Fuel	TSP	PM_{10}	$PM_{2.5}$
Diesel	28.6	28.3	27.7
Gas-oil	28.6	28.3	27.7
Residual oil	125	123	121

Table 2-26. Particle size distribution, [% PM].

Fuel	PM_{10}	$PM_{2.5}$
Diesel	96	90
Residual oil	99	97
Gasoline, kerosene	99	84

Emissions from airplanes landing and take-off (LTO) of international flights were estimated according to statistical number of take-offs. Separate airplanes models take-offs contributions to total take-offs were taken from flight control centre of Vilnius airport. Take-offs in Vilnius international airport takes 95 % of total take-offs in Lithuania's international airports. Statistical number of take-offs is treated as number of LTO's. Airplane model specific emission factors and fuel consumption factors per LTO were taken from [5] reference and listed in Table 2-27.

Table 2-27. Airplanes emission factors for LTO, [g/LTO]. Airplanes models take-offs contributions to total take-offs are written in brackets.

Airplane model	CO	NO_x	NMVOC	SO_2	Fuel consumption, [kg/LTO]
Boeing 737 (65 %)	11831	8300	666.8	825.4	825.4
Fokker 50 (25 %)	728.1	1268	0	125.7	125.7
Dash 8 (5 %)	1140.2	2427	0	211.7	211.7
Saab 2000 (5 %)	826	1040	35.6	146.7	146.7

Heavy metal emission factors for diesel and gasoline engines, also from residual fuel oil and distillate oil fuel (gas-oil) used in navigation was taken from [5] reference (Table 2-28).

Table 2-28. Heavy metal emission factors, [g/t].

Pollutant	Emission factors			
	Diesel	Gasoline	Distillate oil fuel (gas-oil)	Residual oil
As	0	0	0.05	0.5
Cd	0.01	0.01	0.01	0.03
Cr	0.05	0.05	0.04	0.2
Cu	1.7	1.7	0.05	0.5
Hg	0	0	0.05	0.02
Ni	0.07	0.07	0.07	30
Pb	0	0	0.1	0.2
Se	0.01	0.01	0.2	0.4
Zn	1	1	0.5	0.9

POP's emission factors were taken from [5] reference, in which emission factors from diesel and four-stroke petrol engines are proposed (Table 2-29). These emission factors are used for all off-road transport consuming diesel or gasoline.

Table 2-29. POP's emission factors for diesel and four-stroke gasoline engines, [µg/kg].

Substance	Diesel engines	Four-stroke gasoline engines
Benzo(b)fluoranthene	50	40
Benzo(a)pyrene	30	40

2.3. Fugitive emissions from fuels

Fugitive NMVOC emission from crude oil extraction and gasoline distribution were estimated (NFR sectors 1B2). Emissions from oil storage and handling at petroleum refining plant were reported according to Stock Company "Mažeikių Nafta" submission. Fugitive NMVOC emission from crude oil distribution was estimated according to data on extracted statistical oil and emission factors derivated from [18] reference. Fugitive NMVOC emission from gasoline distribution was estimated according to statistical gasoline consumption (including distribution losses) and emission factors derivated from [18] reference. In reference [18] technical properties and compliance to Directive 94/63/EC of tanks in Lithuania were evaluated and NMVOC emissions in 2006 year were estimated. Derivated emission factors from [18] reference are listed in Table 2-30.

Table 2-30. Fugitive NMVOC emission factors.

	Fuel	Losses from storage [g/t fuel]	Losses from loading [g/t fuel]
Marine terminal "Butinge"	Crude oil	48.51	5279.35
Terminals	Gasoline	1.52	3964.31
	Diesel	19.36	21.31
Service stations	Gasoline	-	1857.49
	Diesel	-	96.95

3. INDUSTRIAL PROCESSES

The economic structure of Lithuania has gone through noticeable changes. During the period of 1992–1994, the share of industry in the GDP dropped from 35.5 % to 20.4 %, while the share of trade in the GDP structure grew from 4.5 to 23.5 %. Since 1992, economic recession resulted in the reduction of energy consumption, but the latter was slower than the decline in GDP. Therefore, energy demand of the national economy during this period was growing in relative terms. It is evident that the production output varied between different industries. As the most serious decline was observed in the production of electronic equipment, machinery, metalworking, the likelihood of reaching the former levels of production is quite low for these sectors. Since 1991, Lithuania's export to the western countries has increased from 5.1 % to 54.6 % of total exports. It should be noted that the share of imports from these countries into Lithuania has also increased from 9.8 % to 67.1 % of the total imports. The main trading partners of Lithuania are Russia, Germany, Belarus, Latvia, Ukraine, the Netherlands, Poland, and Great Britain.

