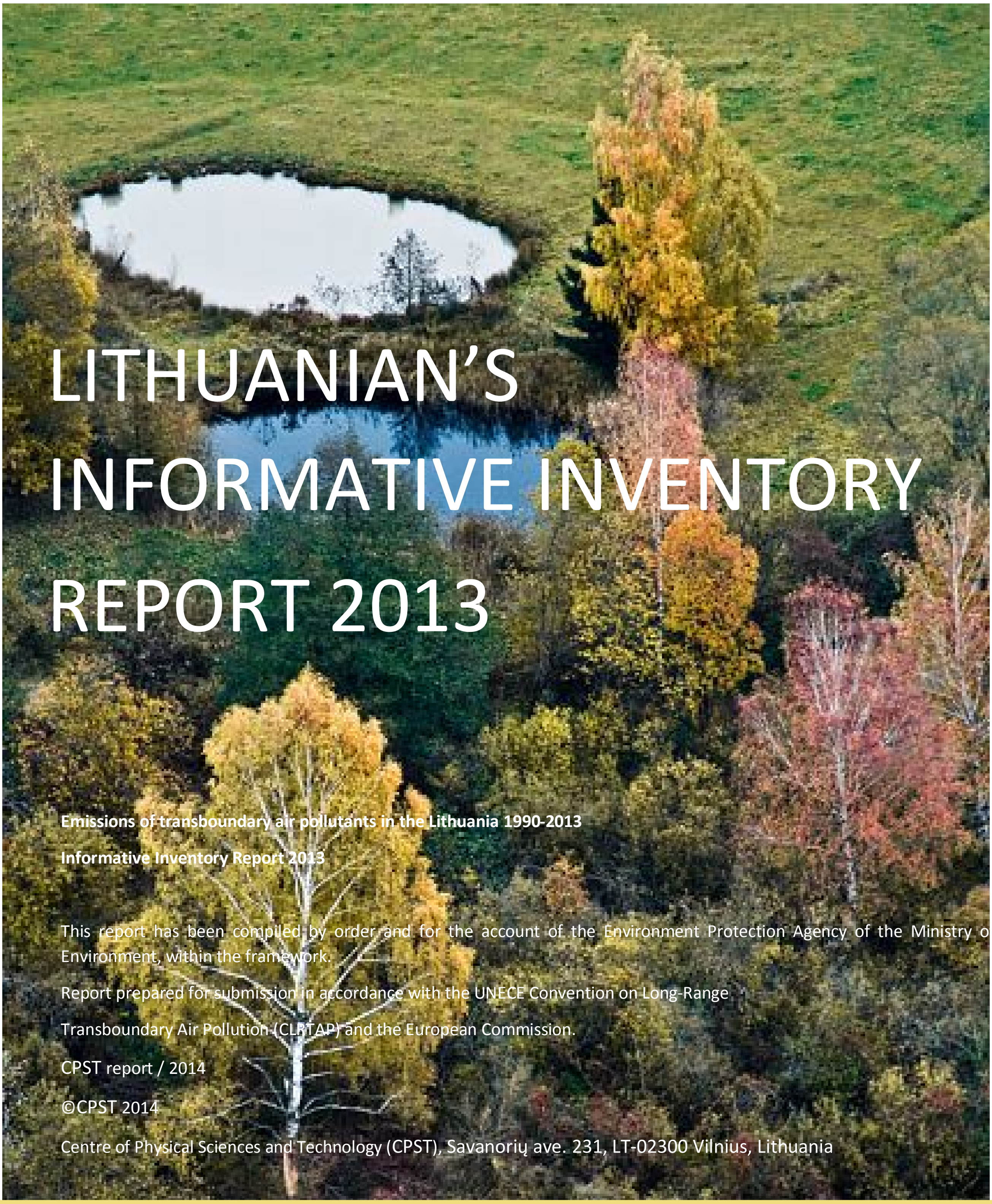

LITHUANIAN'S INFORMATIVE INVENTORY REPORT 2013

Emissions of transboundary air pollutants in the Lithuania 1990-2013

Informative Inventory Report 2013

This report has been compiled by order and for the account of the Environment Protection Agency of the Ministry of Environment, within the framework.

Report prepared for submission in accordance with the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP) and the European Commission.

CPST report / 2014

Centre of Physical Sciences and Technology (CPST), Savanorių ave. 231, LT-02300 Vilnius, Lithuania

Contact: Scientific Report from Centre of Physical Sciences and Technology (CPST), Savanorių ave. 231, LT-02300 Vilnius, Lithuania. Fax: (+370 5) 260 231. Tel. 8 (682) 62087.

Cover Photo: Kazys Mikalauskas

CONTENT

List of Figures

List of Tables

Units

g Gramme
g I-Teq Gramme International Toxic Equivalent
Gg Gigagramme, 10^9 gramme
GJ Gigajoule, 10^9 joule
GWh Gigawatt hour
kg Kilogramme, 10^3 gramme
kPa Kilopascal, 10^3 Pa
Mg Megagramme, 10^6 gramme
mg Milligramme, 10^{-3} gramme
µg Mikrogramme, 10^{-6} gramme
MJ Megajoule, 10^6 joule
ng Nanogramme, 10^{-9} gramme
TJ Terajoule, 10^{12} joule
PJ Petajoule, 10^{15} joule

Abbreviations

CORINAIR – The Core Inventory of Air Emissions in Europe
SBL – Central Statistical Bureau of Lithuania
EDR – Emission Data Report
EMEP – Co-operative Programme for Monitoring and Evaluation od the Long Range Transmission of Air Pollutants in Europe
EMEP/CORINAIR - Atmospheric emission inventory guidebook, Cooperative Programme for Monitoring and Evaluation on the Long Range Transmission of Air Pollutants in Europe, The Core Inventory of Air Emmisions in Europe;
EMEP/EEA 2009 - The EMEP/EEA air pollutant emission inventory guidebook;
GHG – Greenhouse GasesIPCC – Intergovernmental Panel on Climate Change
IPCC 1996 – Revised 1996 IPCC Guidelines for National Greenhouse gas Inventories (1997)
IPCC GPG 2000 – IPCC Good Practice Guidance and Uncertainty management in national Greenhouse Gas Inventories (2000)
MoE - Ministry of the Environmental Protection
NCV –Net calorific value
NFR – Nomenclature For Reporting
OECD – Organisation for Economic Co-operation and Development
UN – United Nations
UNFCCC – United Nations Framework Convention on Climate Change
Tier 1 – A method using readily available statistical data on the intensity of processes (activity rates) and default emission factors. These emission factors assume a linear relation

between the intensity of the process and the resulting emissions. The Tier 1 default emission factors also assume an average or typical process description. This method is the simplest method, has the highest level of uncertainty and should not be used to estimate emissions from key categories.

Tier 2 – is similar to Tier 1 but uses more specific emission factors developed on the basis of knowledge of the types of processes and specific process conditions that apply in the country for which the inventory is being developed. Tier 2 methods are more complex, will reduce the level of uncertainty, and are considered adequate for estimating emissions for key categories.

Pollutants

As – arsenic
Cr – chromium
Cd – cadmium
Cu – copper
CO – carbon monoxide
Hg – mercury
HM – heavy metals
SO_2 – sulphur dioxide
NH_3 – ammonia
Ni – nickel
BC – black carbon
NMVOC – non-methane volatile organic compounds
NO_2 – nitrogen dioxide
Se – Selenium
NOx – nitrogen oxides
Pb – lead
DIOX – dioxins
TSP – total suspended particulates
PM2.5 – particulate matter, particle size smaller than 2.5 µm
PM10 – particulate matter, particle size smaller than 10 µm
POP – persistent organic pollutants
Zn – zinc
PAHs – polyaromatic hydrocarbons
HCB – hexachlorobenzene

Notation keys

IE Included elsewhere – Emissions for this source are estimated and included in the inventory but not presented separately for this source (the source where included is indicated).

NA Not applicable – The source exists but relevant emissions are considered never to occur. Instead of NA, the actual emissions are presented for source categories where both the sources and their emissions are well-known due to availability of bottom-up data (i.e. mainly in the energy and industrial processes sectors).

NE Not estimated – Emissions occur, but have not been estimated or reported.

NO Not occurring – A source or process does not exist within the country.

C Confidential information – Emissions are aggregated and included elsewhere in the inventory because reporting at a disaggregated level could lead to the disclosure of confidential information.

NR Not relevant - According to paragraph 9 in the Emission Reporting Guidelines, emission inventory reporting should cover all years from 1980 onwards if data are available. However, NR (not relevant) is introduced to ease the reporting where emissions are not strictly required by the different protocols.

EXECUTIVE SUMMARY

Lithuania, as a party to the Convention on Long-range Transboundary Air Pollution (CLRTAP) is required to report annual emission data, projections of main pollutants, activity data and provide an Informative Inventory Report.

This report is Lithuanian's Annual Informative Inventory Report (IIR) due March 15, 2012 to the UNECE-Convention on Long-Range Transboundary Air Pollution (LRTAP). The report contains information on Lithuanian's inventories for 1990-2013 years. The air pollutants reported under the LRTAP Convention are SO_2, NO_X, NMVOC, CO, NH_3, BC, As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn, dioxins/furans, HCB, PAHs, TSP, PM10 and PM2.5.

The annual emission inventory for Lithuania is reported in the Nomenclature for Reporting format.

The issues addressed in this report are: trends in emissions, description of each NFR category, planned improvements and procedures for quality assurance and control.

Information contained in this report is available to the public in Lithuanian.

This report and the NFR tables are available on the Eionet central data repository: http://cdr.eionet.europa.eu/lt/un/UNECE_CLRTAP_LT

1. INTRODUCTION

1.1. NATIONAL INVENTORY BACKGROUND

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, BC and NH_3, particulate matter, various heavy metals and POPs and projection.

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).

Lithuanian's emissions inventory is based on the IPCC 1996/2006, IPCC GPG 2000, EMEP/EEA 2009 and EMEP/EEA 2013 and country specific EF. NFR format is used to prepare inventory for years 1990–2013. To calculate emissions, supplemental locally developed database in Excel format was used for all sectors except Road Transport.

At 5-year intervals, the inventory submissions under CLRTAP should include compilations of emissions for a list of defined large point sources and aggregated sectoral gridded data for the European Monitoring and Evaluation Programme (EMEP) grid cells overlying the national territory. This information is used in EMEP models for evaluating long-range transport of air pollutants and for assessing emission deposition relationships in Europe. Lithuanian's 2014 submission does not contain any update to data for large point sources and sectoral gridded data of emissions on the EMEP grid since the 2010. This Informative Inventory Report (IIR) covering the inventory of air pollutant emissions from Lithuania. The IIR accompanies the emission inventory for 1990-2013.

The reporting of emission projections for SO_2, NO_X, NMVOCs and NH_3 is mandatory every 5 years for Parties to the Gothenburg Protocol and other Parties are encouraged to provide projections for these pollutants. Lithuania provides projections for SO_2, NO_X, NMVOCs and NH_3 in this submission for 2015 and 2020, as they are already prepared in relation to the European Union NEC Directive (EP and CEU, 2001).

1.2. 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 D1-85. 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 1990-2013 was prepared by the expert team from Center for Physical sciences and Technology in co-operation with Air Division specialists, 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.

1.3. THE PROCESS OF INVENTORY PREPARATION

The national database contains data for point and diffuse sources of emissions. The emission inventory for the period of 1990–2007 is based on data pertaining to the large point sources and area sources. In order to accumulate data on point sources, the EPA ask operators of large point sources directly send their annual air pollution reports. Data are presented on each source of pollution and on the facility as a whole. Data from enterprises that have a pollution permit is reported to EPA. Each facility submits data on the fuel consumption. 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 (Fig. 1-1).

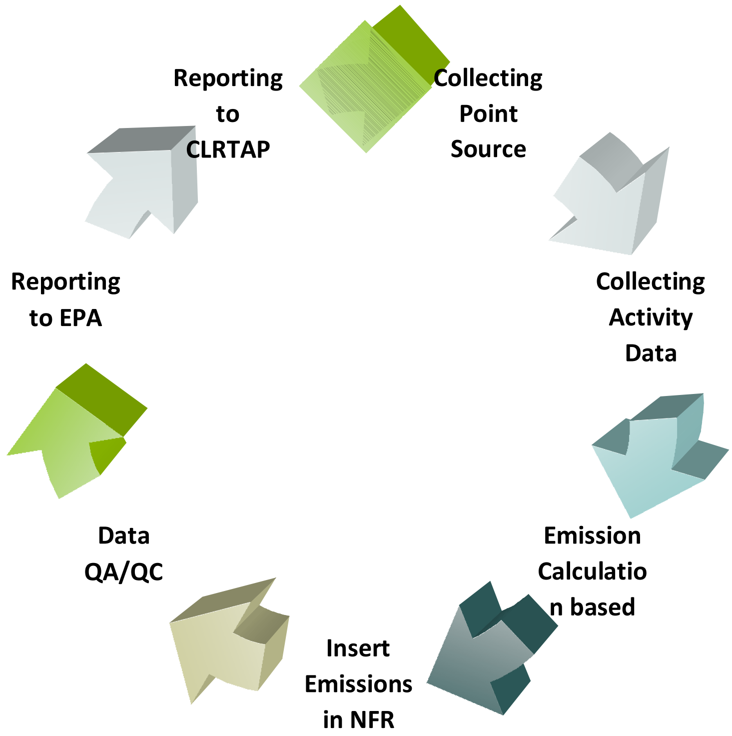

FIGURE 1.3-1. DATA MANAGEMENT AND REPORTING

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 2009/2013. All data collected together with emission estimates were organised in database, where data sources are well documented for future reconstruction of the inventory.

With regard to the calculation of emissions from road transport, we are using the COPERT 4.10 methodology and emission factors. Total emissions are calculated on the basis of the combination of firm technical data and activities data (e.g. number of vehicles, annual mileage per vehicle, average trip, speed, fuel consumption, and monthly temperatures). Meteorological data is provided by the Meteorological and Hydrological Institute.

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 Excel database management system; The EPA annually submits inventory reports to the European Commission secretariat.

1.4. Work plan for preparation and submission of National LRTAP inventory

TABLE 1.4-1 WORK PLAN FOR PREPARATION

Activity	Responsible organization	Deadline
Updated QA/QC plan	EPA, CFST	July
Data collection - sending of official letters to data providers; Methods development; QC procedures, data archiving	EPA, CFST	September - October
QC procedures, data archiving	EPA	November
Compilation of the draft IIR and sending it to EPA	CFST	December
Comments from EPA and others to EPA (QA)	EPA, other institutions	By 15 December
Submission of NFR tables to European Commission	EPA	By 15 February
Submission of IIR to European Commission	EPA	By 15 March
Finalisation of archiving procedures	CFST, EPA	June

<u>Potential problems that might hinder timely implementation of the planned improvements and QA/QC activities are:</u>

- Lack of institutional capacities;

- Lack of sectoral expert knowledge.

It is expected that experts will increase their knowledge during the review.

1.4.1. Completeness analysis

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

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 (Tables 1-2 - 1-5).

TABLE 1.4-2 BASIS FOR ESTIMATING EMISSIONS FROM MOBILE SOURCES.

NFR09 code	Description	Fuel sold	Fuel used
1 A 3 a i (i)	International aviation (LTO)	X	
1 A 3 a i (ii)	International aviation (Cruise)	X	
1 A 3 a ii (i)	1 A 3 a ii Civil aviation (Domestic, LTO)	X	
1 A 3 a ii (ii)	1 A 3 a ii Civil Aviation (Domestic, Cruise)	X	
1A3b	Road transport	X	
1A3c	Railways	X	
1A3di (i)	International maritime navigation	X	
1A3di (ii)	International inland waterways	X	
1A3dii	National navigation	X	
1A4ci	Agriculture	X	
1A4cii	Off-road vehicles and other machinery	X	

1A4ciii	National fishing	X	
1 A 5 b	Other mobile (Including military)	X	

1.5. KEY SOURCE ANALYSIS

The lists of the Key category analysis (KCA) emission sources that contributed to 80 % of the total national emissions are reported. The Key category analysis (KCA) for years 1990 and 2013 was done by experts according to EMEP/EEA 2013 Level assessment. According to EMEP/EEA 2013 Guidelines, key categories are emission sources which contribute to 80 % of the total national emissions. The KCA was performed for each reported pollutant separately. The results of the Key source analysis are given in Table 1-6. NFR codes of Key source categories are listed in the second columns of Table 1-6 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).

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 point sources information system contains data that is reported by the facilities that have a pollution permit. Each facility submits data on the emissions of polluting substances together with data regarding fuel burnt, used solvents, liquid fuel distribution, etc. Data and process SNAP code are presented on each source of pollution and on the facility. The owners of point sources directly fill their calculated or measured annual emissions into the report.

With regard to the calculation of emissions from road transport, we are using the COPERT 4 methodology and emission factors.

TABLE 1.5-1 KEY SOURCE ANALYSIS FOR MAIN POLLUTANTS 2013

Component	Key categories (Sorted from high to low from left to right)							Total (%)
SOx	1B2aiv (31.3%)	1A4bi (16.8%)	1A1a (16.5%)	1A4ai (11.7%)	2B10a (9.7%)			86.1
NOx	1A3biii (46.0%)	1A3bi (10.3%)	1A1a (7.7%)	1A3c (6.5%)	1A4bi (4.5%)	1A2f (4.5%)	1A3aii(i) (3.3%)	82.8
NH3	3Da1 (30.1%)	3B1a (28.2%)	3B3 (13.8%)	3B1b (12.0%)				84.1
NMVOC	2D3d (21.0%)	1A4bi (19.7%)	1B2aiv (12.5%)	2D3a (12.3%)	2H2 (7.6%)	1A1a (5.3%)	2D3e (3.3%)	81.7
CO	1A4bi (69.7%)	1A3bi (9.9%)	1A1a (4.8%)					84.4
TSP	1A4bi (79.1%)	3B3 (5.5%)						84.6
PM10	1A4bi (78.7%)	1A3biii (4.2%)						83.0
PM2.5	1A4bi (84.8%)							84.8
Pb	1A3bi (26.1%)	1A4bi (25.0%)	1A3bvi (9.2%)	1A1a (8.6%)	1A3c (6.7%)	1A4ai (5.1%)		80.8
Hg	1A2f (23.4%)	1A1a (18.0%)	1A4bi (13.9%)	2K (12.9%)	5C1biii (10.2%)	1A3c (8.6%)		86.9
Cd	1A4bi (68.7%)	1A2gviii (8.6%)	1A1a (7.9%)					85.2
DIOX	1A4bi (85.4%)							85.4
PAH	1A4bi (91.6%)							91.6
HCB	1A1a (73.6%)	1A2gviii (13.5%)						87.1

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 1-7). As a result, we assessed usage of notation key 'NE' influence to the key source analysis by main pollutants.

TABLE 1.5-2 CONTRIBUTION OF NOT ESTIMATED SOURCES EMISSION TO NATIONAL **TOTAL**

Pollutant	Relative contribution, [%]
SO_2	1
NO_x	1
NMVOC	5
CO	0.5
NH_3	7
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.

1.6. RECALCULATIONS AND OTHER CHANGES

Based on in-depth review of emission inventories submitted under the UNECE LRTAP Convention and EU National Emissions Ceilings Directive major renewals in calculations were applied. Correction of activity data and sulphur/lead content in fuels was done 1990-2013. Emission factors were reviewed and corrected. Majority of activity data within all sectors were corrected according NATIONAL GREENHOUSE GAS EMISSION INVENTORY REPORTS – CRF. Main changes occurred for NMVOC in 1B2aiv Refining/storage sector. Emissions of NMVOC was evaluated based on Tier 1, i.e. NMVOC EF was estimated as the emissions reported by EU-27 to E-PRTR for the year 2010 divided by the amount of 'Transformation input in Refineries' in 2010 provided by Eurostat (Supply, transformation, consumption - oil - annual data [nrg_102a]).

1.7. QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The following Quality control (QA/QC) activities were carried out in the inventory preparation process:

- Processing;
- Handling,
- Documentation;
- Recalculations;
- Cross checking.

Lithuanian's **QA/QC plan** (Fig. 1.1.) consists of:

- Data suppliers arrangement (suppliers of data, reviewers, recipients, other inventory compiling institutes):
- Lithuanian inventory was reviewed under stage 3 review in 2013 by the EMEP emission centre CEIP acting as review secretariat. The results are available centre CEIP home page (http://www.ceip.at/ms/ceip_home1/ceip_home/review_proces_intro/review_2013/#c214824).
- Data collection: includes both point sources emissions and diffuse sources activity data collection. Before using activity data common statistical quality checking related to the assessment of trends has been carried out. Lithuania is using 17 point sources data which is checked and validated by local environmental departments.
- Inventory compilation: before submitting data to CEIP/EEA NFR formats have to been checked with RepDab.
- Reporting
- Archiving: The proper archiving and reporting of the documentation related to inventory compilation process is also part of the QA/QC activities. Inventory documentation must be sufficiently comprehensive, clear and sufficient for all present and future experts to be able to obtain and review the references used and reproduce the inventory calculations. The main archives of the inventory are placed within the Environmental Protection Agency.

A basic review of the draft emission estimates and the draft report takes place before the final submissions to the Commission and EEA secretariat: the final draft of the IIR is coordinated with the Environmental Protection Agency, before the submission to the

European Commission and the EEA secretariat. Received corrections are incorporated into the IIR.

The inventory is archived each year.

1.7.1. 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. Before submitting data to CEIP/EEA NFR formats were checked with RepDab.

1.7.2. 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. 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 carried out. Before submitting IIR to CEIP/EEA, data were approved by The The Environmental Protection Agency (EPA).

1.8. GENERAL UNCERTAINTY EVALUATION

The uncertainty assessment has not yet been evaluated in Lithuania.

1.9. COUNTRY INFORMATION

Lithuania is the southernmost of the three Baltic states – and the largest and most populous of them. Lithuania was the first occupied Soviet republic to break free from the Soviet Union and restore its sovereignty via the declaration of independence on 11 March 1990.

Major cities include Vilnius with a population of 549,000, Kaunas with a population of 349,000 and Klaipeda with a population of 183,000. Siauliai and Panevezys are also important cities for commerce. The climate is midway between maritime and continental, with an average daytime temperature of -5° C in January and 20° C in July.

Lithuania

Year of EU entry: 2004

Capital city: Vilnius

Total area: 65 000 km²

Population: 3.3 million

Currency: litas (Lt)

Schengen area: Member of the Schengen area since 2007

The Lithuanian landscape is predominantly flat, with a few low hills in the western uplands and eastern highlands. The highest point is Aukštasis at 294 metres. Lithuania has 758 rivers, more than 2 800 lakes and 99 km of the Baltic Sea coastline, which are mostly devoted to recreation and nature preservation. Forests cover just over 30% of the country.

Some 84% of the population are ethnic Lithuanians. The two largest minorities are Poles, who account for just over 6.7% of the population, and Russians, who make up just over 6.3%. and 3.6% other (Belarusians, Ukrainians, Latvians, etc.). The Lithuanian language belongs to the family of Indo-European languages. Most of the population is Roman Catholic, but there are also Russian Orthodox, Evangelical Lutherans, Evangelical Reformers, Old

Believers, Jews, Sunni Muslims and Karaites. The official state language is Lithuanian, which is the most archaic living Indo-European language and is closely related to Sanskrit. It is possible to compare Lithuanian and Sanskrit in such a way that even those who have not studied linguistics may observe the similarities. The 32-letter Lithuanian alphabet is Latin-based. English and Russian are widely spoken.

The capital, Vilnius, is a picturesque city on the banks of the rivers Neris and Vilnia, and the architecture within the old part of the city is some of Eastern Europe's finest. Vilnius university, founded in 1579, is a renaissance style complex with countless inner courtyards, forming a city within the city.

The Lithuanian president is elected directly for a five-year term and is active principally in foreign and security policy. The unicameral Lithuanian Parliament, the Seimas has 141 members.

1.10. POLLUTANTS EMISSION TRENDS

1.10.1. Main pollutant emissions in the period 1990-2013 (Gg).

Lithuania has been reporting data regarding national total and sectoral emissions under The LRTAP onvention since 2000.

TABLE 1.10-1 MAIN POLLUTANT EMISSIONS IN THE PERIOD 1990-2013

	NOx	NMVOC	SO2	NH3
1990	128,39	120,67	168,95	97,72
1991	124,66	132,34	195,45	90,87
1992	86,89	103,02	103,76	63,25
1993	64,76	97,26	91,81	54,45
1994	58,90	85,69	89,68	49,43
1995	61,82	95,51	69,17	47,54
1996	62,93	98,74	71,47	49,56
1997	64,52	94,37	67,16	47,92
1998	64,58	88,05	84,12	45,21
1999	52,37	79,62	62,26	42,90
2000	50,74	71,93	37,14	39,32

2001	51,78	75,07	40,83	41,08
2002	51,54	76,49	34,86	42,96
2003	51,95	74,16	27,00	43,90
2004	52,68	75,58	27,50	43,85
2005	54,30	76,31	31,39	44,67
2006	56,58	75,71	29,57	46,86
2007	53,56	72,52	26,11	45,23
2008	55,07	74,65	22,07	42,41
2009	47,95	72,04	20,93	43,07
2010	49,55	71,47	20,70	43,22
2011	46,11	68,52	23,20	41,98
2012	47,71	68,08	20,01	41,51
2013	46,17	63,39	18,93	40,41
Trend 1990-2013, %	**-64%**	**-48%**	**-89%**	**-59 %**
Trend 2005-2013, %	**-15%**	**-17%**	**-40%**	**-10 %**
Reduction commintments from 2005 (GP)	**-48%**	**-32%**	**-55%**	**-10%**

1.10.2. Nitrogen Oxides (NO_x)

Total nitrogen oxides emissions have decreased 60 % from 128.4 Gg in 1990 to 46.2 Gg in 2013 (Figure 1.10-1).

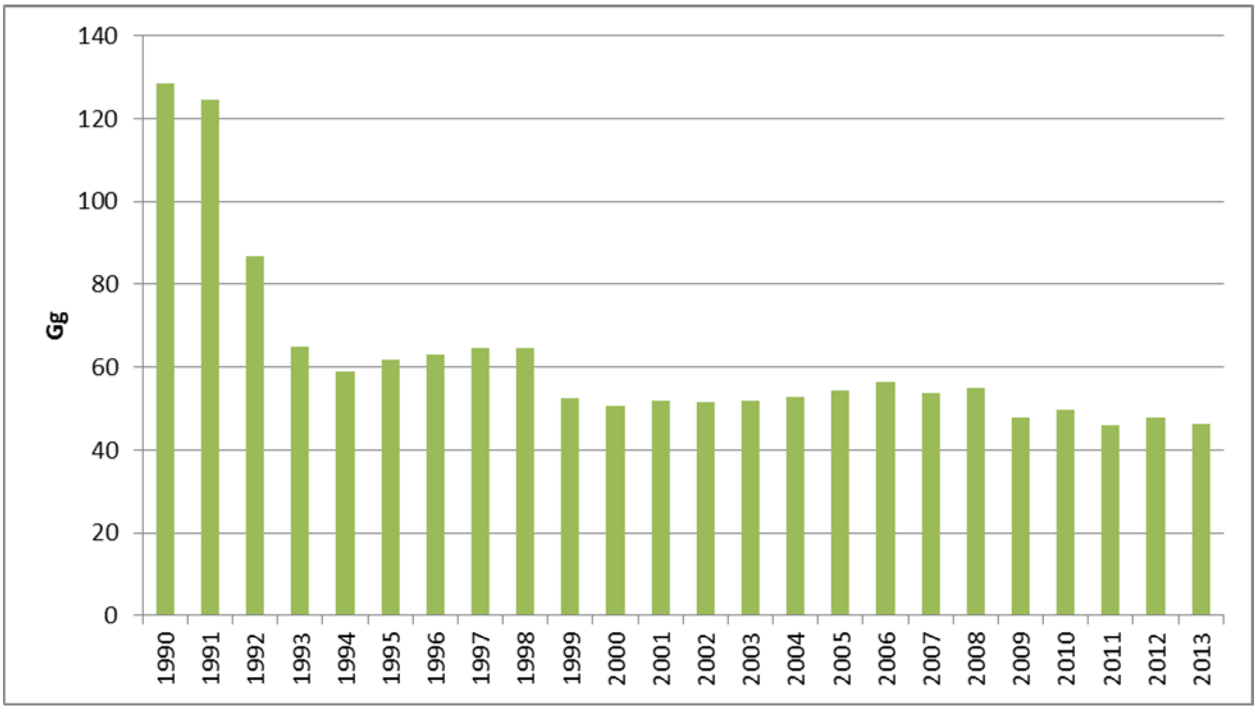

FIGURE 1.10-1 NATIONAL TOTAL EMISSION TREND FOR NOX, 1990 - 2013

Road Transport (1.A.3) is the principal source of NOx emissions, contributing ~70.0 per cent (and 46 Gg) of the total in 2013 (Figure 1.10-2). The Public Electricity and Heat Production (1.A.1.a) sector accounts for a decreasing percentage of the national total. The contribution of the sector in 1990 to the national total was 7.7 per cent, decreased to 3.6 Gg in 2013 as a result of the decreases in fuel consumption due to the economic crisis impacting upon the sector. The Small Combustion (Commercial/Institutional (1A4a) and Residential Stationary Plants (1A4b)) sectors are another main source of NOx emissions, accounting for 4 per cent of emissions in 2013. Emissions from this sector have decreased between 1990 (27 Gg) and 2013 (4.4 Gg). Commercial/Institutional and Residential (1.A.4.a and 1.A.4.b), Agriculture/Forestry/Fishing (1.A.4.c) sectors combined account for 10 per cent of the total and combustion sources. The remainder of the NOx emissions arise from combustion sources in the Agriculture/Forestry/Fishing: Off-road vehicles and Railways sectors, which are presented in Other NFR sectors that together account for 10-15 per cent of the total in 1990.

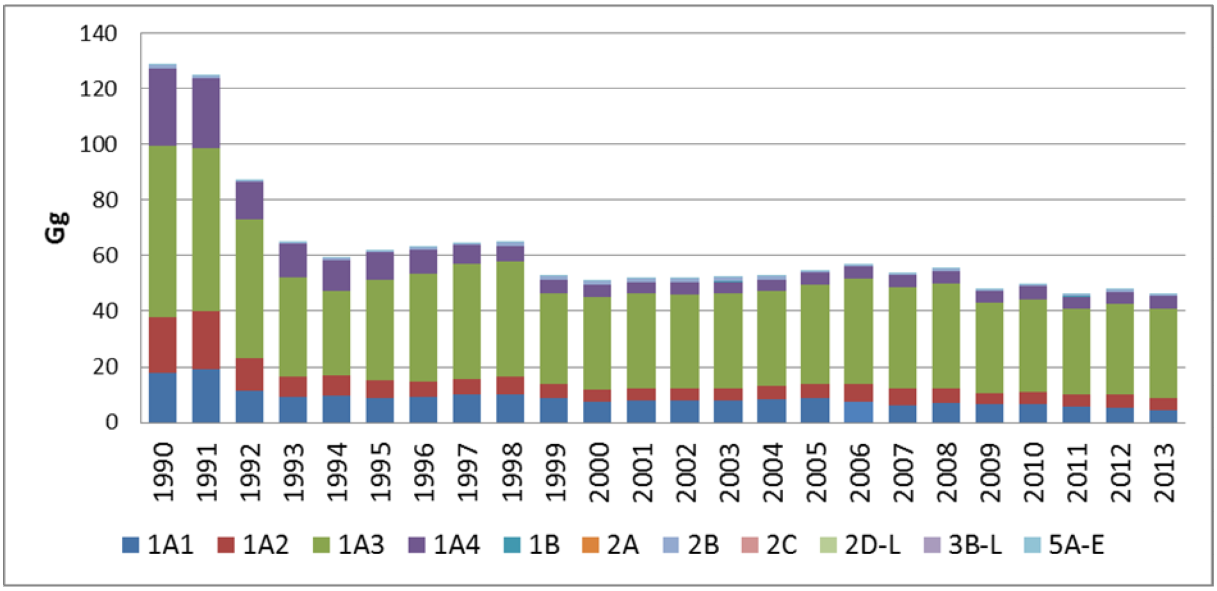

FIGURE 1.10-2EMISSION TREND FOR NOX BY SECTORS, 1990 – 2013

The largest reduction of emissions has occurred in the road transport sector. These reductions have been achieved as a result of fitting three-way catalysts to petrol fuelled vehicles. The reduction has been achieved also due to installation of low-NO_X burners and denitrifying units in power plants and district heating plants.

1.10.3. Non-Methane Volatile Organic Compounds (NMVOC)

Total non-methane volatile organic compound emissions have decreased by 30 per cent, from 85.6 Gg in 1990 to 59.7 Gg in 2013 (Figure 1.10-3).

The emissions of NMVOC can be divided into main groups: solvents and incomplete combustion. The main contributor of NMVOC in the year 2013 is solvent use (45 per cent), followed by small combustion.

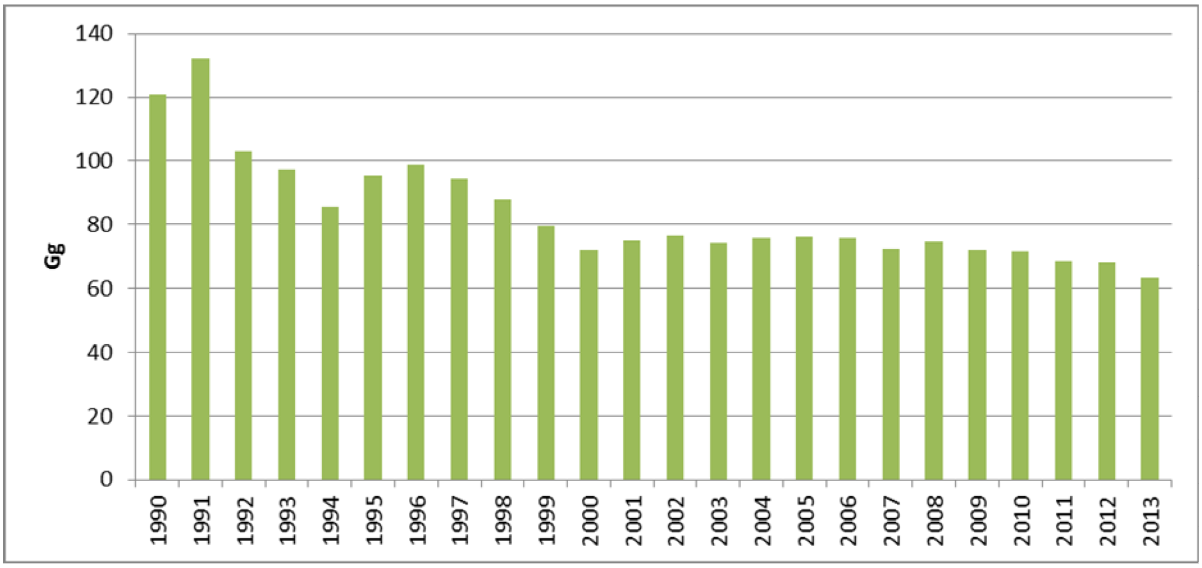

FIGURE 1.10-3 NATIONAL TOTAL EMISSION TREND FOR NMVOC, 1990-2013

The decline in emissions since 1990 has primarily been due to reductions achieved in the road transport sector due to the introduction of vehicle catalytic converters, driven by tighter vehicle emission standards. The reductions in NMVOC emissions have been enhanced by the switching from petrol to diesel cars.

The NMVOC emissions are determined mainly by Solvent and Other Product Use and Road Transport. The combined solvents produced 42 per cent of the 2013 total of NMVOC emissions in Lithuania having decreased between 1990 (76.23 Gg) and 2013 (26.9 Gg).

Technological controls for volatile organic compounds (VOCs) in motor vehicles have been more successful than in the case of NOX, and have contributed to a significant reduction in emissions from Road Transport (1.A.3.b), with the total transport sector's contribution having decreased by 80 per cent between 1990 (28.8 Gg) and 2013 (4.9 Gg).

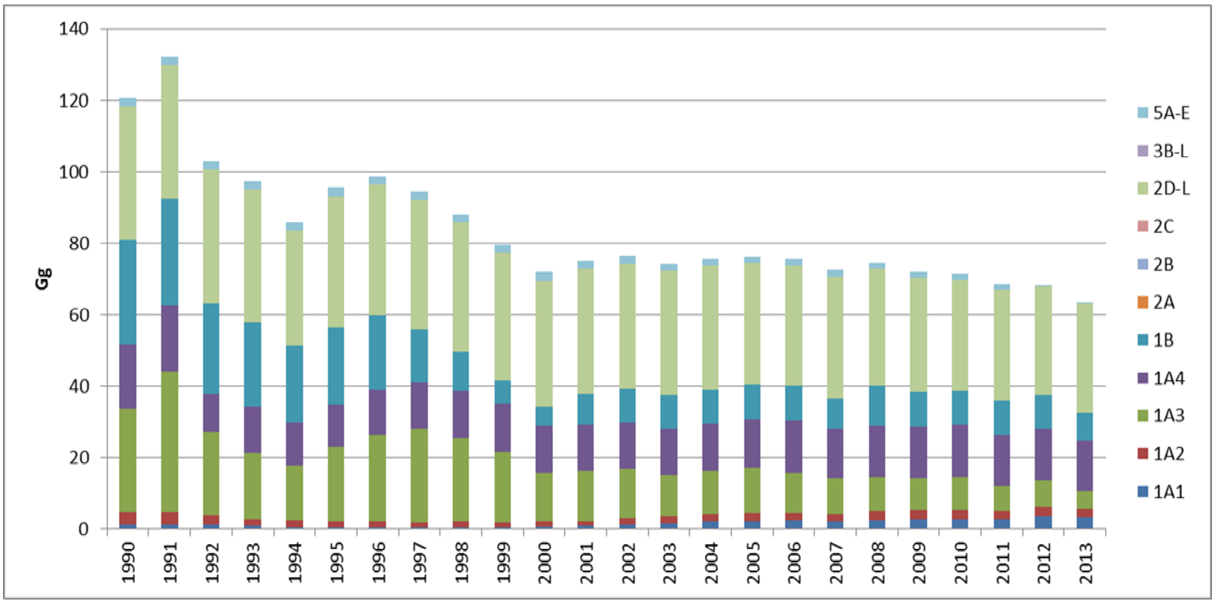

Figure 1.10-4. Emission trend for NMVOC by sectors, 1990-2013

Combustion sources in the Residential (1.A.4.b) sector is another important source, accounting for 19.7 per cent of national total NMVOC emissions in 2013.

1.10.4. Sulphur Dioxide (SO_2)

The main part of the SO_2 emission originates from combustion of fossil fuels, mainly coal and oil in public power plants and district heating plants. Total sulphur dioxide emissions decreased by 82.6 per cent, from 168.9 Gg in 1990 to 18.9 Gg in 2013 (Figure 1.10-5). The Fugitive emissions oil: Refining / storage and Residential (1.B.2.a.iv and 1.A.4.b) sectors remain the principal source of SO_2 emissions, contributing 48 per cent of the total in 2013.

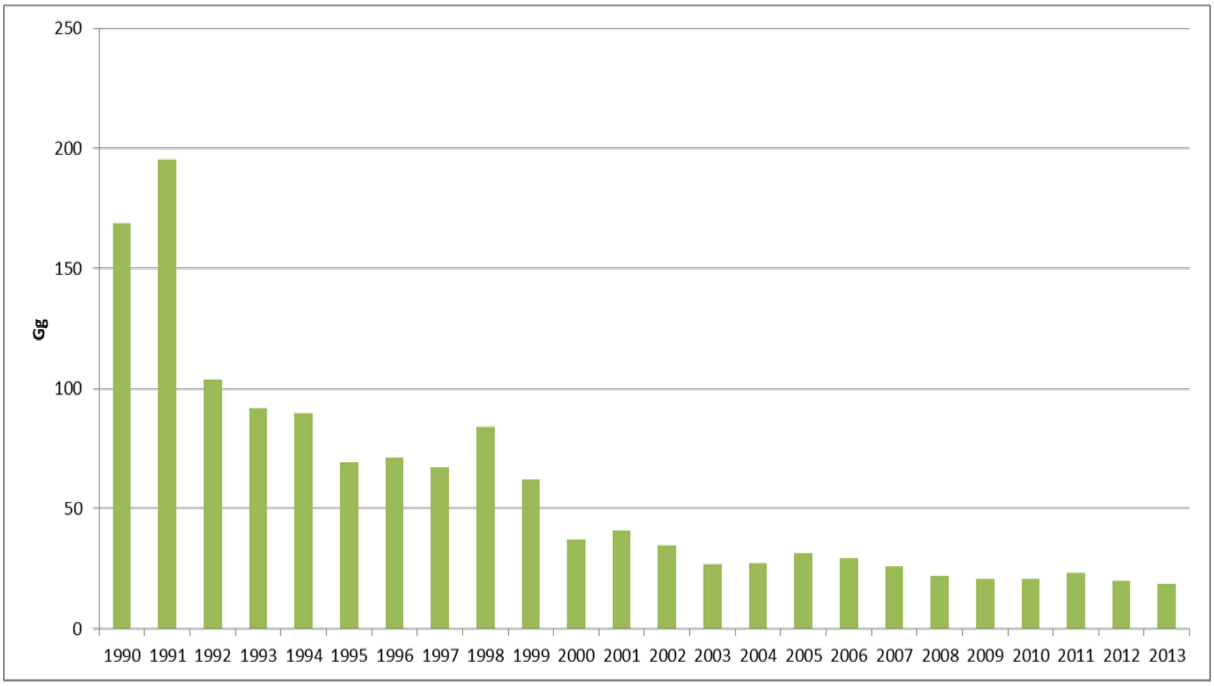

FIGURE 1.10-5. NATIONAL TOTAL EMISSION TREND FOR SO_2, 1990-2013

Public Electricity and Heat Production (1.A.1.a) sector accounts for 16.5 per cent of the total in 2013 and Commercial/institutional: Stationary and Mobile sectors largely account for the remainder of the emissions, with contribution of 11.7 per cent in 2013. Chemical industry: Othere (2.B.10.a) sector account for 9.7 per cent of national total emissions of SO_2 in 2013.

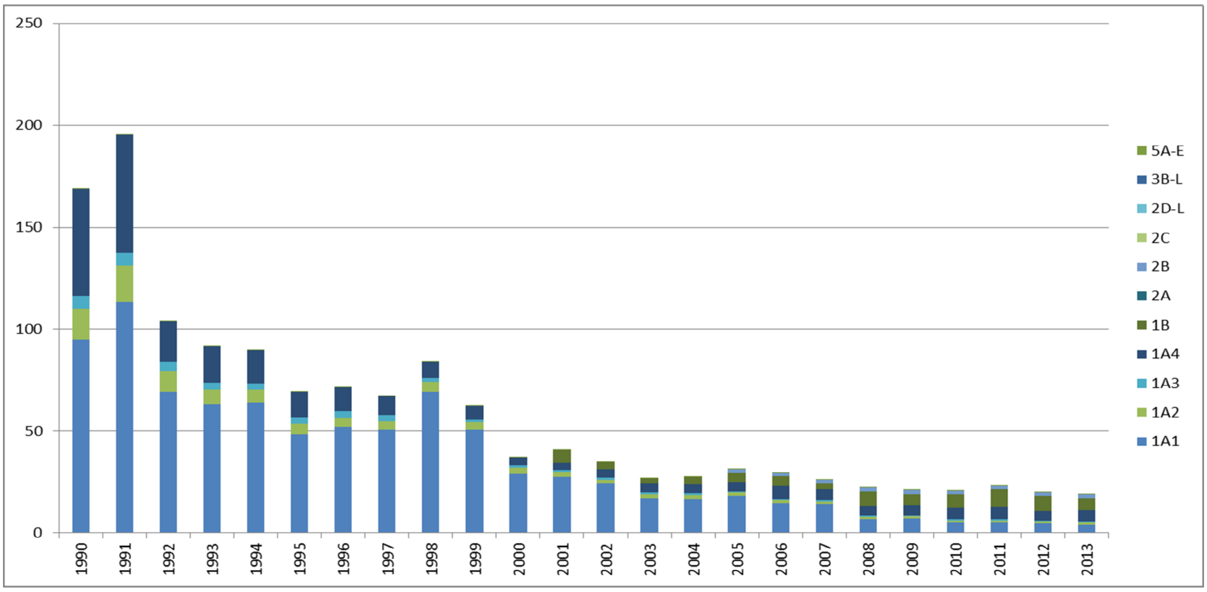

FIGURE 1.10-6 EMISSION TREND FOR SOX BY SECTORS, 1990-2013

The large reduction is largely due to installation of desulphurisation plant, use of fuels with lower content of sulphur in public power and district heating plants, introduction of liquid fuels with lower content of sulphur and substitution of high-sulphur solid and liquid fuels to low-sulphur fuels such as natural gas. Despite the large reduction of the SO_2 emissions, these plants make up about 71 per cent of the total emission.

1.10.5. Ammonia (NH_3)

Almost all atmospheric emissions of NH_3 result from agricultural activities (94 per cent in the year 2013). Residential: Stationary use accounts for 4 per cent and Public electricity and heat production sector accounted for 1 per cent of the total in 2013. Only a minor part originates from other combustion sectors. The total ammonia emission decreased from 98 Gg in 1990 to 40 Gg in 2013. This is due to decreasing livestock population (Figure 1.10-8).

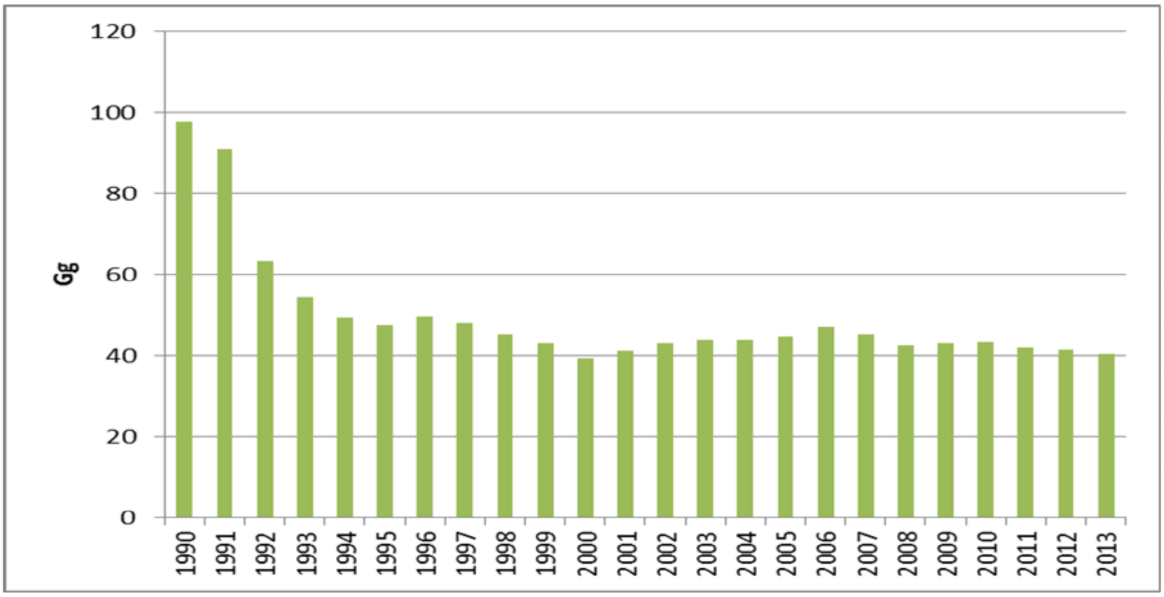

FIGURE 1.10-7. NATIONAL TOTAL EMISSION TREND FOR NH3, 1990-2013

Throughout the 1990–2013 time series, the small contribution by Transport (1.A.3) sources has increased. Emissions from Sector 1.A.3.b have increased from 0.01 Gg in 1990 to 0.2 Gg in 2013.