This chapter covers emissions from industrial processes (NFR sectors 2A, 2B, 2D). The food industry in Lithuania is dominated by meat production, diary and fish products. The fishing industry is concentrated in Klaipėda, and in 1993 this industry was the largest in the food sector. High prices of the primary food products have contributed to the decline of food industry.

Emissions from lime production, organic chemicals (i.e. polyethylene, polyvinylchloride, polypropylene, polystyrene) production and food and beverages (i.e. bear, wine, spirit, bread, cake, meat, fat, animal feed) production were estimated according to statistical production of commodities. Emissions from cement, sulphur from petroleum, sulphur acid, nitric acid, ammonia, ammonium nitrate, urea, phosphate fertilizer and formaldehyde production were reported according to submissions of large point sources.

Emissions from lime production, organic chemicals production and food and beverages production were estimated using emission factors proposed by [5] reference. Emission factors are listed in Tables 3-1, 3-2.

Table 3-1. TSP emission factor from industrial process, [g/Mg production].

Process	TSP emission factor
Lime production	2967

Table 3-2. NMVOC emission factors from organic chemicals and food production, [g/Mg production].

Process	NMVOC emission factor
Polyethylene production	5700
Polyvinylchloride production	1500
Polypropylene production	3000
Polystyrene production	2600
Wine production [g/m^3]	350
Bear production [g/m^3]	350
Spirit production [g/m^3]	150000
Animal feed production	1000

Bread production	4500
Cake production	1000
Fat (margarine) production	10000
Meat, fish, poultry production	300
Sugar production	10000

4. AGRICULTURE

This chapter covers emissions from manure management, direct soil emissions and application of mineral fertilizer (NFR sectors 4B, 4D1 and 4D1i). Emissions from manure management were estimated according to statistical livestock and poultry number. Direct emissions from soil were estimated according to statistical data on N-fertilizers produced and sold in Lithuania. Number of livestock and poultry, also mass of N-fertilizers used are reported in Excel template Table IV 2E.

Agriculture has always been a very important sector of Lithuania's economy, and like other economic sectors, it has undergone sudden changes and reforms since the country achieved independence. These changes include land privatisation and the introduction of market-based prices, which influenced a significant drop in agricultural production in 1992 and 1993.

4.1. Manure management

Number of livestock and poultry was taken from Department of Statistics and reported in Table 4-1 [1]. NH3 emission factors for livestock and poultry manure management was taken from literature [5] and used in estimations (Table 4-2).

Table 4-1. Number of livestock and poultry, [heads].

Livestock/poultry	Heads
Dairy cows	376200
Cows	404500
Sows	62300
Fattening pigs	860900
Sheep	43300
Goats	19700
Horses	860900
Broilers	4289832
Laying hens	4309626
Other poultry	1275366

Table 4-2. Manure management NH_3 emission factors, [g/head].

Livestock/Poultry	NH_3 emission factor
Dairy cows	29700
Other cattle	14800
Sheep	1340
Goats	1340
Horses	8200
Fattening pigs	6630
Sows	16430
Broilers	280
Laying hens	370
Other poultry	920

4.2. Direct soil emission

Direct NH_3 emission from soil was estimated according to statistics of produced and sold amount of N-fertilizers in Lithuania. It is not likely that imported N-fertilizers are used in Lithuanian agriculture as N-fertilizers are produced in Lithuania and feeds Lithuanian marked and great part of them are exported to European countries. It is assumed, that mass of N-fertilizers sold is equal to mass of N-fertilizers used in agriculture. NH_3 emission factor is taken from [5] reference (emission factor for nitrogen solution was taken) and used in estimations. The result is reported in Table 4-3.

Table 4-3. Direct soil NH_3 emission.

	N-fertilizer used, [Mg N]	Emission factor, [g NH_3/Mg N]
Urea	4795.292	150000
Urea & ammonium nitrate	15806.965	80000
Other N fertilizer	17837.553	20000

4.3. Application of Mineral Fertilizer

The emission factors for the simple methodology are provided in Table 4.4. These are based largely on the estimates of [12-14].