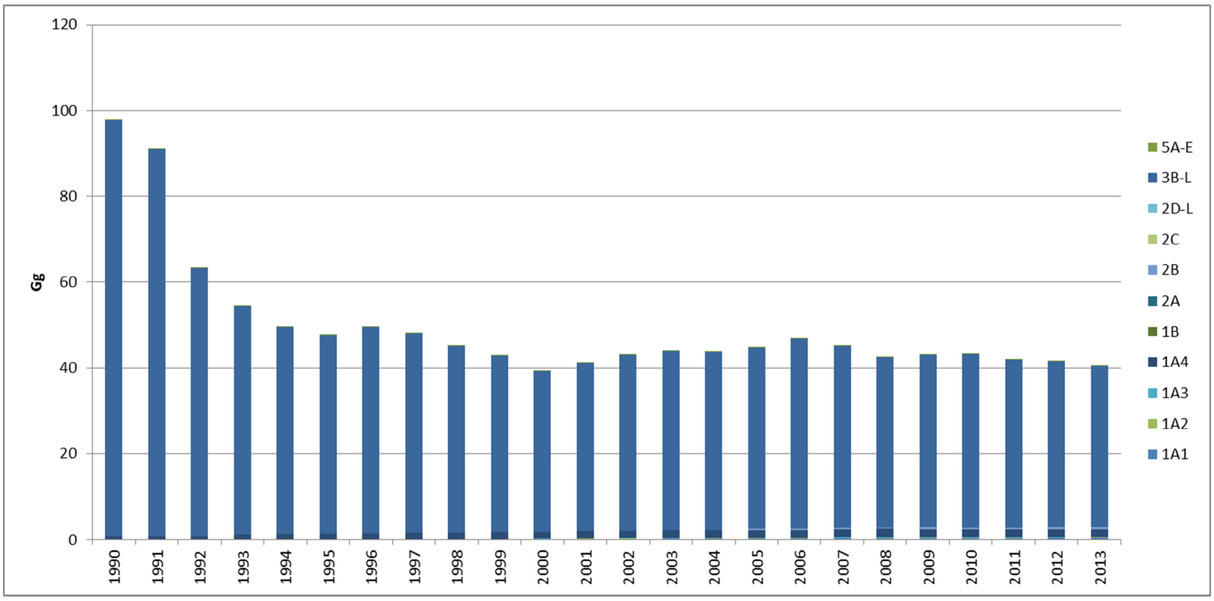

FIGURE 1.10-8. EMISSION TREND FOR NH_3 BY SECTORS, 1990-2013

The emission ceilings of NECD were 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 (1990–2012) as well as emission targets for air pollutants are shown in Figures 1-2 – 1-9.

1.11. Gothenburg protocol (GP)

The 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone The Executive body adopted the Gothenburg protocol (GP) on 30 November 1999. The Protocol entered into force on 17 May 2005. The objective of the 1999 Protocol was to control and reduce emissions of sulphur, nitrogen oxides, ammonia and volatile organic compounds that are caused by anthropogenic activities and are likely to cause adverse effects on human health, natural ecosystems, materials and crops, due to acidification, eutrophication or ground-level ozone as a result of long-range transboundary atmospheric transport. Once the Protocol is fully implemented, Europe's sulphur emissions should be cut by at least 63%, its

NOx emissions by 41%, its VOC emissions by 40% and its ammonia emissions by 17% compared to 1990.

In May 2012 the protocol was amended to include, amongst other changes, new emission reduction commitments for 2020 for NO_x, NMVOC, SO_x, NH_3 and also $PM_{2.5}$. The amended protocol has not yet entered into force.

Changes in acidification, eutrophication and ground level ozone from the base year (2005) to the target year of the revised Gothenburg Protocol (2020) The revised Gothenburg Protocol defines emission reduction targets for 2020 with respect to 2005. For the first time, emission reduction commitments for fine particulate matter are included. In total, the emissions for the member states of the EU are expected to decline by 59% (SOx), 42% (NOx), 28% (NMVOC), 6% (NH3) and 22% (PM) between 2005 and 2020 (figure 1.11-1).

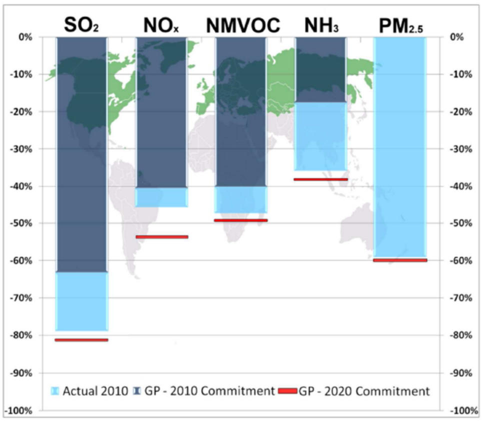

FIGURE 1.11-1. EMISSION REDUCTION TARGETS FOR 2010 OF THE ORIGINAL GOTHENBURG PROTOCOL COMPARED TO NEW 2020 COMMITMENTS

Thirty-tree Parties* to the Convention have defined 2010 targets of NOx, SOx, NMVOC and NH3 in the GP. Comparing the reported emissions with the 2010 ceilings, it seems that the total reduction targets for individual pollutants were reached at least for the group of countries, which ratified the GP. However, figures indicate that a number of countries were not fully successful in reducing their emissions and did not reach their individual ceilings.

* Parties with 2010 GP targets: Armenia, Austria, Belgium, Bulgaria, Belarus, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Liechtenstein, Lithuania, Luxembourg, Latvia, the Republic of Moldova, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, the United Kingdom and the Ukraine.

NOx emissions: 21 countries reported 2010 emissions lower than their GP targets. Twelve countries missed their NOx GP targets: Luxembourg (+320%), Austria (+75%), Liechtenstein (+71%), France (+26%), Belgium (+22%), Germany (+22%), Norway (+18%), Ireland (+16%), Sweden (+9%), the Netherlands (+4%), Spain (+4%) and Denmark (+1%).

NMVOC emissions: GP targets for NMVOC were reached by almost all countries except for three: Germany (+6%), Denmark (+1 %) and Spain (only +0.3 % when considering only emissions reported for the EMEP grid domain).

SOx emissions: All countries reported 2010 emissions lower than their GP targets.

NH3 emissions: 28 countries reported 2010 emissions lower than their GP targets and seven countries reported emissions higher that their emission ceilings (Figure 1-12): Croatia (+25%), Finland (+20%), Denmark (+8%) and Spain (+4%).

TABLE 1.11-1 DISTANCE OF 2010 NO_X, SO_X, NMVOC AND NH_3 TO THE GP CEILINGS

NO_X	2010 emissions [Gg]	GP ceilings [Gg]	Distance to ceiling
Belgium	221	181	22%
Bulgaria	115	266	-57%
Croatia	71	87	-19%
Cyprus	18	23	-22%
Czech Republic	239	286	-16%
Denmark	129	127	1%
Finland	167	170	-2%
France	1,080	860	26%
Germany	1,323	1,081	22%
Hungary	162	198	-18%
Latvia	34	84	-60%
Lithuania	58	110	-47%
Luxembourg	46	11	320%
Netherlands	276	266	4%
Norway	184	156	18%
Portugal	186	260	-28%
Romania	272	437	-38%
Slovakia	89	130	-32%
Slovenia	45	45	0%
Spain	890	847	5%
Sweden	161	148	9%
Switzerland	79	79	0%
United Kingdom	1,106	1,181	-6%
United States of America	—	6,897	—
EU-15	7,219	6,671	8%

NMVOC	2010 emissions [Gg]	GP ceilings [Gg]	Distance to ceiling
Belgium	105	144	-27%
Bulgaria	91	185	-51%
Croatia	76	90	-15%
Cyprus	11	14	-19%
Czech Republic	151	220	-31%
Denmark	86	85	1%
Finland	116	130	-10%
France	852	1,100	-23%
Germany	1,053	995	6%
Hungary	109	137	-21%
Latvia	65	136	-52%
Lithuania	69	92	-25%
Luxembourg	9	9	-2%
Netherlands	151	191	-21%
Norway	140	195	-28%
Portugal	175	202	-13%
Romania	445	523	-15%
Slovakia	62	140	-55%
Slovenia	35	40	-13%
Spain	656	669	-2%
Sweden	197	241	-18%
Switzerland	89	144	-38%
United Kingdom	789	1,200	-34%
United States of America	—	4,972	—
EU-15	5,670	6,600	-14%

SO_x	2010 emissions [Gg]	GP ceilings [Gg]	Distance to ceiling
Belgium	67	106	-37%
Bulgaria	387	856	-55%
Croatia	41	70	-41%
Cyprus	22	39	-43%
Czech Republic	170	283	-40%
Denmark	14	55	-74%
Finland	67	116	-42%
France	262	400	-35%
Germany	449	550	-18%
Hungary	32	550	-94%
Latvia	3	107	-97%
Lithuania	38	145	-74%
Luxembourg	2	4	-45%
Netherlands	34	50	-32%
Norway	19	22	-12%
Portugal	67	170	-61%
Romania	372	918	-59%
Slovakia	69	110	-37%
Slovenia	10	27	-62%
Spain	435	774	-44%
Sweden	34	67	-49%
Switzerland	13	26	-51%
United Kingdom	406	625	-35%
United States of America	—	16,013	—
EU-15	2,405	4,059	-41%

NH_3	2010 emissions [Gg]	GP ceilings [Gg]	Distance to ceiling
Belgium	69	74	-7%
Bulgaria	51	108	-53%
Croatia	37	30	25%
Cyprus	5	9	-41%
Czech Republic	69	101	-32%
Denmark	75	69	8%
Finland	37	31	20%
France	645	780	-17%
Germany	548	550	0%
Hungary	65	90	-27%
Latvia	17	44	-61%
Lithuania	30	84	-64%
Luxembourg	5	7	-32%
Netherlands	122	128	-5%
Norway	23	23	-1%
Portugal	48	108	-56%
Romania	161	210	-23%
Slovakia	24	39	-37%
Slovenia	17	20	-13%
Spain	368	353	4%
Sweden	52	57	-9%
Switzerland	63	63	-1%
United Kingdom	284	297	-4%
EU-15	2,867	3,129	-8%

Distance of 2010 SO_x and NH_3 emissions (reported in 2012) to the Gothenburg Protocol ceilings

This has lead to a major improvement in risk damage of acidification to ecosystems all over Europe. In 1990, 33% of the ecosystem area in Europe was at risk. In 2010, the unprotected area has decreased to 5% for Europe.

The newly revised GP includes national emission reduction commitments for the main air pollutants to be achieved in 2020 and beyond. The revised GP includes, for the first time, emission reduction commitments for fine particulate matter, the pollutant whose ambient air concentrations notoriously exceed air quality standards throughout Europe.

For 2020, the percentage reductions with respect to 2005 defined in the revised GP has been applied, see Tables 1-11-2. For the 2020 run, ship emissions have been kept on the level of 2010 in order to estimate the effect of the redutions in the revised GP alone.

TABLE 1.11-2 2005 EMISSION LEVELS (EXPRESSED IN THOUSANDS OF METRIC TONNES) AND NATIONAL EMISSION REDUCTION COMMITMENTS IN 2020 AND BEYOND (EXPRESSED AS PERCENTAGE REDUCTION FROM 2005 LEVELS)

	SO2		NOX		NH3		VOC		PM 2.5	
	Emission levels 2005	Reduction from 2005 level	Emission levels 2005	Reduction from 2005 level	Emission levels 2005	Reduction from 2005 level	Emission levels 2005	Reduction from 2005 level	Emission levels 2005	Reduction from 2005 level
Belarus	79	20%	171	21%	136	7%	349	15%	46	10%
Croatia	63	55%	81	31%	40	1%	101	34%	13	18%
Norway	24	10%	200	23%	23	8%	218	40%	52	30%
Switzerland	17	21%	94	41%	64	8%	103	30%	11	26%
Austria	27	26%	231	37%	63	1%	162	21%	22	20%
Belgium	145	43%	291	41%	71	2%	143	21%	24	20%
Bulgaria	777	78%	154	41%	60	3%	158	21%	44	20%
Cyprus	38	83%	21	44%	5.8	10%	14	45%	2.9	46%
Czech Rep.	219	45%	286	35%	82	7%	182	18%	22	17%
Denmark	23	35%	181	56%	83	24%	110	35%	25	33%
Estonia	76	32%	36	18%	9.8	1%	41	10%	20	15%
Finland	69	30%	177	35%	39	20%	131	35%	36	30%
France	467	55%	1,430	50%	661	4%	1,232	43%	304	27%
Germany	517	21%	1,464	39%	573	5%	1,143	13%	121	26%
Greece	542	74%	419	31%	68	7%	222	54%	56	35%
Hungary	129	46%	203	34%	80	10%	177	30%	31	13%
Ireland	71	65%	127	49%	109	1%	57	25%	11	18%
Italy	403	35%	1,212	40%	416	5%	1,286	35%	166	10%
Latvia	6.7	8%	37	32%	16	1%	73	27%	27	16%
Lithuania	44	55%	58	48%	39	10%	84	32%	8.7	20%
Luxemburg	2.5	34%	19	43%	5.0	1%	9.8	29%	3.1	15%
Malta	11	77%	9.3	42%	1.6	4%	3.3	23%	1.3	25%
Netherlands	65	28%	370	45%	141	13%	182	8%	21	37%
Poland	1,224	59%	866	30%	270	1%	593	25%	133	16%
Portugal	177	63%	256	36%	50	7%	207	18%	65	15%
Romania	643	77%	309	45%	199	13%	425	25%	106	28%
Slovakia	89	57%	102	36%	29	15%	73	18%	37	36%
Slovenia	40	63%	47	39%	18	1%	37	23%	14	25%
Spain	1,282	67%	1,292	41%	365	3%	809	22%	93	15%
Sweden	36	22%	174	36%	55	15%	197	25%	29	19%
UK	706	59%	1,580	55%	307	8%	1,088	32%	81	30%
Eu[a)]	7,828	59%	11,355	42%	3,813	6%	8,842	28%	1,504	22%

a) The sum of the exact emission levels in 2005 by EU Member States, as reported

2. ENERGY

2.1. Energy Sector overview

Energy Sector is the main source of the emissions accounting.

NFR 1.A.1.a Public electricity and heat production includes pollutants emission data from large point sources (LPS) reported by operators and from diffuse sources.

NFR 1.A.1.b Petroleum refining**.** Emissions are calculated on the basis of measurements or the combined method by producers (ORLEN Lietuva) (measurements plus calculations).

NFR 1.A.1.c The manufacture of solid fuels includes fuel data reported by statistics Lithuania.

Emissions from this source category have historically contributed significantly to the total anthropogenic emissions.

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 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. The closure of the Ignalina Nuclear Power Plant in Lithuania dramatically slashed the volume of electricity produced in the Baltic states. Finding new sources of energy to satisfy the needs of both businesses and the people of the region has become an overriding strategic priority.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 and gaseous fuels which are imported from the single source.

In February 2007, the three Baltic states (Lithuania, Latvia and Estonia) and Poland agreed to build a new nuclear plant at Ignalina, initially with 3200 MWe capacity (2 x 1600 MWe). Though located next to the Soviet-era Ignalina plant, the new one was to be called Visaginas after the nearby town of that name. The Visaginas Nuclear Energy (***Visagino Atominė Elektrinė***, VAE) company was established in August 2008 for the new units.

TABLE 0-1 PLANNED POWER REACTORS IN LITHUANIA

Reactor	*Type*	*Gross MWe*	*Construction start*	*Operation*
Visaginas 1	ABWR	1350	2014?	2020

Visaginas is envisaged as the cornerstone of the new Baltic Energy Market Interconnector Plan linking to Poland, Finland and Sweden. A high-voltage (400 kV) 1000 MW interconnection, costing €250-300 million, to improve transmission capacity between Lithuania and Poland is to be built, with 500 MW by 2015 and another 500 MW by 2020. Much of the funding is from the European Union (EU). This follows inauguration of an interconnector between Estonia and Finland – Estlink-1, a 150 kV, 350 MW DC cable costing €110 million and also supported by EU funding. Estlink-2 will provide a further 650 MW in 2014. Another major transmission link under the Baltic Sea, the 700 MWe NordBalt project, is planned between Klaipeda in Lithuania and Nybro in Sweden. The €550 million project is expected to be completed by 2015. (The Baltic states and Belarus have good interconnection of grids from the Soviet era, but this did not extend to Poland, let alone to Germany. Kaliningrad gets all of its electricity from Russia, via the Lithuanian grid.)

Lithuania is also objecting on the same basis to Belarus plans to build a new nuclear power plant at Ostrovetsk, 23 km from the border and 55 km from Vilnius.

Statistics Lithuania informs that GDP, estimated based on available statistical data and econometric models, in 2011 compared to 2010, grew by 6 %.

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.

District heating has an approximately 68% market share in the Lithuanian heat market, including delivery to industry. Approx. 58% of households are connected to the heating grid, the remaining percentage is due to the industrial and commercial sector. In total, 19,7 TWh heat was delivered to the grid system in 1997. Gas has a 55% share and oil 37% of input for district heat production.

Lithuania is mostly a lowlands country, and as such does not have huge amounts of hydroelectric power potential. There are two major hydroelectric facilities on the Nemunas, both near the city of Kaunas; the larger of these is a pumped storage facility that eventually (after a second phase of construction) could have a capacity of as much as 1 600 MWe.

2.2. PUBLIC ELECTRICITY AND HEAT PRODUCTION (1.A.1.A)

In the electricity sector the government owns the majority of production, transportation and distribution enterprises. The Law on Electricity of Lithuania, adopted on 7 February 2012, provides the legal framework for the development and enhancement of the competitiveness of the Lithuanian electricity market and ensures the activities of the power transmission system operator are separated from those of other power sector enterprises.

Lithuania faces some challenges in the district heating sector and these are related to the possibility of integrating renewable and local energy resources. A wider use of renewable energy can help energy supplies be diversified and the targets for sustainable development to be met.

In terms of the natural gas supply, Lithuania has to rely on two main wholesale companies, "Lietuvos Dujos" AB and "Dujotekana" UAB, which dominate the natural gas supply market. The natural gas retail market is 100% open in Lithuania but, due to the high concentration on the supply side, customers may not use the advantage of the open market. On the distribution side, it should be noted that approximately one third of the territory of Lithuania has not been gasified. Lithuania's natural gas transmission system is connected to Belarus', Latvia's and the Russian Federation's gas systems. International connections with these countries are regulated on a contract basis. The technical capacities of the existing interconnection with Belarus are sufficient to meet customer needs. At present, Lithuania's natural gas market is not integrated with those of other EU member states. In 2010 the Lithuanian Government made the decision to construct an LNG terminal in Klaipeda. The state enterprise Klaipedos Nafta was selected as the main terminal construction instrument. The projected potential capacity of the terminal is at its maximum 3 billion cubic metres (bcm)/a. The plan is that the plant will start its operations in 2014. The LNG terminal project is included in the Baltic Energy Market Interconnection Plan (BEMIP), which was approved by the European Commission and eight Baltic Sea states on 17 June 2009.

The production of electricity and heat from fossil fuels has traditionally been the most important source of key pollutants such as SO_2 and NO_X in most countries. 1.A.1.a sector remains one of the major emission categories, even though the emissions of SO_2 and NO_X and other substances have decreased significantly over the 1990–2013 time series (Fig. 2.2-2). The level of emissions in Sector 1.A.1.a depends heavily on the mix of fossil fuels used for electricity production. In 1990, coal, residual oil, diesel oil and natural gas were the principal fuels used. The use of coal and residual oil declined as biomass and natural gas became the preferred fuel during latter years, especially for new entrants in electricity production (Fig. 2.2-1).

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.

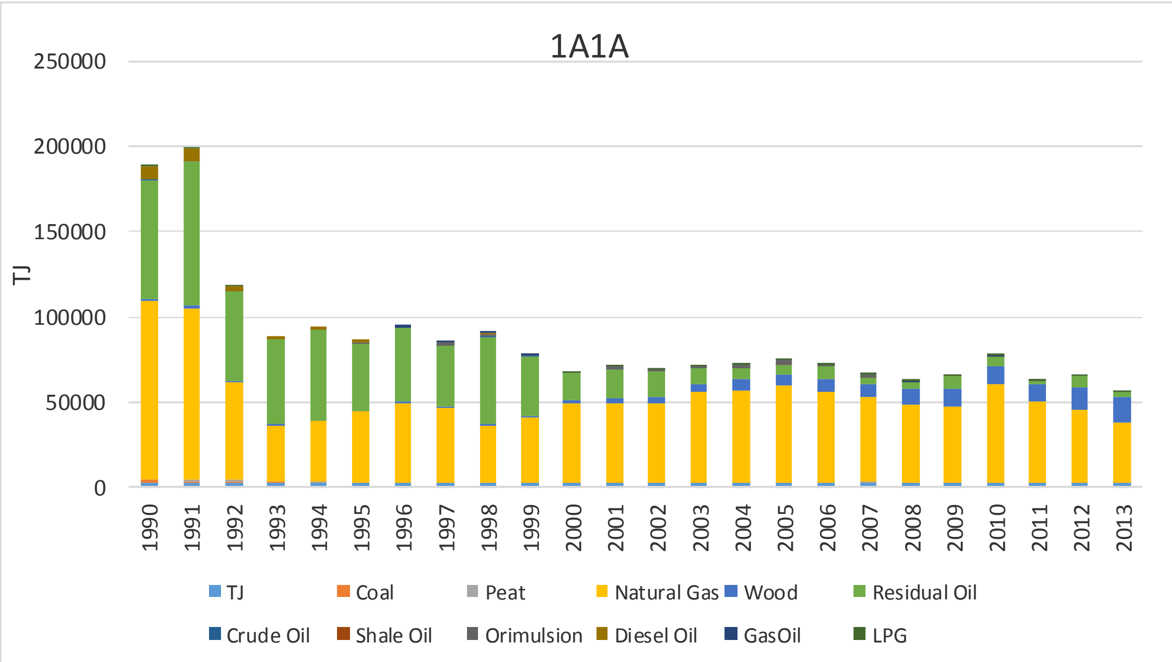

FIGURE 2.2-1 TENDENCIES OF FUEL CONSUMPTION 1A1A

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.

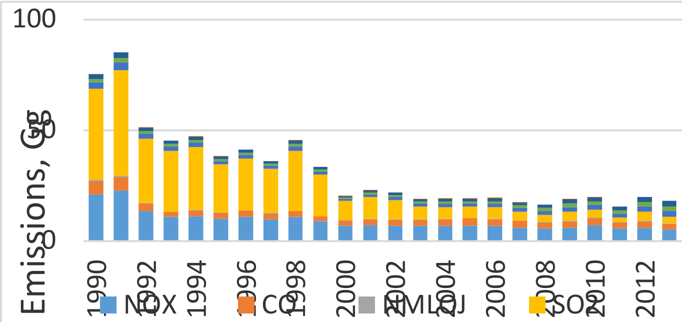

FIGURE 2.2-2 MAIN POLLUTANT EMISSION TREND IN 1.A.1.A SECTOR

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.

TABLE 2.2-1 POLLUTANT EMISSIONS FROM THE 1.A.1.A IN THE PERIOD 1990-2013

	NO_x	NMLOJ	SOx	NH3	PM2,5	PM10	TSP	BC	CO
1990	15,12	0,68	80,88	1,62	2,10	0,10	6,22	0,02	15,12
1991	16,40	0,80	96,99	1,96	2,52	0,13	6,23	0,04	16,40
1992	10,04	0,57	60,36	1,22	1,57	0,08	3,44	0,03	10,04
1993	8,01	0,47	57,38	1,14	1,47	0,08	2,36	0,03	8,01
1994	8,26	0,31	60,05	1,15	1,48	0,08	2,46	0,02	8,26
1995	7,39	0,32	45,92	0,91	1,17	0,06	2,61	0,02	7,39
1996	8,00	0,41	48,94	0,99	1,27	0,07	2,78	0,02	8,00
1997	7,30	0,44	43,18	0,87	1,12	0,06	2,66	0,03	7,30
1998	7,66	0,55	60,15	1,17	1,51	0,08	2,49	0,04	7,66

1999	6,42	0,40	40,87	0,81	1,04	0,05	2,22	0,02	6,42
2000	5,21	0,62	18,09	0,57	0,70	0,03	2,34	0,06	5,21
2001	5,59	0,96	20,59	0,77	0,95	0,04	2,52	0,11	5,59
2002	5,33	1,22	17,51	0,89	1,08	0,04	2,63	0,15	5,33
2003	5,16	1,52	11,21	0,91	1,08	0,04	2,78	0,19	5,16
2004	5,21	2,15	9,46	1,06	1,26	0,04	3,02	0,24	5,21
2005	5,51	2,15	9,97	0,23	0,28	0,01	5,87	0,23	5,51
2006	5,01	2,25	8,29	0,23	0,28	0,01	6,03	0,24	5,01
2007	5,01	2,11	10,48	0,25	0,34	0,01	5,76	0,22	5,01
2008	4,77	2,51	3,59	0,24	0,32	0,01	6,19	0,27	4,77
2009	4,82	2,78	3,75	0,26	0,36	0,02	6,83	0,30	4,82
2010	4,89	2,80	3,15	0,25	0,33	0,02	7,28	0,29	4,89
2011	4,38	2,56	2,84	0,16	0,22	0,01	6,47	0,27	4,38
2012	4,33	3,48	2,80	0,23	0,30	0,02	7,43	0,39	4,33
2013	3,57	3,34	3,13	0,16	0,21	0,01	7,09	0,44	3,57
Trend 1990-2013, %	**-76,37%**	**389,5%**	**-96,1%**	**-89,8%**	**-89,8%**	**-89,2%**	**13,83%**	**2180,9%**	**-76,3%**
Trend 2005-2013, %	**-35,1%**	**55,1%**	**-68,6%**	**-28,0%**	**-23,8%**	**-21,5%**	**20,62%**	**91,4%**	**-35,1%**

2.2.1. Source category description

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 EPA under Ministry of Environment. Emissions from area sources are estimated according to statistical fuel consumption data (Statistics Lithuania).

2.2.2. Methodological issues

The main source of data for all energy industries in the Lithuania for the period 1990-2013 is Statistics Lithuania. Tier 1 methods was used in 1A1c, 1A2f, 1A4a, 1A4b, 1A4c, 1B2a for all compounds and Tier 2 in 1A1b for main pollutants (SOx, NOx, NMVOC, TSP). The Tier 2 approach was appliesd with the activity data and the country-specific emission factors according to a country's fuel usage and installed combustion technologies.

2.2.3. Emission factors

EMEP/EEA Emission guidebook 2013 EF for SO_x, NO_x, CO, NMVOC, NH_3, TSP, PM10, PM2.5 was used. Emissions were estimated by multiplying heat value of combusted fuel by corresponding emission factor. Emissions factors for heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn) and POP's are taken from Emission Inventory Guidebook, 2013, Energy industries Tables 2.2-2-5.

TABLE 2.2-2 TIER 1 EMISSION FACTORS FOR SOURCE CATEGORY 1.A.1.A USING HARD COAL

Code			Name		
NFR Source Category		1.A.1.a		Public electricity and heat production	
Fuel			Hard Coal		
Not applicable					
Not estimated			NH3		
Pollutant	**Value , unit**			**95% confidence interval**	**Reference**
NOx	209	g/GJ	200	350	US EPA (1998), chapter 1.1
CO	8.7	g/GJ	6.15	15	US EPA (1998), chapter 1.1
NMVOC	1.0	g/GJ	0.6	2.4	US EPA (1998),

					chapter 1.1
SOx	820	g/GJ	330	5000	See Note
TSP	11.4	g/GJ	3	300	US EPA (1998), chapter 1.1
PM10	7.7	g/GJ	2	200	US EPA (1998), chapter 1.1
PM2.5	3.4	g/GJ	0.9	90	US EPA (1998), chapter 1.1
BC	2.2	% of PM2.5	0.27	8.08	See Note
Pb	7.3	mg/GJ	5.16	12	US EPA (1998), chapter 1.1
Cd	0.9	mg/GJ	0.627	1.46	US EPA (1998), chapter 1.1
Hg	1.4	mg/GJ	1.02	2.38	US EPA (1998), chapter 1.1
As	7.1	mg/GJ	5.04	11.8	US EPA (1998), chapter 1.1
Cr	4.5	mg/GJ	3.2	7.46	US EPA (1998), chapter 1.1
Cu	7.8	mg/GJ	0.233	15.5	Expert judgement derived from Guidebook (2006)
Ni	4.9	mg/GJ	3.44	8.03	US EPA (1998), chapter 1.1
Se	23	mg/GJ	16	37.3	US EPA (1998), chapter 1.1
Zn	19	mg/GJ	7.75	155	Expert judgement derived from Guidebook (2006)
PCB	3.3	ng WHO-TEG/GJ	1.1	9.9	Grochowalski & Konieczyński, 2008
PCDD/F	10	ng I-TEQ/GJ	5	15	UNEP (2005); Coal fired power boilers
Benzo(a)pyrene	0.7	µg/GJ	0.245	2.21	US EPA (1998), chapter 1.1
Benzo(b)fluoranthene	37	µg/GJ	3.7	370	Wenborn et al.,

					1999
Benzo(k)fluoranthene	29	µg/GJ	2.9	290	Wenborn et al., 1999
Indeno(1,2,3-cd)pyrene	1.1	µg/GJ	0.591	2.36	US EPA (1998), chapter 1.1
HCB	6.7	µg/GJ	2.2	20.1	Grochowalski & Konieczyński, 2008

TABLE 2.2-3 TIER 1 EMISSION FACTORS FOR SOURCE CATEGORY 1.A.1.A USING BROWN COAL

Tier 1 default emission factors					
Code			Name		
NFR Source Category		1.A.1.a		Public electricity and heat production	
Fuel			Brown Coal		
Not applicable					
Not estimated			BC, NH3, PCB, HCB		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	247	g/GJ	143	571	US EPA (1998), chapter 1.7
CO	8.7	g/GJ	6.72	60.5	US EPA (1998), chapter 1.7
NMVOC	1.4	g/GJ	0.84	3.36	US EPA (1998), chapter 1.7
SOx	1680	g/GJ	330	5000	See Note
TSP	11.7	g/GJ	20	80	US EPA (1998), chapter 1.7
PM10	7.9	g/GJ	15	60	US EPA (1998), chapter 1.7
PM2.5	3.2	g/GJ	7	28	US EPA (1998), chapter 1.7
Pb	15	mg/GJ	10.6	24.7	US EPA (1998), chapter 1.7
Cd	1.8	mg/GJ	1.29	3	US EPA (1998), chapter 1.7

Hg	2.9	mg/GJ	2.09	4.88	US EPA (1998), chapter 1.7
As	14.3	mg/GJ	10.3	24.1	US EPA (1998), chapter 1.7
Cr	9.1	mg/GJ	6.55	15.3	US EPA (1998), chapter 1.7
Cu	1.0	mg/GJ	0.2	5	Guidebook (2006)
Ni	9.7	mg/GJ	7.06	16.5	US EPA (1998), chapter 1.7
Se	45	mg/GJ	32.8	76.5	US EPA (1998), chapter 1.7
Zn	8.8	mg/GJ	0.504	16.8	Guidebook (2006)
PCBs	3.3	ng WHO-TEG/GJ	1.1	9.9	Grochowalski & Konieczyński, 2008
PCDD/F	10	ng I-TEQ/GJ	5	15	UNEP (2005); Coal fired power boilers
Benzo(a)pyrene	1.3	µg/GJ	0.26	6.5	US EPA (1998), chapter 1.7
Benzo(b)fluoranthene	37	µg/GJ	3.7	370	Wenborn et al., 1999
Benzo(k)fluoranthene	29	µg/GJ	2.9	290	Wenborn et al., 1999
Indeno(1,2,3-cd)pyrene	2.1	µg/GJ	0.42	10.5	US EPA (1998), chapter 1.7
HCB	6.7	µg/GJ	2.2	20.1	Grochowalski & Konieczyński, 2008

TABLE 2.2-4 TIER 1 EMISSION FACTORS FOR SOURCE CATEGORY 1.A.1.A USING GASEOUS FUELS

Tier 1 default emission factors					
Code			Name		
NFR Source Category	1.A.1.a		Public electricity and heat production		
Fuel			Gaseous fuels		
Not applicable					
Not estimated			NH3, PCBs, HCB		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	89	g/GJ	15	185	US EPA (1998), chapter 1.4
CO	39	g/GJ	20	60	US EPA (1998), chapter 1.4
NMVOC	2.6	g/GJ	0.65	10.4	US EPA (1998), chapter 1.4
SOx	0.281	g/GJ	0.169	0.393	US EPA (1998), chapter 1.4
TSP	0.89	g/GJ	0.445	1.34	US EPA (1998), chapter 1.4
PM10	0.89	g/GJ	0.445	1.34	US EPA (1998), chapter 1.4
PM2.5	0.89	g/GJ	0.445	1.34	US EPA (1998), chapter 1.4
BC	2.5	% of PM2.5	1	6.3	See Note
Pb	0.0015	mg/GJ	0.0005	0.0045	Nielsen et al., 2012
Cd	0.00025	mg/GJ	0.00008	0.00075	Nielsen et al., 2012
Hg	0.1	mg/GJ	0.01	1	Nielsen et al., 2010
As	0.12	mg/GJ	0.04	0.36	Nielsen et al., 2012
Cr	0.00076	mg/GJ	0.00025	0.00228	Nielsen et al., 2012

Cu	0.000076	mg/GJ	0.000025	0.000228	Nielsen et al., 2012
Ni	0.00051	mg/GJ	0.00017	0.00153	Nielsen et al., 2012
Se	0.0112	mg/GJ	0.00375	0.0337	US EPA (1998), chapter 1.4
Zn	0.0015	mg/GJ	0.0005	0.0045	Nielsen et al., 2012
PCDD/F	0.5	ng I-TEQ/GJ	0.25	0.75	UNEP (2005)
Benzo(a)pyrene	0.56	µg/GJ	0.19	0.56	US EPA (1998), chapter 1.4 ("Less than" value based on method detection limits)
Benzo(b)fluoranthene	0.84	µg/GJ	0.28	0.84	US EPA (1998), chapter 1.4 ("Less than" value based on method detection limits)
Benzo(k)fluoranthene	0.84	µg/GJ	0.28	0.84	US EPA (1998), chapter 1.4 ("Less than" value based on method detection limits)
Indeno(1,2,3-cd)pyrene	0.84	µg/GJ	0.28	0.84	US EPA (1998), chapter 1.4 ("Less than" value based on method detection

					limits)

TABLE 2.2-5 TIER 1 EMISSION FACTORS FOR SOURCE CATEGORY 1.A.1.A USING HEAVY FUEL OIL

Code			Name		
NFR Source Category		1.A.1.a		Public electricity and heat production	
Fuel			Heavy Fuel Oil		
Not applicable					
Not estimated			NH3, PCBs, Benzo(a)pyrene, HCB		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	142	g/GJ	70	300	US EPA (2010), chapter 1.3
CO	15.1	g/GJ	9.06	21.1	US EPA (2010), chapter 1.3
NMVOC	2.3	g/GJ	1.4	3.2	US EPA (2010), chapter 1.3
SOx	495	g/GJ	146	1700	See Note
TSP	35.4	g/GJ	2	200	US EPA (2010), chapter 1.3
PM10	25.2	g/GJ	1.5	150	US EPA (2010), chapter 1.3
PM2.5	19.3	g/GJ	0.9	90	US EPA (2010), chapter 1.3
BC	5.6	% of PM2.5	0.22	8.69	See Note
Pb	4.56	mg/GJ	2.28	9.11	US EPA (2010), chapter 1.3
Cd	1.2	mg/GJ	0.6	2.4	US EPA

					(2010), chapter 1.3
Hg	0.341	mg/GJ	0.17	0.682	US EPA (2010), chapter 1.3
As	3.98	mg/GJ	1.99	7.97	US EPA (2010), chapter 1.3
Cr	2.55	mg/GJ	1.27	5.1	US EPA (2010), chapter 1.3
Cu	5.31	mg/GJ	2.66	10.6	US EPA (2010), chapter 1.3
Ni	255	mg/GJ	127	510	US EPA (2010), chapter 1.3
Se	2.06	mg/GJ	1.03	4.12	US EPA (2010), chapter 1.3
Zn	87.8	mg/GJ	43.9	176	US EPA (2010), chapter 1.3
PCDD/F	2.5	ng I-TEQ/GJ	1.25	3.75	UNEP (2005); Heavy fuel fired power boilers
Benzon(b)fluoranthene	*4.5*	*µg/GJ*	*1.5*	*13.5*	*US EPA (2010), chapter 1.3*
Benzon(k)fluoranthene	*4.5*	*µg/GJ*	*1.5*	*13.5*	*US EPA (2010), chapter 1.3*
Indeno(1,2,3-cd)pyrene	6.92	µg/GJ	3.46	13.8	US EPA (2010), chapter 1.3

2.2.4. Uncertainty

Monte Carlo methos was applied to evaluate the uncertainty of activity data (2%). The uncertainty in emission factors is 10 %.

2.3. PETROLEUM REFINING (1.A.1.B)

2.3.1. Source category description

Refineries require electrical and thermal energy in substantial quantities. Electrical and thermal energy is typically generated by combined heat and power (CHP) or cogeneration facilities at the refinery. Thermal energy can be provided directly (process furnaces on the production unit) or via steam produced within the production unit or from a utilities facility. The technologies for production of energy from combustion can be identical to those for 1.A.1.a, activities but in many instances the difference will be that the fuels utilised will be refinery gaseous and liquid fuels. Where non-refinery fuels are used in combustion processes the information provided in the 1.A.1.a activity can be applied.

This chapter presents the entire consumption of fuels in oil industry (Fig. 2.3-1). Main representative of this sector is only one company. Refineries process crude oil into a variety of hydrocarbon products such as gasoline, kerosene and etc. UAB ORLEN Lietuva[1] is the only petroleum refining company operating in the Baltic States. Oil refinery processes approximately 10 million tons of crude oil a year. The company is the most important supplier of petrol and diesel fuel in Lithuania, Latvia and Estonia.

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

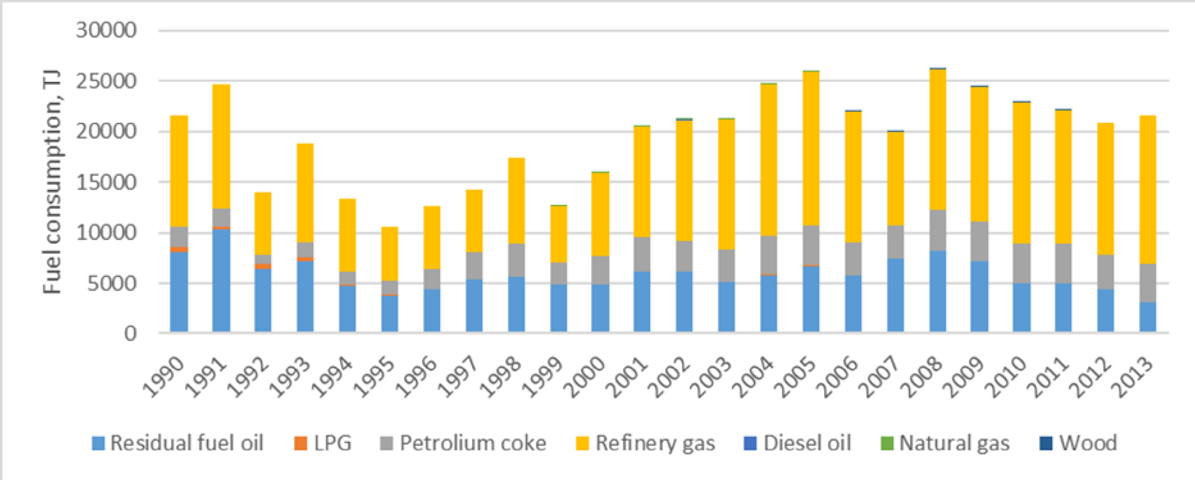

FIGURE 2.3-1 TENDENCIES OF FUEL CONSUMPTION 1A1B IN 1990-2013

Motor gasoline, jet kerosene, gas/diesel oil, residual fuel oil, LPG and non-liquefied petroleum gas used in Lithuania are produced by the oil refinery UAB ORLEN Lietuva. Imports of the fuels specified above comprise only a minor fraction of the fuels used in Lithuania.

2.3.2. Emission factors

Emissions factors for main pollutants, heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn) and POP's are taken from Emission Inventory Guidebook, 2013, Energy industries Tables 2.3-1-3.

TABLE 2.3-1 POLLUTANT EMISSIONS FROM THE 1.A.1.B SECTOR IN THE PERIOD 1990-2013

	SOx, Gg	NOx, Gg	PM2.5	PM10	CO
1990	16,23	2,62	0,17	0,21	0,56
1991	8,79	2,82	0,21	0,27	0,64
1992	5,61	1,35	0,13	0,17	0,34
1993	3,81	1,34	0,15	0,19	0,51
1994	2,35	1,25	0,10	0,12	0,36
1995	3,22	1,00	0,08	0,10	0,27
1996	7,58	1,15	0,09	0,12	0,31
1997	9,20	2,66	0,11	0,14	0,33
1998	9,92	2,53	0,12	0,15	0,42

1999	10,80	2,22	0,10	0,13	0,30
2000	6,89	2,13	0,10	0,13	0,40
2001	6,48	2,18	0,13	0,16	0,52
2002	5,79	2,43	0,13	0,16	0,57
2003	7,24	2,50	0,11	0,14	0,59
2004	8,10	2,86	0,13	0,16	0,68
2005	6,50	3,05	0,14	0,18	0,70
2006	3,81	2,52	0,12	0,16	0,59
2007	3,08	1,18	0,15	0,20	0,48
2008	3,41	2,17	0,17	0,22	0,67
2009	2,20	1,87	0,15	0,19	0,63
2010	2,27	1,85	0,11	0,14	0,63
2011	1,96	1,22	0,11	0,14	0,60
2012	1,11	0,90	0,10	0,12	0,58
2013	3,13	0,77	0,07	0,09	0,63
Trend 1990-2013, %	**-80,72%**	**-70,62%**	**-55,40%**	**-56,65%**	**0,56**
Trend 2005-2013, %	**-51,87%**	**-74,78%**	**-48,45%**	**-49,47%**	**0,64**

TABLE 2.3-2 TIER 1 EMISSION FACTORS FOR SOURCE CATEGORY 1.A.1.B, REFINERY GAS

Tier 1 default emission factors					
Code			Name		
NFR Source Category	1.A.1.b			Petroleum refining	
Fuel			Refinery Gas		
Not applicable					
Not estimated			NH3, PCDD/F, HCB		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	**63**	**g/GJ**	**31.5**	**84.4**	**US EPA (1998), chapter 1.4**
CO	39.3	g/GJ	23.6	55.1	US EPA (1998), chapter 1.4
NMVOC	2.58	g/GJ	1.29	5.15	US EPA

					(1998), chapter 1.4
SOx	0.281	g/GJ	0.169	0.393	US EPA (1998), chapter 1.4
TSP	0.89	g/GJ	0.297	2.67	US EPA (1998), chapter 1.4
PM10	0.89	g/GJ	0.297	2.67	US EPA (1998), chapter 1.4
PM2.5	0.89	g/GJ	0.297	2.67	US EPA (1998), chapter 1.4
BC	18.4	% of PM2.5	5.2	36.3	US EPA, 2011
Pb	1.79	mg/GJ	0.895	3.58	API (1998, 2002)

TABLE 2.3-3 TIER 1 FUEL CLASSIFICATIONS

Table 4-1 Tier 1 fuel classifications **Tier 1 fuel type**	**Associated fuel types**	**Location**
Natural gas	Natural gas	See 1.A.l.a Tier 1
Heavy fuel oil	Residual fuel oil, refinery feedstock, petroleum coke	See 1.A.1.a Tier 1
Other liquid fuels	(a) Gas oil, kerosene, naphtha, natural gas liquids, liquefied petroleum gas, orimulsion, bitumen, shale oil (b) refinery gas	(a) See 1.A.1.a Tier 1 (b) Table 4-2

2.4. MANUFACTURE OF SOLID FUEL AND OTHER ENERGY INDUSTRIES (1.A.1.C)

2.4.1. Source description

Emissions in this sector arise from fuel combustion in manufacturing of solid fuels and other energy industries. Emissions were calculated applying Tier 1. For calculation of emissions in category Manufacture of Solid Fuels and other Energy Industries (1.A.1.c) activity data had been obtained from the Lithuanian Statistics database.

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.

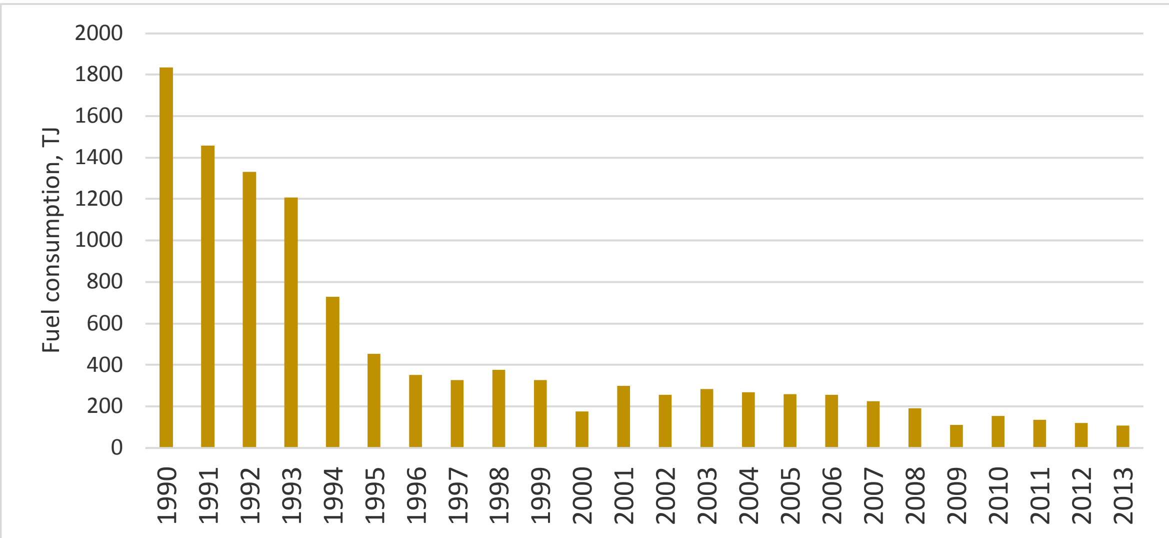

FIGURE 2.4-1 FUEL CONSUMPTION IN 1.A.1.C IN 1990-2013

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).

2.4.2. Methodological issues and emission factors

National emission factors of other pollutants, i.e. CO, NOx and NMVOC were taken from Emission Inventory Guidebook, 2013. Emissions factors for heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn) and POP's are taken from Emission Inventory Guidebook, 2013.