Table 4-4. Simpler methodology estimates of total NH3 emissions from cultures due to fertilizer volatilization, foliar emissions and decomposing vegetation (second column). The estimates are compared with other literature values. Values are kg NH3-N volatilized per kg of N in fertilizers applied.

Fertilizer type	Present simpler methodology to apply
Estimates from	fertilizer and plants
Ammonium sulphate	0.08
Ammonium nitrate	0.02
Calcium ammonium nitrate	0.02
Anhydrous ammonia	0.04
Urea	0.15
Nitrogen solution (mixed urea and ammonium nitrate)	0.08
Combined ammonium phosphates (generally diammonium phosphate)	0.05
Mono-ammonium phosphate	0.02
Di-ammonium phosphate	0.05
Other complex NK, NPK fert	0.02

To calculate NH3 emissions from fertilized cultures in a country, the use of each fertilizer type (expressed as mass of fertilizer-N used per year), is multiplied by the appropriate emission factor, and the emissions for the different fertilizer types summed.

5. SOLVENT AND OTHER PRODUCT USE

NMVOC emission from industrial and non-industrial paint application, metal degreasing, application of glues and adhesives, use of domestic solvent were estimated (NFR sector 3). Emission from solvent and other product use were estimated according to number of population and NMVOC emission factor in [g/inhabitant] units given in [5]. Derived and used in estimation NMVOC emission factors are listed in Table 5-1.

Table 5-1. Solvent and other product use NMLOJ emission factors, [g/inhabitant].

Activity	NMVOC emission factor
Industrial paint application	4500
Non industrial paint application	400
Metal degreasing	640
Application of glues and adhesives	600
Domestic solvent use	800

6. OTHER SOURCES AND SINKS

6.1 Biogenic emission

There are four major factors controlling natural BVOC emissions: landscape average (species-specific) emission potential ε (□g $g^{-1}h^{-1}$), foliar biomass density D (g (dry weight) m^{-2}), and environmental correction factor γ (nondimensional). Emission fluxes (□g m^{-2} h^{-1}) can then be modeled by:

$$F = \varepsilon D \gamma, \qquad (1)$$

Environmental correction factor for isoprene and monoterpene

The environmental correction factor for isoprene emissions is [16]:

$$\gamma_{ISO} = C_T C_L\,, \qquad (2)$$

here C_T is the temperature correction and C_L is the light correction.
The light correction has the form:

$$C_L = \frac{\alpha C_{L1} L}{\sqrt{1+\alpha^2 L^2}}\,, \qquad (3)$$

here L is the photosynthetically active photon flux density (PPFD), µmol photons m^{-2} s^{-1}, $\alpha = 0.0027$ and $C_{L1} = 1.066$ are empirical coefficients.
The temperature correction is:

$$C_T = \frac{\exp(\dfrac{C_{T1}(T - T_S)}{RT_S T}}{C_{T3} + \exp(\dfrac{C_{T2}(T - T_M)}{RT_S T}}, \tag{4}$$

here T is the leaf temperature in K, T_S *is* the leaf temperature under standard conditions (303.15 K), R is the universal gas constant, C_{T1} = 95 000 J mol^{-1}, C_{T2} = 230 000 J mol^{-1}, C_{T3} = 0.961, and T_M = 314 K are empirical coefficients given by [17].

The environmental correction for monoterpene emissions is:

$$\gamma_{TERP} = \exp(\beta(T - T_S)), \tag{5}$$

here β = 0.09 C^{-1} is an empirical coefficient.
This correction factor is also generally used for other VOCs (Oxygenated volatile organic compounds (OVOCs)), because experimental data on the OVOC emissions are still too scarce to facilitate the development of specific emission algorithms.

Table 6-1. Average values of integrated environmental correction factors, G-iso and G-mts for 6 and 12 month growing seasons (unit= hours).

Γ-mts = Γ-ovoc		Γ□iso	
6-month	12-month	6-month	12-month
675	813	516	613

Table 6-2. Land use emission factors and area [g/ha] [19].

Land cover category	Area, [ha]	NMVOC emission factors, [g/ha]
Urban	7488	898.69
Dry crop	2223305	2366.74
Irrigated crop	828061	3952.09
Crop grass	428134	3098.44
Crop wild land	522490	19594.06
Grassland	880	2495.47
Shrub land	224026	17875.26
Shrub grass	3591	36192.32
Deciduous forest	413773	53218.23
Coniferous forest	724834	84671.95
Mix forest	719636	52248.64

6.2 Forest and Other Vegetation Fires

Emissions are obtained in a two-step process:
(i) Estimate the emissions of carbon from the burned land.
(ii) Estimate the emissions of other trace gases using emission ratios with respect to carbon.