TABLE 2.4-1TIER 1 EMISSION FACTORS FOR SOURCE CATEGORY 1.A.1.C

Tier 1 default emission factors					
Code			Name		
NFR Source Category		1.A.1.c		Manufacture of solid fuels and other energy industries	
Fuel			Coal		
Not applicable					
Not estimated			BC, PCBs, HCB		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	21	g/GJ	11.5	42	See note
CO	6	g/GJ	3	12	See note
NMVOC	0.8	g/GJ	0.08	8.1	See note
SOx	91	g/GJ	60	120	See note
TSP	82	g/GJ	40	160	See note
PM10	79	g/GJ	40	160	See note
PM2.5	55	g/GJ	28	110	See note
Pb	28	mg/GJ	5.92	145	See note
Cd	1.6	mg/GJ	0.32	9	See note
Hg	30	mg/GJ	6	150	See note
As	11	mg/GJ	2.2	55	See note
Cr	5.7	mg/GJ	1.18	29.5	See note
Cu	25	mg/GJ	5	125	See note
Ni	5.2	mg/GJ	1.1	26	See note
Se	2.9	mg/GJ	0.6	15	See note
Zn	46	mg/GJ	9.4	235	See note
PCDD/F	26	ng I-TEQ/GJ	5.2	130	See note
Benzo(a)pyrene	0.29	mg/GJ	0.066	1.65	See note
Benzo(b)fluoranthene	0.003	mg/GJ	0.0006	0.015	See note
Benzo(k)fluoranthene	0.001	mg/GJ	0.0002	0.005	See note
Indeno(1,2,3-cd)pyrene	0.001	mg/GJ	0.0002	0.005	See note

The tier 1 emission factors are calculated as an average of the tier 2 emission factors. The tier 2 emission factors have been converted using a NCV of 28.2 GJ/Mg.

2.5. MANUFACTURING INDUSTRIES AND CONSTRUCTION (1.A.2)

Emissions from 1.A.2 sector are calculated using fuel consumption data from the Statistics Lithuania and some industrial manufactures prepared within Annual questionnaires. Natural gas is the main fuel used in chemical industry in Lithuania (Figs. 2-2 – 2-4). During 1990-2012 periods it has contained 85-99% of total fuel used in industry. Emissions factors for heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Se, Zn) and POP's are taken from Emission Inventory Guidebook, 2013, 1.A.2 Manufacturing industries and construction (combustion) Tables 2.5-1-3.

2.5.2. Iron and steel (1.A.2.a)

There is no iron and steel industry in Lithuania. All emissions are reported as not occurring.

2.5.3. Non-Ferrous Metals (1.A.2.b)

There is non-ferrous metals industry in Lithuania. All emissions are reported as not occurring.

2.5.4. Chemicals (1.A.2.c)

The chemical industry is the second largest manufacturing industry in Lithuania. It produces a number of different products such as chemicals, plastics, solvents, petrochemical products, cosmetics etc. During the latter decade it has been noticed an intensive development of this industry (Fig. 2.5-1).

Combustion in the chemicals sector ranges from conventional fuels in boiler plant and recovery of process by-products using thermal oxidisers to process-specific combustion activities (for example catalytic oxidation of ammonia during nitric acid manufacture).

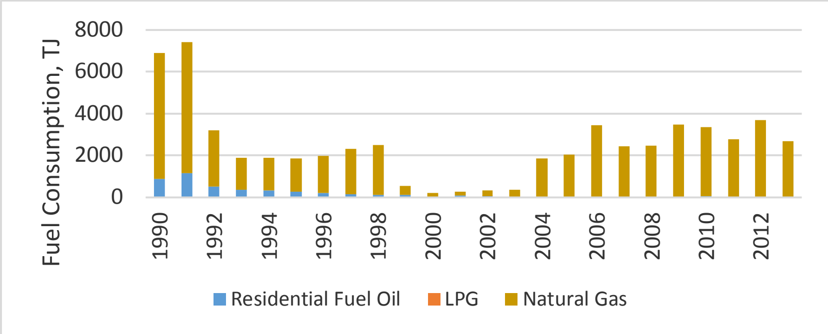

FIGURE 2.5-1. TENDENCIES OF FUEL CONSUMPTION IN CHEMICAL INDUSTRIES DURING 1990-2013, TJ

TABLE 2.5-1 POLLUTANT EMISSIONS FROM THE 1.A.2.C SECTOR IN THE PERIOD 1990-2013

	NOx	NMVOC	SOx	PM2,5	PM10	CO
1990	0,90	0,16	1,39	0,02	0,02	0,23
1991	1,06	0,17	0,62	0,03	0,03	0,26
1992	0,47	0,07	0,43	0,01	0,01	0,11
1993	0,30	0,04	0,38	0,01	0,01	0,07
1994	0,28	0,04	0,34	0,01	0,01	0,07
1995	0,26	0,04	0,24	0,01	0,01	0,06
1996	0,23	0,05	0,19	0,01	0,01	0,06
1997	0,24	0,05	0,14	0,00	0,00	0,07
1998	0,24	0,06	0,14	0,00	0,00	0,08
1999	0,09	0,01	0,10	0,00	0,00	0,02
2000	0,06	0,01	0,10	0,00	0,00	0,01
2001	0,06	0,01	0,05	0,00	0,00	0,01
2002	0,04	0,01	0,05	0,00	0,00	0,01
2003	0,05	0,01	0,00	0,00	0,00	0,01
2004	0,14	0,04	0,05	0,00	0,00	0,05
2005	0,12	0,03	0,05	0,00	0,00	0,06
2006	0,21	0,06	0,00	0,00	0,00	0,10
2007	0,14	0,04	0,03	0,00	0,00	0,07
2008	0,40	0,79	0,04	0,00	0,00	0,07

2009	0,53	1,11	0,09	0,00	0,00	0,10
2010	0,53	1,08	0,03	0,00	0,00	0,10
2011	0,40	0,88	0,04	0,00	0,00	0,08
2012	0,48	1,17	0,03	0,00	0,00	0,11
2013	0,37	0,86	0,03	0,00	0,00	0,08
Trend 1990-2013, %	**-58,36%**	**439,21%**	**-97,79%**	**-90,63%**	**-90,63%**	**-66,51%**
Trend 2005-2013, %	**212,60%**	**2621,92%**	**-36,96%**	**22,04%**	**22,04%**	**31,85%**

During 2008-2009, the growth rates of fuel consumption in Chemical industries went slow and 1,3% fuel consumption decrease has been noticed in 2009. Natural gas is the main fuel used in chemical industry in Lithuania. During 1990 - 2012 period it has contained 71-99% of total fuel used in industry.

TABLE 2.5-2TIER 1 EMISSION FACTORS FOR 1.A.2 COMBUSTION IN INDUSTRY USING SOLID FUELS TIER 1 DEFAULT EMISSION FACTORS

Code			Name		
NFR Source Category		1.A.2		Manufacturing industries and construction	
Fuel			Solid Fuels		
Not applicable					
Not estimated			NH3		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	173	g/GJ	150	200	Guidebook (2006) chapter B216
CO	931	g/GJ	150	2000	Guidebook (2006) chapter B216
NMVOC	88.8	g/GJ	10	300	Guidebook (2006) chapter B216
SOx	900	g/GJ	450	1000	Guidebook (2006) chapter B216
TSP	124	g/GJ	70	250	Guidebook (2006) chapter B216
PM10	117	g/GJ	60	240	Guidebook (2006) chapter B216
PM2.5	108	g/GJ	60	220	Guidebook (2006) chapter B216
BC	6.4	% of PM2.5	2	26	See Note
Pb	134	mg/GJ	50	300	Guidebook (2006) chapter B216
Cd	1.8	mg/GJ	0.2	5	Guidebook (2006) chapter B216
Hg	7.9	mg/GJ	5	10	Guidebook (2006)

					chapter B216
As	4	mg/GJ	0.2	8	Guidebook (2006) chapter B216
Cr	13.5	mg/GJ	0.5	20	Guidebook (2006) chapter B216
Cu	17.5	mg/GJ	5	50	Guidebook (2006) chapter B216
Ni	13	mg/GJ	0.5	30	Guidebook (2006) chapter B216
Se	1.8	mg/GJ	0.2	3	Guidebook (2006) chapter B216
Zn	200	mg/GJ	50	500	Guidebook (2006) chapter B216
PCB	170	µg/GJ	85	260	Kakareka et al. (2004)
PCDD/F	203	ng I-TEQ/GJ	40	500	Guidebook (2006) chapter B216
Benzo(a)pyrene	45.5	mg/GJ	10	150	Guidebook (2006) chapter B216
Benzo(b)fluoranthene	58.9	mg/GJ	10	180	Guidebook (2006) chapter B216
Benzo(k)fluoranthene	23.7	mg/GJ	8	100	Guidebook (2006) chapter B216
Indeno(1,2,3-cd)pyrene	18.5	mg/GJ	5	80	Guidebook (2006) chapter B216
HCB	0.62	µg/GJ	0.31	1.2	Guidebook (2006) chapter B216

TABLE 2.5-3 TIER 1 EMISSION FACTORS FOR 1.A.2 COMBUSTION IN INDUSTRY USING BIOMASS

Tier 1 default emission factors					
Code			Name		
NFR Source Category		1.A.2		Manufacturing industries and construction	
Fuel			Biomass		
Not applicable					
Not estimated			NH3		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	91	g/GJ	20	120	Lundgren et al. (2004) 1)
CO	570	g/GJ	50	4000	EN 303 class 5 boilers, 150-300 kW
NMVOC	300	g/GJ	5	500	Naturvårdsverket, Sweden
SO2	11	g/GJ	8	40	US EPA (1996) AP-42, Chapter 1.9
NH3	37	g/GJ	18	74	Roe et al. (2004) 2)
TSP	150	g/GJ	75	300	Naturvårdsverket, Sweden
PM10	143	g/GJ	71	285	Naturvårdsverket, Sweden 3)
PM2.5	140	g/GJ	70	279	Naturvårdsverket, Sweden 3)

BC	28	% of PM2.5	11	39	Goncalves et al. (2010), Fernandes et al. (2011), Schmidl et al. (2011) 4)
Pb	27	mg/GJ	0.5	118	Hedberg et al. (2002), Tissari et al. (2007) , Struschka et al. (2008), Lamberg et al. (2011)
Cd	13	mg/GJ	0.5	87	Hedberg et al. (2002), Struschka et al. (2008), Lamberg et al. (2011)
Hg	0.56	mg/GJ	0.2	1	Struschka et al. (2008)
As	0.19	mg/GJ	0.05	12	Struschka et al. (2008)
Cr	23	mg/GJ	1	100	Hedberg et al. (2002) , Struschka et al. (2008)
Cu	6	mg/GJ	4	89	Hedberg et al. (2002), Tissari et al. (2007) , Struschka et al. (2008), Lamberg et al. (2011)
Ni	2	mg/GJ	0.5	16	Hedberg et al. (2002), Struschka et al. (2008), Lamberg et al. (2011)
Se	0.5	mg/GJ	0.25	1.1	Hedberg et al. (2002)
Zn	512	mg/GJ	80	1300	Hedberg et al. (2002), Tissari et al. (2007) , Struschka et al. (2008), Lamberg et al. (2011)
PCBs	0.06	?g/GJ	0.006	0.6	Hedman et al. (2006)
PCDD/F	100	ng I-TEQ/GJ	30	500	Hedman et al. (2006)
Benzo(a)pyrene	10	mg/GJ	5	20	Boman et al. (2011); Johansson et al. (2004)
Benzo(b)fluoranthene	16	mg/GJ	8		32
Benzo(k)fluoranthene	5	mg/GJ	2		10
Indeno(1,2,3-cd)pyrene	4	mg/GJ	2		8
HCB	5	µg/GJ	0.1	30	Syc et al. (2011)

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

The production of pulp and paper requires considerable amounts of steam and power. Most pulp and paper mills produce their own steam in one or more industrial boilers or combined heat and power (CHP) units which burn fossil fuels and/or wood residues. Mills that pulp wood with a chemical process (Kraft, sulphite, soda, semi-chemical) normally combust their spent pulping liquor in a combustion unit, for example a Kraft recovery furnace, to recover pulping chemicals for subsequent reuse. These units are also capable of providing process steam and power for mill operations. The pulp, paper and print industry is an important branch of manufacturing industry in Lithuania (Fig. 2.5-2).

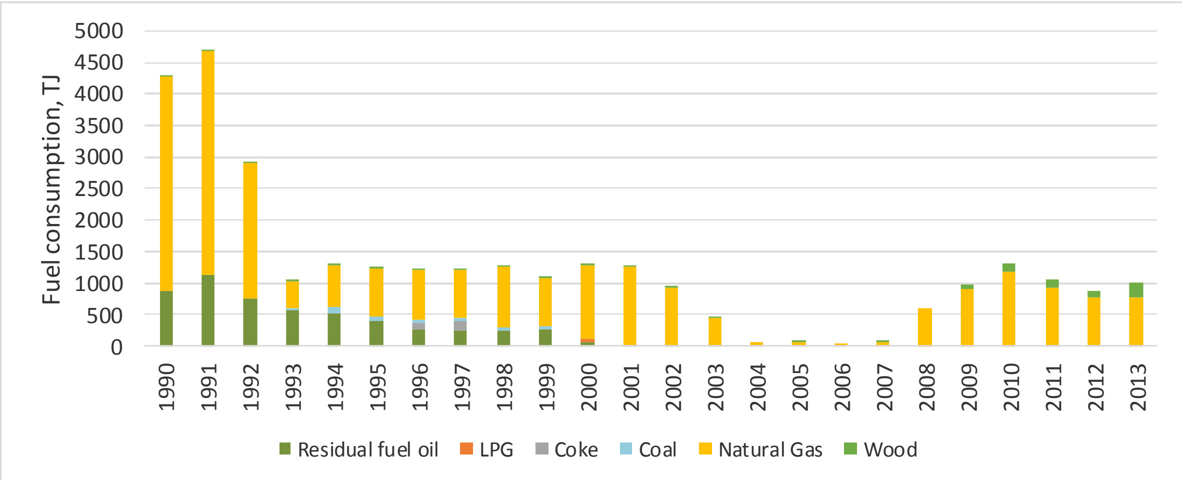

FIGURE 2.5-2. TENDENCIES OF FUEL CONSUMPTION IN PULP, PAPER AND PRINT INDUSTRIES DURING 1990-2013, TJ

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

Food processing, beverages and tobacco industry has old traditions in Lithuania. Currently this branch of the manufacturing industry consists of the following important structural parts – production of meet and its products, preparation and processing of fish and its products, preparation, processing and preservation of fruits, berries and vegetables, production of dairy products, production of grains, production of strong and soft drinks as well tobacco. During economic crisis the decline rates have been the lowest (3,9% a year).

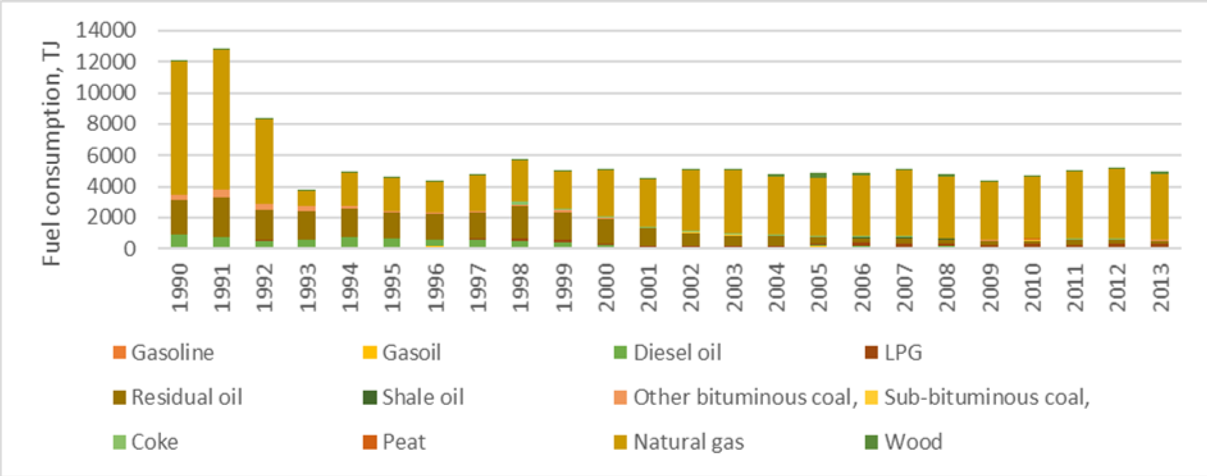

FIGURE 2.5-3. TENDENCIES OF FUEL CONSUMPTION IN FOOD PROCESSING, BEVERAGES AND TOBACCO INDUSTRIES DURING 1990-2013, TJ

During the last decade food processing industry has passed a rapid restructuring process, when number of active economic entities in the main branches of food industry (except in fruit and berries industry) has noticeably decreased. However, the share of large companies has increased.

2.5. STATIONARY COMBUSTION IN MANUFACTURING INDUSTRIES AND CONSTRUCTION (1.A.2.F)

2.5.2. Source category description

This chapter presents the consumption of fuels and emissions of air pollutants in five specific types of industry, all other are hidden under other industry where also fuel for construction industry is included. For this reason, that in "NFR Code 1A2f " a big number of enterprises are included.

In 1.A.2.f sector the largest reductions have been noticed in liquid (residual fuel oil) consumption during the period 1990-2013. The share of residual fuel oil has decreased from 67% (1990) till 1% (2013). Although, volume of natural gas has been reducing, however its share has remained rather stable during 1995-2012. During the period of rapid economic development coking coal has rapidly penetrated the market, i.e. the share has increased till 40% (2007). During 2008-2012 consumption of coking coal has been reducing, however the share has remained stable – 35-40%. The share of wood/wood waste fluctuates around 15% in the structure of fuel consumption during 2005-2013.

2.5.3. Methodological issues

All the emission calculations are based on the Tier 1 method. Emissions from these transport sectors are calculated by multiplying the statistical fuel consumption by respective emission factors. Default emission factors for the main pollutants and heavy metals are taken from the EMEP/EEA emission guidebook 2013.

Emissions of SO_2 are dependent on fuel consumption and fuel type. SO2 emissions are calculated by multiplying statistical fuel use (Table 3.52) by emission factors (Table 3.50). SO_2 emissions are estimated according to the assumption that all sulphur in the fuel is completely transformed into SO_2. Equation (1) can be applied to the industrial, commercial, household/gardening and agricultural sectors, while equation (2) is solely for the national fishing sector:

$$E_{SO2} = 2 \text{ x } k \text{ x } FC \qquad (1)$$

$$E_{SO2} = 20 \text{ x } S \text{ x } FC \qquad (2)$$

where:

E_{SO2} – emissions of SO_2

k – weight related sulphur content in fuel (kg/kg fuel)

S – percentage sulphur content in fuel (%)

FC – fuel consumption

Pb emissions are estimated by assuming that 75% of the lead contained in gasoline is emitted into the air. Pb content in fuel are presented in Table 2-12.

Equation:

$$E_{Pb} = 0.75 \times k \times FC \qquad (3)$$

TABLE 2.5-1 EMISSION FACTORS FOR OTHER MOBILE SOURCES (KG/T)

Fuel	1990	2000	2001	2003	2004	2005	2006	2008	2009	2011
Light fuel oil	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1
Diesel	0.5	0.5	0.05	0.035	0.03	0.005	0.004	0.004	0.001	0.1

Table 2-12. Lead content in fuel

NFR	Fuel	Unit	1990	2000	2004
1A2fii **1A4aii** **1A4bii** **1A4cii** **1A4ciii**	Gasoline	g/l	0.15	0.013	0.005
1A4ciii	Diesel/Light fuel oil	g/t	0.13	0.13	0.13

2.5.4. Source-specific planned improvements

No source-specific improvements have been planned.

3. TRANSPORT (1.A.3)

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.

The main document, analysing transport impact on the environment is the State Program "Transport and Environmental Protection". It includes the the activities to be followed:

1. On motor road transport:

    national distribution of traffic flows,

    perfection of means for selection and training of drivers,

    trolley-bus network development in Vilnius and Kaunas,

    optimisation of fuel prices,

    construction of new biotransport routes.

2. On railway transport:

    electrification of Lithuanian railways,

    pipeline transport development for oil products transportation.

3. On Sea transport:

    power supply from the municipal power network to the ships in the port.

4. On the Entire Means of Transport:

the formation of the fleet of various means of transport, taking into account the existing ecological requirements, development and implementation of national ecological standards.

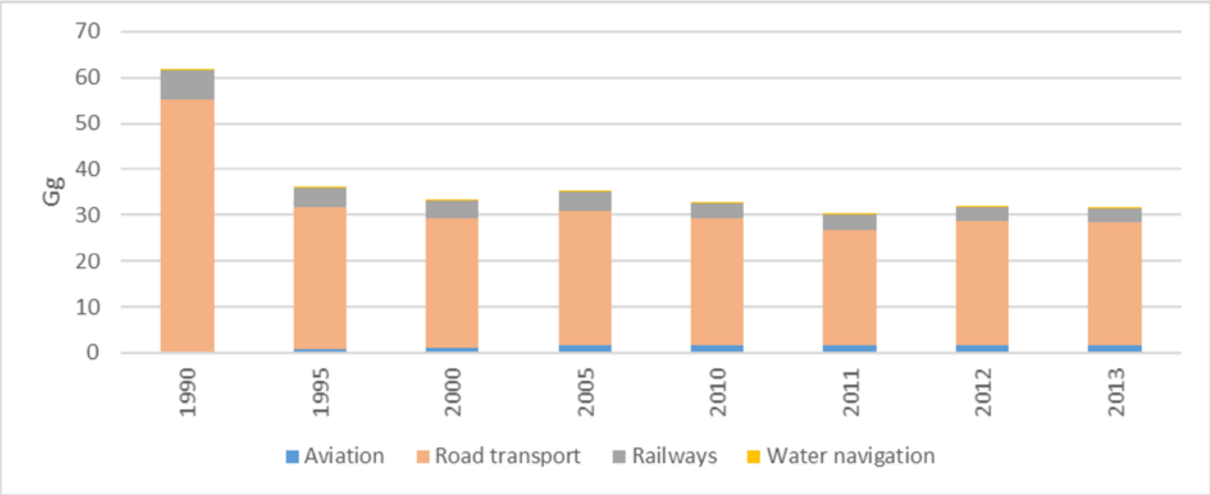

Figure 2.5-1. NOx emissions from the transport sector in 1990-2013

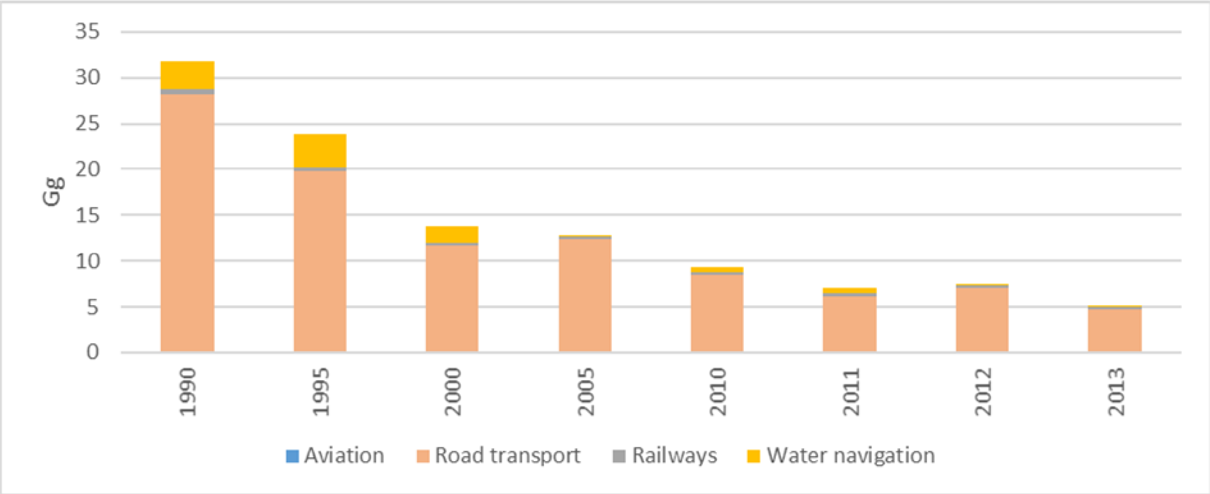

Figure 2.5-2NMVOC emissions from the transport sector in 1990-2013

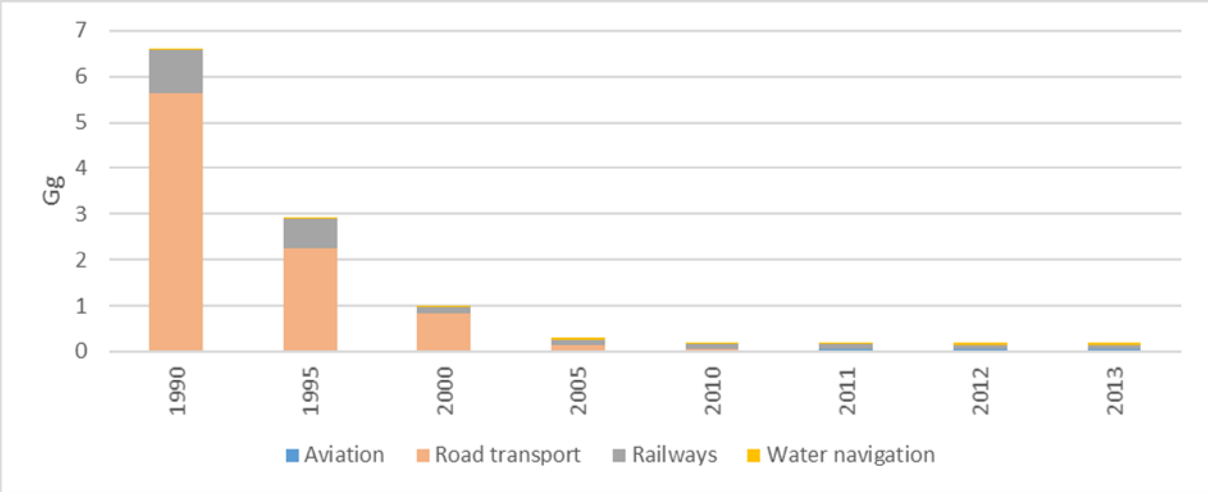

FIGURE 2.5-3. SOX EMISSIONS FROM THE TRANSPORT SECTOR IN 1990-2013

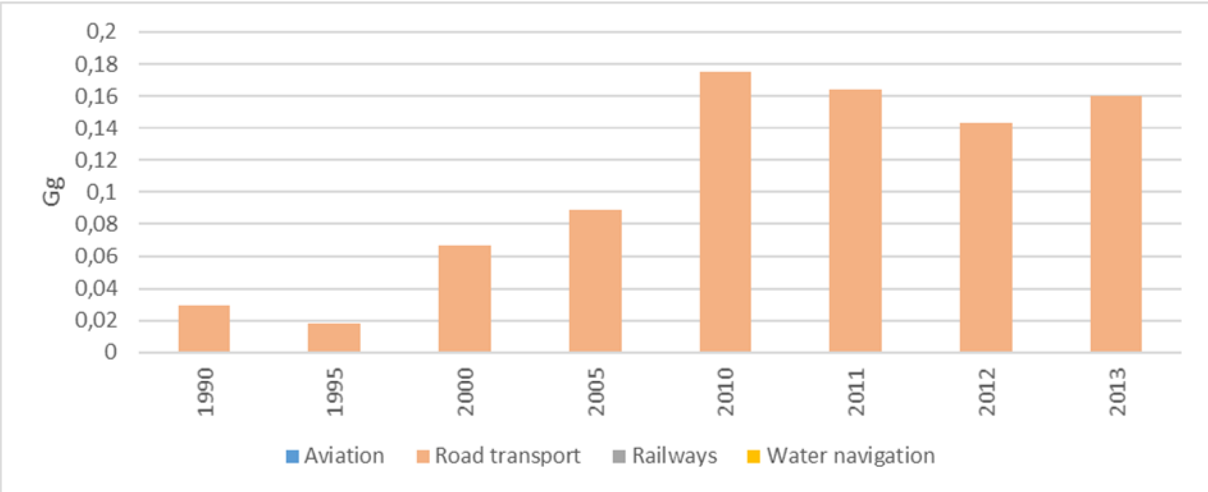

FIGURE 2.5-4 NH_3 EMISSIONS FROM THE TRANSPORT SECTOR IN 1990-2013

3.1. Road transport (1.A.3.b)

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 v.11 model. Road transport was differentiated into the passenger cars, light duty vehicles, heavy duty vehicles, buses and motorcycles categories.

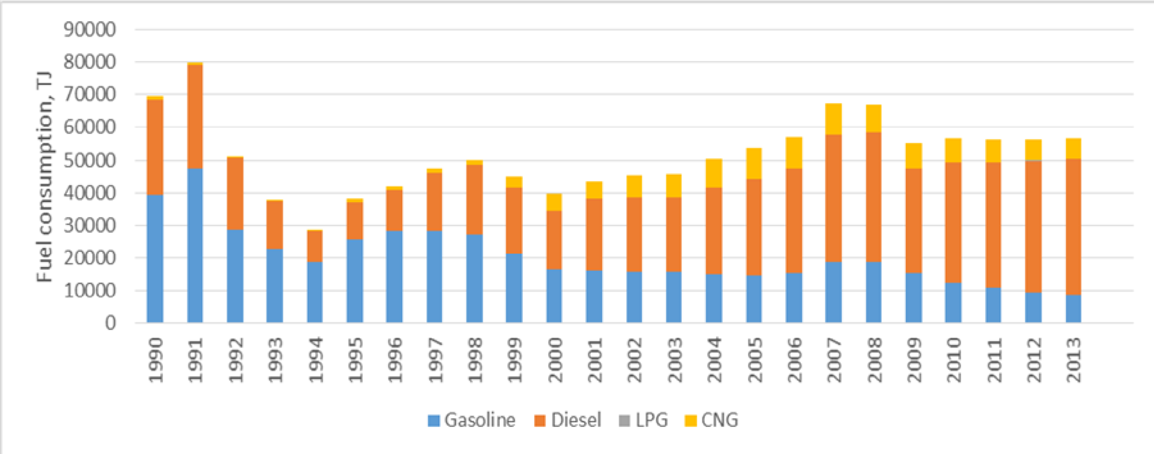

FIGURE 0-1 FUEL CONSUMPTION IN ROAD TRANSPORT IN 1990-2013, TJ

5.4.2. 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]:

$$E_{SO_2,j}^{CALC} = 2 \cdot k_{S,m} \cdot FC_{jm}^{CALC} , \quad (1)$$

where, $k_{S,m}$ - weight related sulphur content in fuel of type m [kg/kg fuel]. Calculation results are listed in Table 2-13.

TABLE 2-13. EMISSION FACTORS FOR SO_2, [G/KG].

Fuel	k	Emission factor
Gasoline	0.005; 0.001	1
Diesel oil	0.002 0.001	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 2-14).

TABLE 2-14. 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 2-15 - 2-18.

TABLE 2-15. 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	51.96	0	0	0
		Euro II	1122.26	110.84	11.24	51.96	0	0	0
		Euro III	924.22	73.89	8.03	51.96	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	47.53	0	0	0
		Euro II	776.26	90.68	8.22	47.53	0	0	0
		Euro III	639.27	60.45	5.48	47.53	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	44.72	0	0	0
		Euro II	296.82	83.88	12.41	44.72	0	0	0
		Euro III	244.44	55.92	8.27	44.72	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	79.48	76.3	68.75
		Euro I	81.36	305.55	14.47	0.49	35.52	34.1	30.72
		Euro II	81.36	305.55	14.47	0.49	35.52	34.1	30.72
		Euro III	81.36	235.27	12.3	0.49	25.57	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	79.48	76.3	68.75
		Euro I	81.36	305.55	14.47	0.49	35.52	34.1	30.72
		Euro II	81.36	305.55	14.47	0.49	35.52	34.1	30.72
		Euro III	81.36	235.27	12.3	0.49	25.57	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	60.09	0	0	0
		Euro II	227.59	76.97	10.29	60.09	0	0	0
		Euro III	187.43	51.31	7.35	60.09	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	51.87	0	0	0
		Euro II	330.34	65.25	9.05	51.87	0	0	0
		Euro III	272.05	43.5	6.03	51.87	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	75.13	72.12	64.99
		Euro I	60.57	270.74	18.2	0.55	19.15	18.38	16.56
		Euro II	60.57	270.74	18.2	0.55	19.15	18.38	16.56
		Euro III	60.57	208.47	15.47	0.55	13.78	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	75.13	72.12	64.99
		Euro I	60.57	270.74	18.2	0.55	19.15	18.38	16.56
		Euro II	60.57	270.74	18.2	0.55	19.15	18.38	16.56
		Euro III	60.57	208.47	15.47	0.55	13.78	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 2-16. 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 2-17. 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 2-18. 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 2-19. 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

5.4.3. 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 2-20.

TABLE 2-20. EMISSION FACTOR FOR LEAD, G/L.

Fuel	1990	2003	2006	2010
Leaded Gasoline	0.15	-	-	-
Unleaded Gasoline	0.013	0.005	0.003	0.0001

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 2-21). LPG doesn't contain heavy metal; therefore there are no heavy metals emissions from road transport using LPG.

TABLE 2-21. 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

2.4.2. 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 2-22. Emission factors were converted to mass per heat value units according to the fuel consumption factors estimated with COPERT IV.

TABLE 2-22. 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

2.4.3. Gasoline evaporation (1A.3.2.5)

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 and mileage data estimated by Institute of Transport. NMVOC emission factors were taken from [18] literature (Table 2-23).

TABLE 2-23. 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

2.4.2. 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 2-24) is used as activity rates for estimating tyre, brake wear and road abrasion emissions.

TABLE 2-24. ROAD TRANSPORT MILEAGE BY CATEGORIES, [KM].

Category	Mileage
Passenger cars	7 502 454 100
Light duty vehicle	1 566 991 000
Heavy duty vehicle	1 887 711 951
Buses	752 344 000
Motorcycles	5 632 879
Mopeds	10 176 919

TSP, PM_{10} and heavy metal emission factors for tyre, brake wear and road abrasion were taken from [18] literature and reported in Tables 2-26, 2-27, 2-28. $PM_{2.5}$ emission factors were taken from [7] reference and reported in Table 2-25.

TABLE 2-25. 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 2-26. 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 2-27. $PM_{2.5}$ 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 2-28. 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

2.4.3. Source-specific planned improvements

No improvements planned.

2.4.4. Uncertainty

Uncertainty for the road transport sector's activity data 20 %, emission factors – 20 %.

2.5. Aviation (1.A.3.a.i-ii)

2.5.2. Source category description

The present-day Vilnius International Airport is a state owned enterprise under the Ministry of Transport and Communications. It is the largest of the four major airports in Lithuania by passenger traffic.

Lithuanian Airlines (branded later as FlyLAL) was established as the Lithuanian flag carrier following independence in 1991 and inherited the Vilnius-based Aeroflot fleet of Tupolev Tu-134, Yakovlev Yak-40, Yak-42 and Antonov An-24, An-26 aircraft, but rapidly replaced these Soviet-era aircraft types with modern Boeing 737 and Boeing 757 jets and Saab 340, Saab 2000 turboprops. Operations were suspended effective 17 January 2009 as a result of growing financial difficulties. With the collapse of FlyLAL, the airport lost its scheduled services to Amsterdam, Budapest, Istanbul, Madrid and Tbilisi. FlyLAL used to operate to Dublin, Frankfurt, London, Milan and Paris in competition with Aer Lingus, airBaltic or Lufthansa.

In 2010, the number of take-offs and landings at Lithuanian airports by aircraft of both Lithuanian and foreign airlines amounted to 37.7 thousand, which is by 20.6 per cent more than in 2009. The number of take-offs and landings by aircraft on commercial flights totaled 35.4 thousand, or 93.8 per cent of all flights. In 2010, the number of passengers who arrived at and departed from Lithuanian airports amounted to 2.3 million, which is by 22.2 per cent more than in 2009. The majority of passengers arrived from and departed to the United Kingdom (20.5 per cent), Germany (12 per cent), Denmark (9.1 per cent), Latvia (8.7 per cent), and Ireland (7.4 per cent). The number of passengers on scheduled flights totalled 2 million, or 88.4 per cent of all passengers, which is by 31.5 per cent more than in 2009. 15.4 per cent of all passengers arrived and departed by the aircraft of Lithuanian airlines.

In 2011, the number of take-offs and landings at Lithuanian airports by aircraft of both Lithuanian and foreign airlines amounted to 39.5 thousand, which is by 4.8 per cent more than in 2010. The number of take-offs and landings by aircraft on commercial flights totalled 37.2 thousand, or 94.2 per cent of all flights. In 2011, the number of passengers who arrived at and de-parted from Lithuanian airports amounted to 2.7 million, which is by 17.9 per cent more than in 2010. The majority of passen-gers arrived from and departed to the United Kingdom (20.7 per cent), Germany (10.6 per cent), Latvia (8.8 per cent), Denmark (6.6 per cent), and Ireland (6.6 per cent). The number of passengers on scheduled flights totalled 2.4 million, or 90.8 per cent of all passengers, which is by 21.1 per cent more than in 2010. 7.6 per cent of all passengers arrived and departed by the aircraft of Lithuanian airlines.

In 2012, the number of take-offs and landings at Lithuanian airports by aircraft of both Lithuanian and foreign airlines amoun- ted to 41.5 thousand, which is by 5.1 per cent more than in 2011. The number of take-offs and landings by aircraft on commercial flights totalled 39.3 thousand, or 94.6 per cent of all flights. In 2012, the number of passengers who arrived at and de- parted from Lithuanian airports amounted to 3.2 million, which is by 17.6 per cent more than in 2011. The majority of passen- gers arrived from and departed to the United Kingdom (22.7 per cent), Germany (11 per cent), Latvia (6.8 per cent), Denmark (6.1 per cent), Norway (6 per cent), and Ireland (6 per cent). The number of passengers on scheduled flights totalled 2.9 million, or 91.9 per cent of all passengers, which is by 19 per cent more than in 2011. 6 per cent of all passengers arrived and departed by the aircraft of Lithuanian airlines. In 2012, freight and mail loaded and unloaded at Lithuanian airports amounted to 14.3 thousand tonnes, which is by 8.3 per cent more than in 2011. In 2012, the total number of passengers carried by the aircraft of Lithuanian airlines amounted to 576 thousand, which is by 29.6 per cent more than in 2011. The number of passengers carried on scheduled flights amounted to 110.3 thousand, or 19.2 per cent, which is by 82.7 per cent more than in 2011. All passengers on scheduled flights were carried between foreign airports. The number of passengers carried on non-scheduled flights amounted 465.7 thousand, or 80.8 per cent, which is by 21.2 per cent more than in 2011. Passenger-kilometres amounted to 1069.6 million, which is by 34.2 per cent more than in 2011.

2.5.3. Emission factors

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 2-29.

TABLE 2-29. 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

2.5.4. Methodological issues

Emissions calculations from the LTO cycle are based on the Tier 2 method and cruise emission calculations Tier 1 (EMEP/EEA air pollutant emission inventory guidebook 2009). For the LTO phase, fuel consumed and the emissions of pollutants per LTO cycle are based on representative aircraft type group data. The energy use by aircraft is calculated for both domestic and international LTOs by multiplying the LTO fuel consumption (jet fuel and aviation gasoline) factor for each representative aircraft type by the corresponding number of LTOs. In order to calculate domestic and international LTO emissions, the number of LTOs for each aircraft type is multiplied by the respective emissions per LTO.

Emissions calculations from the LTO cycle are based on the Tier 2 method and cruise emission calculations Tier 1 (EMEP/EEA air pollutant emission inventory guidebook 2009).

2.5.5. Source-specific planned improvements

No improvements planned.

2.5.6. Uncertainty

Uncertainty for activity data is 2%, emission factors – 30 %.

2.6. Railways (1.A.3.c)

5.6.1. Source category description

In 2013, the operational length of railways amounted to 1767.6 km. The length of electrified lines remained unchanged (122 km).

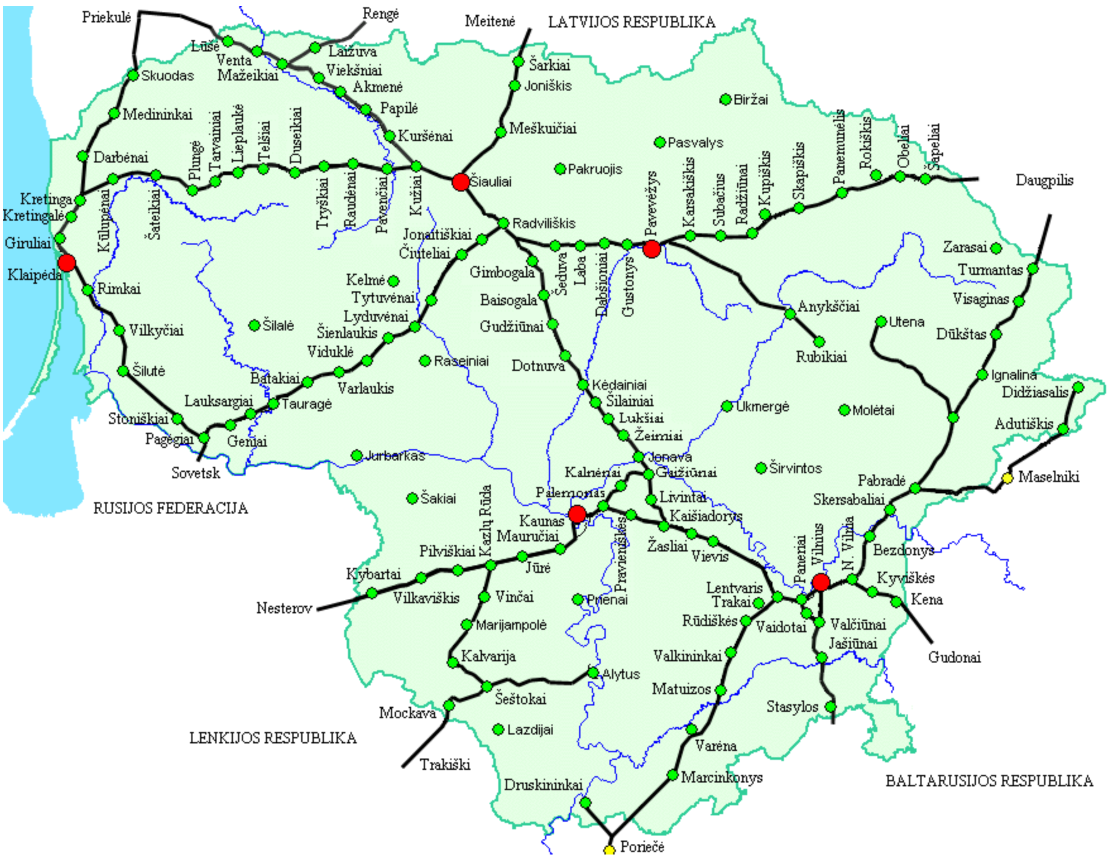

FIGURE 2.6-1 MAP OF LITHUANIAN RAILWAYS

In 2013, compared to 2012, the number of railway vehicles increased: that of locomotives – by 5.5, wagons – 1, coaches (including diesel and electric railcars) – 2.2 per cent. 66 per cent of locomotives, 77 per cent of coaches (including diesel and electric railcars) and 87 per cent of wagons were produced 15 and more years ago.

In 2013, goods transport by rail amounted to 48 million tonnes, which is by 2.7 per cent less than in 2012. National goods transport by rail amounted to 15.1 million tonnes, which is by 1.6 per cent more than in 2012; international goods transport by rail amounted to 32.9 million tonnes, which is by 4.6 per cent less than in 2012. In 2013, 32.3 per cent of all the goods carried by rail (15.5 million tonnes) were coke and refined petroleum products; compared to 2012, their carriage decreased by 7.1 per cent. Chemicals, chemical products and man-made fibres, rubber and plastic products, nuclear fuel carried by rail amounted to 11.2 million tonnes, or 23.4 per cent of all the goods carried; compared to 2012, their carriage decreased by 15.6 per cent. Metal ores and other mining and quarrying products, peat, uranium and thorium amounted to 5.8 million tonnes, or 12.1 per cent of all the goods carried by rail; compared to 2012, their carriage increased by 30.4 per cent. The major proportion of goods was carried from Belarus (62.1 per cent) and Russia (26.4 per cent). Most goods from Lithuania were carried to Latvia (22.2 per cent), Belarus (19.8 per cent), and Ukraine (17.5 per cent). In 2013, the number of passengers carried by rail totalled 4.8 million, which is by 0.9 per cent more than in 2012. In 2013, passenger-kilometres amounted to 391 million, which is by 3 per cent less than in 2012.

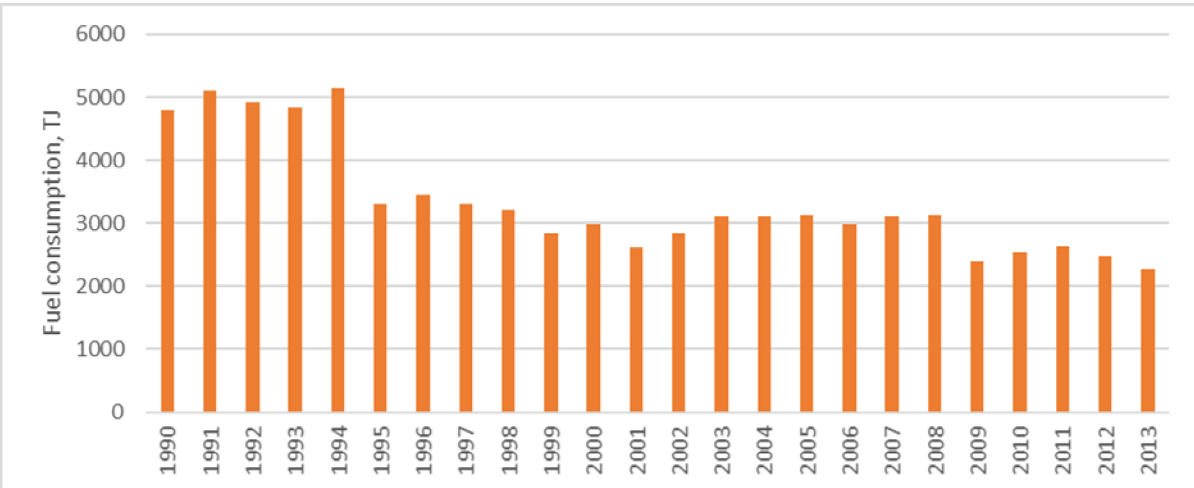

FIGURE 2.6-2 TENDENCIES OF FUEL CONSUMPTION 1A3C IN 1990-2013

TABLE 2.6-1POLLUTANT EMISSIONS FROM THE 1.A.3.C SECTOR IN THE PERIOD 1990-2013

	NOX	NMLOJ	Sox	PM2,5	PM10	TSP
1990	6,33	0,56	0,96	0,17	0,17	0,18
1991	6,72	0,60	1,02	0,18	0,18	0,19
1992	6,49	0,58	0,99	0,18	0,17	0,19
1993	6,38	0,57	0,97	0,18	0,17	0,19
1994	6,77	0,60	1,03	0,19	0,18	0,20
1995	4,37	0,39	0,66	0,12	0,11	0,13
1996	4,55	0,40	0,69	0,12	0,12	0,13
1997	4,36	0,39	0,66	0,12	0,11	0,13
1998	4,21	0,37	0,64	0,12	0,11	0,12
1999	3,73	0,33	0,57	0,10	0,10	0,11
2000	3,94	0,35	0,15	0,11	0,10	0,11
2001	3,46	0,31	0,13	0,10	0,09	0,10
2002	3,74	0,33	0,14	0,10	0,10	0,11
2003	4,10	0,36	0,16	0,11	0,11	0,12
2004	4,08	0,36	0,11	0,11	0,11	0,12
2005	4,13	0,37	0,11	0,11	0,11	0,12
2006	3,93	0,35	0,10	0,11	0,10	0,11
2007	4,09	0,36	0,11	0,11	0,11	0,12
2008	4,13	0,37	0,11	0,11	0,11	0,12
2009	3,16	0,28	0,08	0,09	0,08	0,09
2010	3,35	0,30	0,09	0,09	0,09	0,10
2011	3,49	0,31	0,09	0,10	0,09	0,10
2012	3,27	0,29	0,09	0,09	0,09	0,09
2013	3,01	0,27	0,08	0,08	0,08	0,09
Trend 1990-2013, %	**-52,47%**	**-52,47%**	**-91,68%**	**-52,47%**	**-52,47%**	**-52,47%**
Trend 2005-2013, %	**-27,19%**	**-27,19%**	**-27,19%**	**-27,19%**	**-27,19%**	**-27,19%**

In 2013, compared to 2012, national passenger transport increased by 0.7, international transport – by 1.6 per cent. In 2013, compared to 2012, the number of arriving passengers increased by 12.9, that of departing passengers – by 16.6 per cent. The majority of passengers departed to (70.1 per cent) and arrived from (68.3 per cent) Belarus.