The basic calculation of the mass of carbon emitted, M(C), follows the methodology of [18]:

$$M(C) = 0.45 \times A \times B \times \alpha \times \beta, \quad (1)$$

where:

0.45 is the average fraction of carbon in fuel wood, "A" is the area burnt (m^2), "B" is the average total biomass of fuel material per unit area (kg/m^2), " α " is the fraction of the above average above-ground biomass relative to the total average biomass B, " β " is the burning efficiency (fraction burnt) of the above-ground biomass.

The "α" and "β" fractions assumed for this biome are derived from the Spanish CORINAIR 1990-93 inventories. Values of B, "α" and "β" are given for relevant biomes in Table 6.3.

Table 6-3. Values of B, "α" and "β".

	Biomass (kg/m^2)	Aboveground biomass fraction	Burning effeciency
	B	"α"	"β"
Boreal forest	25	0.75	0.2

Table 6-4. Fired forest area and emission factors (g/ha) for emissions [20].

Fired forest area, [ha]	Pollutant	Emission factor, [g/ha]
112.4	CO	3881000
	NH3	30000
	NMLOJ	354000
	NOX	135000
	SO2	30000

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ANNEX 1. 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	TSP
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	TSP
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	TSP
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	TSP
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	TSP
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	TSP
1.	Power plants								
2.	Heat boiler houses								
3.	Industry								
4.	Small companies								
5.	Households								
6. 6.1.	Transport Road transport	73	S = 0.05% 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: **KEROSENE** Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	TSP
1.	Power plants								
2.	Heat boiler houses			0.1	0.1				
3.	Industry	74	0.022	0.100	0.100	0.0020	0.0015	0.002	0.011
4.	Small companies	74	0.022	0.050	0.190	0.0020	0.0015	0.002	0.011
5.	Households	74	0.022	0.050	0.190	0.0020	0.0015	0.002	0.011
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport	74	0.022	0.326	0.326	0.0010	0.0015	0.059	0.016
6.5.	Agricultural machines								

No.	Fuel use category	Fuel type: **OTHER PROCESSED FUEL** Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	TSP
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								

No.	Fuel use category	Fuel type: **COMBUSTIBLE AUXILIARY ENERGY RESOURCES** Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMVOC	TSP
1.	Power plants	78	0.468xS%	0.24	0.13	0.0035	0.0025	0.0035	0.25xAs%
2.	Heat boiler houses	78	0.468xS%	0.19	0.17	0.0035	0.0025	0.0035	0.25xAs%
3.	Industry	78	0.468xS%	0.15	0.20	0.0032	0.0025	0.0032	0.25xAs%
4.	Small companies	78	0.468xS%	0.15	0.20	0.0032	0.0025	0.0032	0.25xAs%
5.	Households	78	0.468xS%	0.15	0.30	0.0030	0.0025	0.0030	0.25xAs%
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: CRUDE OIL** Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMLOJ	TSP
1.	Power plants	78	0.488xS%	0.15	0.13	0.0015	0.002	0.0015	0.249xAs%
2.	Heat boiler houses	78	0.488xS%	0.15	0.15	0.0015	0.002	0.0015	0.249xAs%
3.	Industry	78	0.488xS%	0.1	0.19	0.0015	0.002	0.0015	0.249xAs%
4.	Small companies	78	0.488xS%	0.05	0.2	0.0015	0.002	0.0015	0.249xAs%
5.	Households	78	0.488xS%	0.05	0.3	0.0015	0.002	0.0015	0.249xAs%
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines	78	0.488xS%	1.171	0.468	0.0094	0.002	0.178	0.249xAs%

No.	Fuel use category	Fuel type: PEAT Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMLOJ	TSP
78	Power plants	102	0.3	0.3	0.032	0.032	0.004	0.048	0.164xAs%
2.	Heat boiler houses	102	0.3	0.3	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	0.14	0.004	0.13	0.164xAs%
5.	Households	102	0.3	0.141	4.3	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								