5.6.1. Methodological issues

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

$$E_i = FC \cdot EF_i \quad (2.8.3)$$

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.

5.6.2. Emission factors

TABLE 2.6-2 TIER 1 EMISSION FACTORS FOR SOURCE CATEGORY 1.A.3.C

Code			Name		
NFR Source Category		1.A.3.c		Railways	
Fuel			Gas Oil, Diesel		
Not estimated SOx, Pb, Hg, As, PCDD/F, B(k)F, I(1,2,3,-cd)pyrene					
Not applicable			DDT, PCB, HCB		
Pollutant	**Value**		**Unit**	**95% confidence interval**	**Reference**
NOx	52.4	kg/tonne	25	93	Aggregated Tier 2 method
CO	10.7	g/GJ	6	19	EMEP CORINAIR Gdbk 3.2/2006
NMVOC	4.65	g/GJ	6	19	EMEP CORINAIR Gdbk 3.2/2006
TSP	1,52	g/GJ	3	23	Aggregated Tier 2 method
PM10	1.44	g/GJ	2	200	Aggregated Tier 2 method
PM2.5	3.4	g/GJ	2	16	Aggregated Tier 2 method
Cd	0.01	mg/GJ	0.003	0.025	EMEP CORINAIR

					Gdbk 3.2/2006
Cr	0.05	mg/GJ	0.02	0.2	EMEP CORINAIR Gdbk 3.2/2006
Cu	1.7	mg/GJ	0.5	4.9	EMEP CORINAIR Gdbk 3.2/2006
Ni	0.07	mg/GJ	0.02	0.2	EMEP CORINAIR Gdbk 3.2/2006
Se	0.01	mg/GJ	0.003	37.3	EMEP CORINAIR Gdbk 3.2/2006
Zn	19	mg/GJ	7.75	0.025	EMEP CORINAIR Gdbk 3.2/2006
Benzo(a)pyrene	0.03	µg/GJ	0.01	0.1	EMEP CORINAIR Gdbk 3.2/2006
Benzo(b)fluoranthene	0.05	µg/GJ	0.02	0.2	EMEP CORINAIR Gdbk 3.2/2006
Benzo(k)fluoranthene	29	µg/GJ	2.9	290	EMEP CORINAIR Gdbk 3.2/2006

5.6.3. Source-specific planned improvements

Uncertainty analysis for the railway transport sector.

5.7. Water borne navigation (1.A.3.d3i, 1.A.3.d3ii)

5.7.1. Source category description

The Nemunas River is navigable and used for commercial shipping between Kaunas and the Baltic seaport of Klaipeda, reached through a channel in the Kuronian Bay. East of Kaunas, about 204 km inland from Klaipeda, a hydropower dam with no lock prevents the development of inland shipping upstream (Fig. 5.7-1).

FIGURE 5.7-1. NATIONAL NAVIGATION WAYS

The channel is marked by navigation markers between Kaunas and the mouth of the river and by navigation lights on the Kuronian Bay. There is little barge traffic on the river, mainly timber and construction materials.

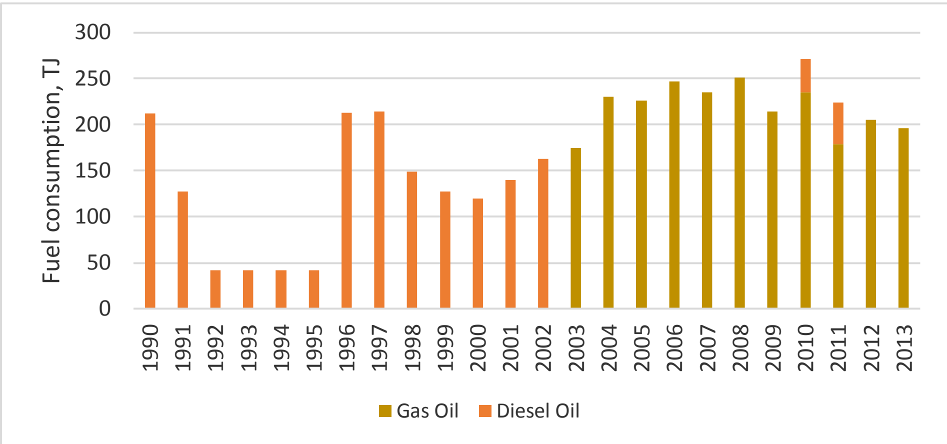

FIGURE 5.7-2 TENDENCIES OF FUEL CONSUMPTION IN 1.A.3.D IN 1990-2013

The activity data of national navigation was provided by Statistics Lithuania. International marine bunkers (international navigation) is defined as fuel delivered to ships of all flags that are engaged in international navigation. Fuel consumption by ships engaged in fishing and domestic navigation vessels is excluded (Memo item).

TABLE 5.7-11POLLUTANT EMISSIONS FROM THE 1.A.3.D SECTOR IN THE PERIOD 1990-2013

	NOX	NMLOJ	SOx	NH3	PM2,5	PM10	TSP	BC	CO
1990	0,05	3,07	0,02	NE	0,01	0,01	0,01	0,00	3,07
1991	0,17	1,84	0,01	NE	0,00	0,00	0,00	0,00	1,84
1992	0,06	0,61	0,00	NE	0,00	0,00	0,00	0,00	0,61
1993	0,06	0,61	0,00	NE	0,00	0,00	0,00	0,00	0,61
1994	0,06	0,61	0,00	NE	0,00	0,00	0,00	0,00	0,61
1995	0,06	0,61	0,00	NE	0,00	0,00	0,00	0,00	0,61
1996	0,28	3,07	0,02	NE	0,01	0,01	0,01	0,00	3,07
1997	0,28	3,09	0,03	NE	0,01	0,01	0,01	0,00	3,09
1998	0,20	2,15	0,02	NE	0,01	0,01	0,01	0,00	2,15
1999	0,17	1,83	0,01	NE	0,00	0,00	0,00	0,00	1,83
2000	0,16	1,73	0,01	NE	0,00	0,00	0,00	0,00	1,73
2001	0,18	2,02	0,02	NE	0,01	0,00	0,01	0,00	2,02
2002	0,21	2,35	0,02	NE	0,01	0,01	0,01	0,00	2,35
2003	0,21	0,02	0,04	NE	0,01	0,01	0,01	NO	2,33
2004	0,28	0,02	0,05	NE	0,01	0,01	0,01	NO	3,06
2005	0,27	0,02	0,05	NE	0,01	0,01	0,01	NO	3,01
2006	0,30	0,03	0,05	NE	0,01	0,01	0,01	NO	3,29
2007	0,29	0,03	0,05	NE	0,01	0,01	0,01	NO	3,13
2008	0,31	0,03	0,05	NE	0,01	0,01	0,01	NO	3,34
2009	0,26	0,02	0,04	NE	0,01	0,01	0,01	NO	2,85
2010	0,33	0,54	0,05	NE	0,01	0,01	0,01	0,00	3,65
2011	0,28	0,67	0,04	NE	0,01	0,01	0,01	0,00	3,03
2012	0,25	0,02	0,04	NE	0,01	0,01	0,01	0,00	2,73
2013	0,24	0,02	0,04	NE	0,01	0,01	0,01	0,00	2,61

5.7.2. Emission factors

Emissions were calculated according to EEA emission guidebook 2013 methodology Tier 1 approach.

TABLE 5.7-2TIER 1 EMISSION FACTORS FOR SHIPS USING BUNKER FUEL OIL

Code			Name		
NFR Source Category		1.A.3.d		Navigation	
Fuel			Bunker Fuel Oil		
Not estimated SOx, Pb, Hg, As, PCDD/F, B(k)F, I(1,2,3,-cd)pyrene					
Not applicable			DDT, PCB, HCB		
Pollutant	**Value**		**Unit**	**95% confidence interval**	**Reference**
NOx	79.3	kg/tonne	0	0	Entec (2007). See also note (2)
CO	7.4	kg/tonne	0	0	Lloyd's Register (1995)
NMVOC	2.7	kg/tonne	0	0	Entec (2007). See also note (2)
SOx	20	kg/tonne	0	0	Note value of 20 should read
TSP	6.2	kg/tonne	0	0	Entec (2007)
PM10	6.2	kg/tonne	0	0	Entec (2007)
PM2.5	5.6	kg/tonne	0	0	Entec (2007)
Pb	0.18	g/tonne	0	0	average value
Cd	0.02	g/tonne	0	0	average value
Hg	0.02	g/tonne	0	0	average value
As	0.68	g/tonne	0	0	average value
Cr	0.72	g/tonne	0	0	average value
Cu	1.25	g/tonne	0	0	average value
Ni	32	g/tonne	0	0	average value
Se	0.21	g/tonne	0	0	average value
Zn	1.2	g/tonne	0	0	average value
PCB	0.57	mg/tonne	0	0	Cooper (2005)

HCB	0.14	kg/tonne	0	0	Cooper (2005)

TABLE 5.7-3 TIER 1 EMISSION FACTORS FOR SHIPS USING MARINE DIESEL OIL/MARINE GAS OIL

Code			Name		
NFR Source Category		1.A.3.d		Navigation	
Fuel			Marine diesel oil/marine gas oil		
Not estimated NH3, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs					
Not applicable			Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex,		
Pollutant	**Value**		**Unit**	**95% confidence interval**	**Reference**
NOx	78.5	kg/tonne	0	0	Entec (2007). See also note (2)
CO	7.4	kg/tonne	0	0	Lloyd's Register (1995)
NMVOC	2.8	kg/tonne	0	0	Entec (2007). See also note (2)
SOx	20	kg/tonne	0	0	Note value of 20 should read
TSP	1.5	kg/tonne	0	0	Entec (2007)
PM10	1.5	kg/tonne	0	0	Entec (2007)
PM2.5	1.5	kg/tonne	0	0	Entec (2007)
Pb	0.13	g/tonne	0	0	average value
Cd	0.01	g/tonne	0	0	average value
Hg	0.03	g/tonne	0	0	average value
As	0.04	g/tonne	0	0	average value
Cr	0.05	g/tonne	0	0	average value
Cu	0.88	g/tonne	0	0	average value
Ni	1	g/tonne	0	0	average value
Se	0.1	g/tonne	0	0	average value
Zn	1.2	g/tonne	0	0	average value
PCB	0.038	mg/tonne	0	0	Cooper (2005)

HCB	0.08	mg/tonne	0	0	Cooper (2005)

Notes

1. S = percentage sulphur content in fuel; pre-2000 fuels: 0.5 % wt. [source: Lloyd's Register, 1995]. For European Union as specified in the Directive 2005/33/EC: a. 0.2 % wt. from 1 July 2000 and 0.1 % wt. from 1 January 2008 for marine diesel oil/marine gas oil used by seagoing ships (except if used by ships crossing a frontier between a third country and a Member State);

b. 0.1% wt. from 1 January 2010 for inland waterway vessels and ships at berth in Community ports.

2. Emission factor for NOx and NMVOC are the 2000 values in cruise for medium speed engines (see Tier 2).

3. Reference: 'average value' is between Lloyd's Register (1995) and Cooper and Gustafsson (2004)

4. BC fraction of PM (f-BC) = 0.31. Source: for further information see Appendix A

TABLE 5.7-4TIER 1 EMISSION FACTORS FOR SHIPS USING GASOLINE

Code			Name		
NFR Source Category		1.A.3.d		Navigation	
Fuel			Marine diesel oil/marine gas oil		
Not estimated NH3, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs					
Not applicable			Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Heptabromo-biphenyl, Mirex,		
Pollutant	**Value**		**Unit**	**95% confidence interval**	**Reference**
NOx	9.4	kg/tonne	0	0	Winther & Nielsen (2006)
CO	573.9	kg/tonne	0	0	Winther & Nielsen (2006)
NMVOC	181.5	kg/tonne	0	0	Winther & Nielsen (2006)
SOx	20	kg/tonne	0	0	Winther &

					Nielsen (2006)
TSP	9.5	kg/tonne	0	0	Winther & Nielsen (2006)
PM10	9.5	kg/tonne	0	0	Winther & Nielsen (2006)
PM2.5	9.5	kg/tonne	0	0	Winther & Nielsen (2006)

Notes: The table contains averaged figures between 2-stroke and 4-stroke engines, assuming a share of 75% 2-stroke and 25% 4-stroke ones. If more detailed data are available the Tier 2 method should be used. BC fraction of PM (f-BC) = 0.05

5.7.3. Methodological issues

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

$$E_i = FC \cdot EF_i \qquad (2.9.3)$$

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.

5.7.4. Uncertainty

Entec (2002) provides estimates of uncertainties for emission factors as indicated in the table below.

TABLE 5.7-5 ESTIMATED UNCERTAINTIES GIVEN AS PERCENTAGE RELATED TO THE EMISSION FACTORS PARAMETER

	at sea	manoeuvring	in port
NOx	±20%	±40%	±30%
SOx	±10%	±30%	±20%
NMVOC	±25%	±50%	±40%
PM	±25%	±50%	±40%
Fuel Consumption	±10%	±30%	±20%

5.7.5. Source-specific planned improvements

No improvements are planned.

5.8. Small Combustion and Non-road mobile sources (1.A.4.A-B)

5.8.1. Source category description

The small combustion installations included in this chapter are mainly intended for heating and provision of hot water in residential and commercial/institutional sectors. Some of these installations are also used for cooking (primarily in the residential sector). In the agricultural sector the heat generated by the installations is used also for crops drying and for heating greenhouses.

Sectors covered in this chapter are:

- NFR Code 1A4a — Commercial / institutional
- NFR Code 1A4b — Residential
- NFR Code 1A2f ii — Mobile combustion in manufacturing industries and construction
- NFR Code 1A4c — Agriculture/Forestry/Fishing

Activity data

For calculation of emissions in category Commercial/ institutional sector (1.A.4.a), Residential (1.A.4.b) and Agriculture/Forestry/Fishing (1.A.4.c) activity data had been obtained from the Lithuanian Statistics database.

Commercial and institutional sector encompasses the following activities in Lithuania: wholesale and retail trade, maintenance of motor vehicle and motorbikes, repairing of household equipments, hotels and restaurants, financial intermediation, real estate management and rent, public management and defence, mandatory social security, education, health treatment and social work, other public, social and individual services, as well private households related activities.

The small combustion installations included in this chapter are mainly intended for heating and provision of hot water in residential and commercials/institutional sectors. Some of these installations are also used for cooking, primarily in the residential sector. Emissions from smaller combustion installations are significant due to their numbers, different type of combustion techniques employed, and range of efficiencies and emissions.

Enterprises consuming fuel and energy belonging to the following economic activities: agricultural (with 10 and more employees), forestry and fishing.

Consumption in agriculture encompasses fuel and energy consumption by enterprises whose economic activity is related to agriculture, hunting and forestry.

Consumption in fishing encompasses fuels delivered to inland, coastal and deep-sea fishing vessels of all flags that are refuelled in the country (including international fishing) and fuel and energy used in the fishing industry.

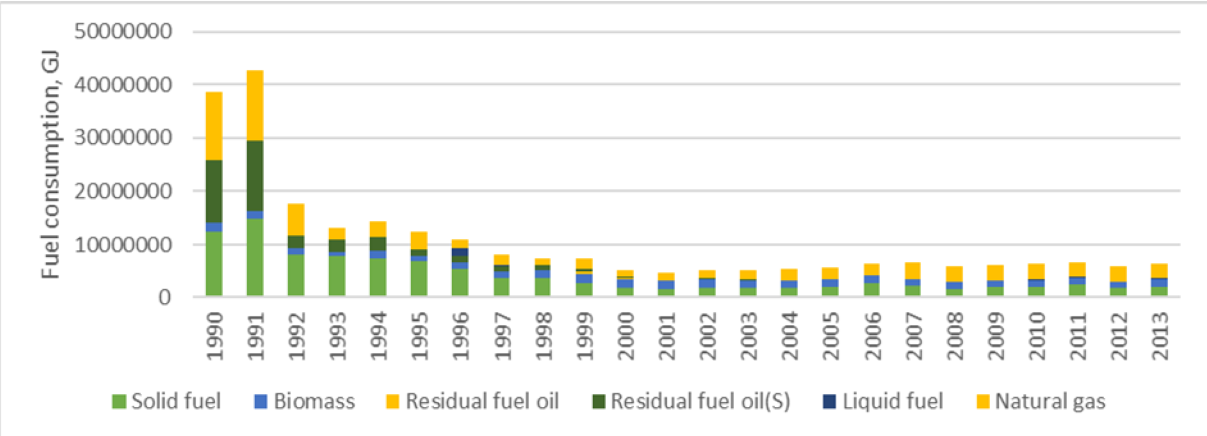

FIGURE 5.8-1FUEL CONSUMPTION IN SMALL COMBUSTION 1.A.4.A SECTOR

After the drastically reduced fuel consumption volume in Commercial / institutional sector during 1990-2000, later (2001-2007) fuel consumption volumes was increasing by 12.6% a year (Biomass 14%, liquid fuel and natural gas 27-28%).

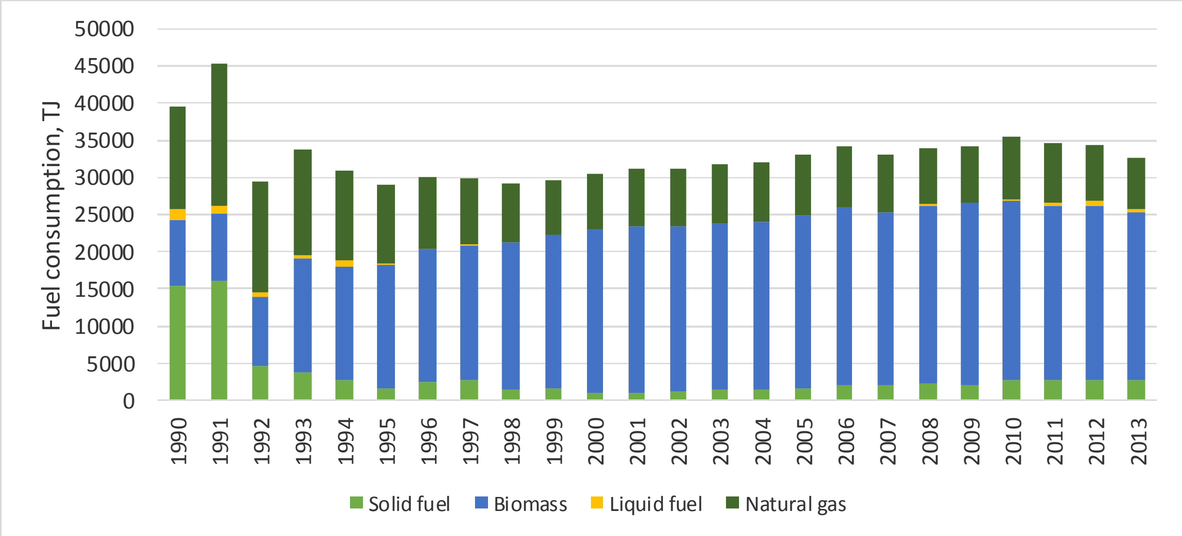

FIGURE 5.8-2FUEL CONSUMPTION IN SMALL COMBUSTION 1.A.4.B SECTOR

TABLE 5.8-1 POLLUTANT EMISSIONS FROM THE 1.A.4.A SECTOR IN THE PERIOD 1990-2013

	NOX	NMLOJ	Sox	NH3	PM2,5	PM10	TSP	BC	CO
1990	9,373	1,845	12,763	0,524	1,773	1,901	2,000	0,280	14,335
1991	10,597	2,082	14,643	0,602	2,031	2,178	2,292	0,314	16,400
1992	3,274	1,017	8,318	0,342	1,051	1,134	1,198	0,115	8,932
1993	2,805	0,872	7,781	0,320	0,980	1,058	1,118	0,093	8,257
1994	3,093	0,912	7,880	0,324	1,001	1,079	1,141	0,102	8,410
1995	2,221	0,803	7,065	0,290	0,874	0,945	1,000	0,081	7,481
1996	2,542	0,699	6,110	0,249	0,776	0,836	0,883	0,081	6,470
1997	1,647	0,516	4,476	0,183	0,562	0,606	0,641	0,056	4,750
1998	1,465	0,506	4,619	0,190	0,574	0,620	0,656	0,051	4,871
1999	1,412	0,469	4,100	0,168	0,512	0,553	0,585	0,049	4,355
2000	0,900	0,357	3,230	0,133	0,396	0,428	0,453	0,034	3,401
2001	0,734	0,320	2,876	0,118	0,349	0,378	0,400	0,029	3,025
2002	0,802	0,349	3,113	0,128	0,378	0,409	0,433	0,032	3,277
2003	0,821	0,334	2,925	0,120	0,357	0,386	0,409	0,032	3,088
2004	0,761	0,331	2,823	0,116	0,342	0,370	0,392	0,032	2,987
2005	0,795	0,354	3,072	0,126	0,372	0,402	0,426	0,033	3,241
2006	0,924	0,421	3,717	0,153	0,449	0,486	0,515	0,039	3,911
2007	0,875	0,375	3,069	0,126	0,372	0,403	0,427	0,037	3,264
2008	0,791	0,329	2,625	0,108	0,319	0,345	0,366	0,033	2,802
2009	0,814	0,353	2,937	0,121	0,356	0,385	0,408	0,034	3,116
2010	0,847	0,363	2,983	0,122	0,362	0,392	0,415	0,036	3,171
2011	0,911	0,400	3,422	0,140	0,414	0,449	0,475	0,038	3,617
2012	0,800	0,342	2,809	0,115	0,341	0,369	0,391	0,034	2,987
2013	0,862	0,377	3,160	0,130	0,383	0,414	0,439	0,036	3,349

Trend 1990-2013, %	**-90,80%**	**-79,57%**	**-75,24%**	**-75,28%**	**-78,42%**	**-78,21%**	**-78,07%**	**-87,00%**	**-76,64%**
Trend 2005-2013, %	**8,50%**	**6,42%**	**2,86%**	**2,82%**	**2,98%**	**2,97%**	**2,96%**	**9,71%**	**3,32%**