No.	Fuel use category	Fuel type: OTHER NATURAL FUEL Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMLOJ	TSP
78	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	0.1	2.5	0.196	0.003	0.23	0.17xAs%
5.	Households	102	0.18	0.05	5	0.4	0.003	0.6	0.17xAs%
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: HEAVY FUEL OIL Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMLOJ	TSP
78	Power plants	78	0.488xS%	0.24	0.13	0.0035	0.0025	0.0035	0.249xAs%
2.	Heat boiler houses	78	0.488xS%	0.19	0.17	0.0035	0.0025	0.0035	0.249xAs%
3.	Industry	78	0.488xS%	0.15	0.2	0.0032	0.002	0.0032	0.249xAs%
4.	Small companies	78	0.488xS%	0.15	0.2	0.0032	0.0025	0.0032	0.249xAs%
5.	Households	78	0.488xS%	0.15	0.3	0.003	0.0025	0.003	0.249xAs%
6.	Transport								
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport	78	0.488xS%	1.46		0.002		0.0648	0.260xAs%
6.4.	Air transport								
6.5.	Agricultural machines								

No.	Fuel use category	Fuel type: DIESEL FUEL OIL Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMLOJ	TSP
			S=0.2 % S=0.05%						
78	Power plants	74	0.094/0.023	0.15	0.13	0.0015	0.002	0.0015	0.0237
2.	Heat boiler houses	74	0.094/0.023	0.15	0.15	0.0015	0.002	0.0015	0.0237
3.	Industry	74	0.094/0.023	0.1	0.15	0.0015	0.002	0.0015	0.0237
4.	Small companies	74	0.094/0.023	0.05	0.2	0.0015	0.002	0.0015	0.0237
5.	Households	74	0.094/0.023	0.05	0.3	0.0015	0.002	0.0015	0.0237
6.	Transport								
6.1.	Road transport	74	0.094/0.023	0.534	0.57	0.0033	0.004	0.113	0.1012
6.2.	Railway transport	74	0.094/0.023	1.1	0.47	0.005	0.003	0.225	0.1012
6.3.	Water transport	74	0.094/0.023	1.16	0.258	0.003	0.003	0.111	0.1012
6.4.	Air transport								
6.5.	Agricultural machines	74	0.094/0.023	1.171	0.468	0.0094	0.002	0.178	0.1012

No.	Fuel use category	Fuel type: AVIATION GASOLINE Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMLOJ	TSP
78	Power plants								
2.	Heat boiler houses								
3.	Industry								
4.	Small companies								
5.	Households								
6.	Transport		S=0.01%						
6.1.	Road transport								
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport	72	0.005	0.196	1.268	0.0869	0.002	0.8182	0.0116
6.5.	Agricultural machines								

No.	Fuel use category	Fuel type: LIQUEFIED PETROLEUM GAS Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMLOJ	TSP
78	Power plants								
2.	Heat boiler houses	65		0.16	0.01	0.0025	0.0015	0.0025	
3.	Industry	65		0.16	0.01	0.0025	0.0015	0.0025	
4.	Small companies	65		0.1	0.041	0.0025	0.0015	0.0025	
5.	Households	65		0.1	0.05	0.001	0.001	0.0021	
6.	Transport								
6.1.	Road transport	65		0.898	1.61	0.0192	0.002	0.3585	
6.2.	Railway transport								
6.3.	Water transport								
6.4.	Air transport								
6.5.	Agricultural machines								

No.	Fuel use category	Fuel type: OTHER PRODUCTS OF REFINERY Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMLOJ	TSP
78	Power plants	74	0.468xS%	0.15	0.13	0.0015	0.002	0.0015	0.024
2.	Heat boiler houses	74	0.468xS%	0.15	0.15	0.0015	0.002	0.0015	0.024
3.	Industry	74	0.468xS%	0.1	0.19	0.0015	0.002	0.0015	0.024
4.	Small companies	74	0.468xS%	0.05	0.2	0.0015	0.002	0.0015	0.024
5.	Households	74	0.468xS%	0.05	0.3	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								

No.	Fuel use category	Fuel type: SHALE OIL Emission factor, kg/GJ							
		CO_2	SO_2	NO_x	CO	CH_4	N_2O	NMLOJ	TSP
78	Power plants	74	0.37	0.15	0.13	0.0015	0.002	0.0015	0.024
2.	Heat boiler houses	74	0.37	0.15	0.15	0.0015	0.002	0.0015	0.024
3.	Industry	74	0.37	0.1	0.19	0.0015	0.002	0.0015	0.024
4.	Small companies	74	0.37	0.05	0.2	0.0015	0.002	0.0015	0.024
5.	Households	74	0.37	0.05	0.3	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 %