TABLE 5.8-2POLLUTANT EMISSIONS FROM THE 1.A.4.B (STATIONARY) SECTOR IN THE PERIOD 1990-2013

	NOX	NMLOJ	Sox	NH3	PM2,5	PM10	TSP	BC
1990	3,112	12,847	13,904	0,635	12,779	13,051	14,024	1,057
1991	3,477	13,258	14,651	0,635	13,115	13,392	14,398	1,079
1992	2,002	7,798	4,234	0,649	8,689	8,901	9,455	0,802
1993	2,369	10,966	3,649	1,059	12,739	13,065	13,824	1,218
1994	2,131	10,458	2,621	1,065	12,343	12,663	13,380	1,195
1995	2,052	10,806	1,746	1,161	12,970	13,312	14,045	1,272
1996	2,186	11,936	2,418	1,252	14,219	14,592	15,405	1,386
1997	2,206	12,239	2,569	1,278	14,562	14,942	15,778	1,418
1998	2,150	12,587	1,599	1,381	15,209	15,613	16,463	1,499
1999	2,198	13,176	1,634	1,448	15,932	16,355	17,245	1,570
2000	2,252	13,693	1,080	1,544	16,695	17,141	18,060	1,656
2001	2,300	13,992	1,094	1,578	17,061	17,517	18,456	1,692
2002	2,296	13,862	1,326	1,548	16,848	17,298	18,230	1,667
2003	2,349	14,102	1,550	1,562	17,096	17,550	18,501	1,688
2004	2,370	14,272	1,453	1,588	17,327	17,789	18,750	1,713
2005	2,451	14,719	1,646	1,629	17,837	18,311	19,303	1,761
2006	2,557	15,397	2,049	1,683	18,587	19,079	20,120	1,830
2007	2,479	14,916	2,166	1,619	17,966	18,441	19,451	1,766
2008	2,553	15,490	2,273	1,680	18,652	19,145	20,194	1,833
2009	2,573	15,694	2,142	1,713	18,934	19,436	20,497	1,863
2010	2,648	15,759	2,738	1,683	18,881	19,378	20,448	1,848
2011	2,585	15,403	2,801	1,637	18,427	18,911	19,959	1,802
2012	2,575	15,450	2,780	1,644	18,489	18,975	20,026	1,808
2013	2,465	14,935	2,789	1,582	17,851	18,320	19,337	1,744
Trend 1990-2013, %	**-20,81%**	**16,25%**	**-79,94%**	**149,40%**	**39,69%**	**40,38%**	**37,88%**	**64,96%**
Trend 2005-2013, %	**0,54%**	**1,47%**	**69,46%**	**-2,84%**	**0,08%**	**0,05%**	**0,17%**	**-0,95%**

5.8.2. Methodological issues

TABLE 5.8-3TIER 1 EMISSION FACTORS FOR NFR SOURCE CATEGORY 1.A.4.B, USING HARD COAL AND BROWN COAL

Code			Name	
NFR Source Category	1.A.4.b.i		Residential plants	
Fuel			Hard Coal and Brown Coal	
Not applicable			HCH	
Not estimated				
Pollutant	**Value**	**Unit**	**95% confidence interval**	**Reference**
Lower			**Upper**	

NOx	110	g/GJ	36	200	Guidebook (2006) chapter B216
CO	4600	g/GJ	3000	7000	Guidebook (2006) chapter B216
NMVOC	484	g/GJ	250	840	Guidebook (2006) chapter B216
SOx	900	g/GJ	300	1000	Guidebook (2006) chapter B216
NH3	0.3	g/GJ	0.1	7	Guidebook (2006) chapter B216
TSP	444	g/GJ	80	600	Guidebook (2006) chapter B216
PM10	404	g/GJ	76	480	Guidebook (2006) chapter B216
PM2.5	398	g/GJ	72	480	Guidebook (2006) chapter B216
BC	6.4	% of PM2.5	2	26	Zhang et al., 2012
Pb	130	mg/GJ	100	200	Guidebook (2006) chapter B216
Cd	1.5	mg/GJ	0.5	3	Guidebook (2006) chapter B216
Hg	5.1	mg/GJ	3	6	Guidebook (2006) chapter B216
As	2.5	mg/GJ	1.5	5	Guidebook (2006) chapter B216
Cr	11.2	mg/GJ	10	15	Guidebook (2006) chapter B216
Cu	22.3	mg/GJ	20	30	Guidebook (2006) chapter B216
Ni	12.7	mg/GJ	10	20	Guidebook (2006) chapter B216
Se	1	mg/GJ	1	2.4	Expert judgement based on Guidebook (2006) chapter B216
Zn	220	mg/GJ	120	300	Guidebook (2006) chapter B216
PCB	170	µg/GJ	85	260	Kakareka et al. (2004)
PCDD/F	800	ng I-TEQ/GJ	300	1200	Guidebook (2006) chapter B216
Benzo(a)pyrene	230	mg/GJ	60	300	Guidebook (2006) chapter B216
Benzo(b)fluoranthene	330	mg/GJ	102	480	Guidebook (2006) chapter B216
Benzo(k)fluoranthene	130	mg/GJ	60	180	Guidebook (2006) chapter B216
Indeno(1,2,3-cd)pyrene	110	mg/GJ	48	144	Guidebook (2006) chapter B216
HCB	0.62	µg/GJ	0.31	1.2	Guidebook (2006) chapter B216

TABLE 5.8-4 TIER 1 EMISSION FACTORS FOR NFR SOURCE CATEGORY 1.A.4.B, USING GASEOUS FUELS

Tier 1 default emission factors					
Code			Name		
NFR Source Category		1.A.4.b.i		Residential plants	
Fuel			Gaseous fuels		
Not applicable			HCH		
Not estimated			NH3, PCB		
Pollutant	**Value**		**Unit**	**95% confidence**	**Reference**
NOx	51	g/GJ	31	71	*
CO	26	g/GJ	18	42	*
NMVOC	1.9	g/GJ	1.1	2.6	*
SOx	0.3	g/GJ	0.2	0.4	*
TSP	1.2	g/GJ	0.7	1.7	*
PM10	1.2	g/GJ	0.7	1.7	*
PM2.5	1.2	g/GJ	0.7	1.7	*
BC	5.4	% of PM2.5	2.7	11	*
Pb	0.0015	mg/GJ	0.0008	0.003	*
Cd	0.00025	mg/GJ	0.0001	0.0005	*
Hg	0.68	mg/GJ	0.3	1.4	*
As	0.12	mg/GJ	0.06	0.24	*
Cr	0.00076	mg/GJ	0.0004	0.0015	*
Cu	0.000076	mg/GJ	0.00004	0.00015	*
Ni	0.00051	mg/GJ	0.0003	0.0010	*

Se	0.011	mg/GJ	0.004	0.011	*
Zn	0.0015	mg/GJ	0.0008	0.003	*
PCDD/F	1.5	ng I-TEQ/GJ	0.8	2.3	*
Benzo(a)pyrene	0.56	µg/GJ	0.19	0.56	*
Benzo(b)fluoranthene	0.84	µg/GJ	0.28	0.84	*
Benzo(k)fluoranthene	0.84	µg/GJ	0.28	0.84	*
Indeno(1,2,3-cd)pyrene	0.84	µg/GJ	0.28	0.84	*

*Tier 2 mean EF

TABLE 5.8-5TIER 1 EMISSION FACTORS FOR NFR SOURCE CATEGORY 1.A.4.B, USING LIQUID FUELS

Tier 1 default emission factors					
Code			Name		
NFR Source Category		1.A.4.b.i		Residential plants	
Fuel			'Other' Liquid Fuels		
Not applicable			HCH		
Not estimated			NH3, HCB, PCB		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	51	g/GJ	31	72	*
CO	57	g/GJ	34	80	*
NMVOC	0.69	g/GJ	0.4	1.0	*
SOx	70	g/GJ	42	97	*
TSP	1.9	g/GJ	1.1	2.6	*
PM10	1.9	g/GJ	1.1	2.6	*
PM2.5	1.9	g/GJ	1.1	2.6	*
BC	8.5	% of PM2.5	4.8	17	*
Pb	0.012	mg/GJ	0.01	0.02	*
Cd	0.001	mg/GJ	0.0003	0.001	*
Hg	0.12	mg/GJ	0.03	0.12	*
As	0.002	mg/GJ	0.001	0.002	*
Cr	0.20	mg/GJ	0.10	0.40	*
Cu	0.13	mg/GJ	0.07	0.26	*
Ni	0.005	mg/GJ	0.003	0.010	*
Se	0.002	*mg/GJ*	0.001	0.002	*
Zn	0.42	mg/GJ	0.21	0.84	*
PCDD/F	5.9	ng I-TEQ/GJ	1.2	30	*
Benzo(a)pyrene	80	ug/GJ	16	120	*
Benzo(b)fluoranthene	40	ug/GJ	8	60	*
Benzo(k)fluoranthene	70	ug/GJ	14	105	*
Indeno(1,2,3-cd)pyrene	160	ug/GJ	32	240	*
* average of Tier 2 EFs for residential liquid fuel combustion for all technologies					

TABLE 5.8-6TIER 1 EMISSION FACTORS FOR NFR SOURCE CATEGORY 1.A.4.B, USING BIOMASS

Tier 1 default emission factors			
Code		Name	
NFR source category	1.A.4.b.i		Residential plants
Fuel		Biomass	

Not applicable			HCH		
Not estimated					
Pollutant	Value	Unit	95 % confidence interval		Reference
Lower			Upper		
NOx	80	g/GJ	30	150	Pettersson et al. (2011) 1)
CO	4000	g/GJ	1000	10000	Pettersson et al. (2011) and Goncalves et al. (2012) 2)
NMVOC	600	g/GJ	20	3000	Pettersson et al. (2011) 2)
SO2	11	g/GJ	8	40	US EPA (1996) AP-42, Chapter 1.9
NH3	70	g/GJ	35	140	Roe et al. (2004) 2)
TSP	800	g/GJ	400	1600	Alves et al. (2011) and Glasius et al. (2005) 3) 2)
PM10	760	g/GJ	380	1520	Alves et al. (2011) and Glasius et al. (2005) 3) 2)
PM2.5	740	g/GJ	370	1480	Alves et al. (2011) and Glasius et al. (2005) 3) 2)
BC	10	% of PM2.5	2	20	Alves et al. (2011), Goncalves et al. (2011), Fernandes et al. (2011), Bølling et al. (2009), US EPA SPECIATE (2002), Rau (1989) 2)
Pb	27	mg/GJ	0.5	118	Hedberg et al. (2002), Tissari et al. (2007) , Struschka et al. (2008), Lamberg et al. (2011)
Cd	13	mg/GJ	0.5	87	Hedberg et al. (2002), Struschka et al. (2008), Lamberg et al. (2011)
Hg	0.56	mg/GJ	0.2	1	Struschka et al. (2008)
As	0.19	mg/GJ	0.05	12	Struschka et al. (2008)
Cr	23	mg/GJ	1	100	Hedberg et al. (2002) , Struschka et al. (2008)
Cu	6	mg/GJ	4	89	Hedberg et al. (2002), Tissari et al. (2007) , Struschka et al. (2008), Lamberg et al. (2011)
Ni	2	mg/GJ	0.5	16	Hedberg et al. (2002), Struschka et al. (2008), Lamberg et al. (2011)
Se	0.5	mg/GJ	0.25	1.1	Hedberg et al. (2002)
Zn	512	mg/GJ	80	1300	Hedberg et al. (2002), Tissari et al. (2007) , Struschka et al. (2008), Lamberg et al. (2011)
PCB	0.06	□g/GJ	0.006	0.6	Hedman et al. (2006) 1)
PCDD/F	800	ng I-TEQ/GJ	20	5000	Glasius et al. (2005); Hedman et al. (2006); Hübner et al. (2005)2)
Benzo(a)pyrene	121	mg/GJ	12	1210	Goncalves et al. (2012); Tissari et al. (2007);

					Hedberg et al. (2002); Pettersson et al. (2011); Glasius et al. (2005); Paulrud et al. (2006); Johansson et al. (2003); Lamberg et al. (2011)
Benzo(b)fluoranthene	111	mg/GJ	11		1110
Benzo(k)fluoranthene	42	mg/GJ	4		420
Indeno(1,2,3-cd)pyrene	71	mg/GJ	7		710
HCB	5	µg/GJ	0.1	30	Syc et al. (2011)

1) Assumed equal to conventional boilers

2) Assumed equal to conventional stoves

3) PM_{10} estimated as 95 % of TSP, $PM_{2.5}$ estimated as 93 % of TSP. The PM fractions refer to Boman et al. (2011), Pettersson et al. (2011) and the TNO CEPMEIP database.

4) If the reference states the emission factor in g/kg dry wood the emission factors have been recalculated to g/GJ based on NCV stated in each reference. If NCV is not stated in a reference, the following values have been assumed: 18 MJ/kg for wood logs and 19 MJ/kg for wood pellets.

TABLE 5.8-7TIER 1 EMISSION FACTORS FOR NFR SOURCE CATEGORY 1.A.4.A/C, 1.A.5.A, USING HARD AND BROWN COAL

Tier 1 default emission factors					
Code			Name		
NFR Source Category		1.A.4.a.i 1.A.4.c.i 1.A.5.a		Commercial / institutional: stationary Stationary Other, stationary (including military)	
Fuel			Hard Coal and Brown Coal		
Not applicable			HCH		
Not estimated			NH3		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	173	g/GJ	150	200	Guidebook (2006) chapter B216
CO	931	g/GJ	150	2000	Guidebook (2006) chapter B216
NMVOC	88.8	g/GJ	10	300	Guidebook (2006) chapter B216
SOx	900	g/GJ	450	1000	Guidebook (2006) chapter B216
TSP	124	g/GJ	70	250	Guidebook (2006) chapter B216
PM10	117	g/GJ	60	240	Guidebook (2006) chapter B216
PM2.5	108	g/GJ	60	220	Guidebook (2006) chapter B216
BC	6.4	% of PM2.5	2	26	See Note
Pb	134	mg/GJ	50	300	Guidebook (2006) chapter B216
Cd	1.8	mg/GJ	0.2	5	Guidebook (2006) chapter B216
Hg	7.9	mg/GJ	5	10	Guidebook (2006)

					chapter B216
As	4	mg/GJ	0.2	8	Guidebook (2006) chapter B216
Cr	13.5	mg/GJ	0.5	20	Guidebook (2006) chapter B216
Cu	17.5	mg/GJ	5	50	Guidebook (2006) chapter B216
Ni	13	mg/GJ	0.5	30	Guidebook (2006) chapter B216
Se	1.8	mg/GJ	0.2	3	Guidebook (2006) chapter B216
Zn	200	mg/GJ	50	500	Guidebook (2006) chapter B216
PCB	170	μg/GJ	85	260	Kakareka et al. (2004)
PCDD/F	203	ng I-TEQ/GJ	40	500	Guidebook (2006) chapter B216
Benzo(a)pyrene	45.5	mg/GJ	10	150	Guidebook (2006) chapter B216
Benzo(b)fluoranthene	58.9	mg/GJ	10	180	Guidebook (2006) chapter B216
Benzo(k)fluoranthene	23.7	mg/GJ	8	100	Guidebook (2006) chapter B216
Indeno(1,2,3-cd)pyrene	18.5	mg/GJ	5	80	Guidebook (2006) chapter B216
HCB	0.62	μg/GJ	0.31	1.2	Guidebook (2006) chapter B216

TABLE 5.8-8TIER 1 EMISSION FACTORS FOR NFR SOURCE CATEGORY 1.A.4.A/C, 1.A.5.A, USING GASEOUS FUELS

Tier 1 default emission factors					
Code			Name		
NFR Source Category		1.A.4.a.i 1.A.4.c.i 1.A.5.a		Commercial / institutional: stationary Stationary Other, stationary (including military)	
Fuel			Gaseous Fuels		
Not applicable			HCH		
Not estimated			NH3, PCB, HCB		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	74	g/GJ	46	103	*
CO	29	g/GJ	21	48	*
NMVOC	23	g/GJ	14	33	*
SOx	0.67	g/GJ	0.40	0.94	*
TSP	0.78	g/GJ	0.47	1.09	*
PM10	0.78	g/GJ	0.47	1.09	*
PM2.5	0.78	g/GJ	0.47	1.09	*
BC	*4.0*	*% of PM2.5*	*2.1*	*7*	*
Pb	0.011	**mg/GJ**	0.006	0.022	*
Cd	0.0009	**mg/GJ**	0.0003	0.0011	*
Hg	0.54	**mg/GJ**	0.26	1.0	*
As	0.10	**mg/GJ**	0.05	0.19	*
Cr	0.013	**mg/GJ**	0.007	0.026	*

Cu	0.0026	**mg/GJ**	0.0013	0.0051	*
Ni	0.013	**mg/GJ**	0.006	0.026	*
Se	0.058	mg/GJ	0.015	0.058	*
Zn	0.73	**mg/GJ**	0.36	1.5	*
PCDD/F	0.52	ng I-TEQ/GJ	0.25	1.3	*
Benzo(a)pyrene	0.72	ug/GJ	0.20	1.9	*
Benzo(b)fluoranthene	2.9	ug/GJ	0.7	12	*
Benzo(k)fluoranthene	1.1	ug/GJ	0.3	2.8	*
Indeno(1,2,3-cd)pyrene	1.08	ug/GJ	0.30	2.9	*
* average of Tier 2 EFs for commercial/institutional gaseous fuel combustion for all technologies					

TABLE 5.8-9TIER 1 EMISSION FACTORS FOR NFR SOURCE CATEGORY 1.A.4.A/C, 1.A.5.A, USING LIQUID FUEL

s Tier 1 default emission factors					
Code			Name		
NFR Source Category		1.A.4.a.i 1.A.4.c.i 1.A.5.a		Commercial / institutional: stationary Stationary Other, stationary (including military)	
Fuel			Liquid Fuels		
Not applicable			HCH		
Not estimated			NH3, PCB, HCB		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	513	g/GJ	308	718	*
CO	66	g/GJ	40	93	*
NMVOC	25	g/GJ	15	35	*
SOx	47	g/GJ	28	66	*
TSP	20	g/GJ	12	28	*
PM10	20	g/GJ	12	28	*
PM2.5	20	g/GJ	12	28	*
BC	56	*% of PM2.5*	33	78	*
Pb	0.08	mg/GJ	0.04	0.16	*
Cd	0.006	mg/GJ	0.003	0.011	*
Hg	0.12	mg/GJ	0.04	0.17	*
As	0.03	mg/GJ	0.02	0.06	*
Cr	0.20	mg/GJ	0.10	0.40	*
Cu	0.22	mg/GJ	0.11	0.43	*
Ni	0.008	mg/GJ	0.004	0.015	*
Se	0.11	mg/GJ	0.06	0.22	*
Zn	29	mg/GJ	15	58	*
PCDD/F	1.4	*ng I-TEQ/GJ*	0.3	7.1	*
Benzo(a)pyrene	1.9	ug/GJ	0.2	1.9	*
Benzo(b)fluoranthene	15	ug/GJ	1.5	15	*
Benzo(k)fluoranthene	1.7	ug/GJ	0.2	1.7	*
Indeno(1,2,3-cd)pyrene	1.5	ug/GJ	0.2	1.5	*
* average of Tier 2 EFs for commercial/institutional liquid fuel combustion for all technologies					

Table 5.8-10Tier 1 emission factors for NFR source category 1.A.4.a/c, 1.A.5.a, using biomass

Tier 1 emission factors					
Code			Name		
NFR source category		1.A.4.a.i 1.A.4.c.i 1.A.5.a		Commercial / institutional: stationary Stationary Other, stationary (including military)	
Fuel			Biomass		
Not applicable			HCH		
Not estimated					
Pollutant	Value	Unit	95 % confidence interval		Reference
Lower			Upper		
NOx	91	g/GJ	20	120	Lundgren et al. (2004) 1)
CO	570	g/GJ	50	4000	EN 303 class 5 boilers, 150-300 kW
NMVOC	300	g/GJ	5	500	Naturvårdsverket, Sweden
SO2	11	g/GJ	8	40	US EPA (1996) AP-42, Chapter 1.9
NH3	37	g/GJ	18	74	Roe et al. (2004) 2)
TSP	150	g/GJ	75	300	Naturvårdsverket, Sweden
PM10	143	g/GJ	71	285	Naturvårdsverket, Sweden 3)
PM2.5	140	g/GJ	70	279	Naturvårdsverket, Sweden 3)
BC	28	% of PM2.5	11	39	Goncalves et al. (2010), Fernandes et al. (2011), Schmidl et al. (2011) 4)
Pb	27	mg/GJ	0.5	118	Hedberg et al. (2002), Tissari et al. (2007) , Struschka et al. (2008), Lamberg et al. (2011)
Cd	13	mg/GJ	0.5	87	Hedberg et al. (2002), Struschka et al. (2008), Lamberg et al. (2011)
Hg	0.56	mg/GJ	0.2	1	Struschka et al. (2008)
As	0.19	mg/GJ	0.05	12	Struschka et al. (2008)
Cr	23	mg/GJ	1	100	Hedberg et al. (2002) , Struschka et al. (2008)
Cu	6	mg/GJ	4	89	Hedberg et al. (2002), Tissari et al. (2007) , Struschka et al. (2008), Lamberg et al. (2011)
Ni	2	mg/GJ	0.5	16	Hedberg et al. (2002), Struschka et al. (2008), Lamberg et al. (2011)
Se	0.5	mg/GJ	0.25	1.1	Hedberg et al. (2002)
Zn	512	mg/GJ	80	1300	Hedberg et al. (2002), Tissari et al. (2007) , Struschka et al. (2008), Lamberg et al. (2011)
PCBs	0.06	□g/GJ	0.006	0.6	Hedman et al. (2006)
PCDD/F	100	ng I-TEQ/GJ	30	500	Hedman et al. (2006)

Benzo(a)pyrene	10	mg/GJ	5	20	Boman et al. (2011); Johansson et al. (2004)
Benzo(b)fluoranthene	16	mg/GJ	8		32
Benzo(k)fluoranthene	5	mg/GJ	2		10
Indeno(1,2,3-cd)pyrene	4	mg/GJ	2		8
HCB	5	µg/GJ	0.1	30	Syc et al. (2011)

1) Larger combustion chamber, 350 kW

2) Assumed equal to low emitting wood stoves

3) PM_{10} estimated as 95 % of TSP, $PM_{2.5}$ estimated as 93 % of TSP. The PM fractions refer to Boman et al. (2011), Pettersson et al. (2011) and the TNO CEPMEIP database.

4) Assumed equal to advanced/ecolabelled residential boilers

5) If the reference states the emission factor in g/kg dry wood the emission factors have been recalculated to g/GJ based on NCV stated in each reference. If NCV is not stated in a reference, the following values have been assumed: 18 MJ/kg for wood logs and 19 MJ/kg for wood pellets.

5.8.3. Uncertainty

Uncertainties of emissions of some air pollutants from fuel combustion in Households (NFR sector 1.A.4.b.i)

Pollutant	**95% confidence interval**		
	lower	upper	
NOx	-45%	70%	
NMVOC	-80%	280%	
Benzapyrene	-70%	180%	

5.8.4. Source-specific planned improvements

No source-specific improvements have been planned.

5.9. Other stationary (including military) (1 A 5 a), Other, Mobile (including military, land based and recreational boats) (1 A 5 b).

Data on fuel consumption for military stationary combustion are not available. The statistical reports are based on information provided by the fuel suppliers therefore data on fuel used for military stationary combustion is included in Commercial/institutional category. Emissions are reported as "IE", i.e. emissions from military stationary combustion (1.A.5.a) are included in Commercial/institutional category (1.A.4.a).

5.10. Fugitive emissions from fuels (1.B)

5.10.1. Source category description

Sectors covered in this chapter are:

• NFR Code 1B1a, 1B1b, 1B1c - Fugitive emissions from solid fuels: Coal mining and handling There are no mining activities in Lithuania and hence no fugitive emissions from coal mines occur. All emissions are reported as not occurring/not applicable.

• NFR Code 1B2a iv - Refining / storage

• NFR Code 1B2av - Distribution of oil products

Fugitive NMVOC emission from crude oil extraction and gasoline distribution were estimated (NFR sectors 1B2). Natural gas is imported into Lithuania from Russia and from the underground gas storage in Lithuania (Fig. 3-3). 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 were estimated.

5.10.2. Methodological issues

To estimate emissions the following methodology has been adopted:

$E = m \times EF$

E – emission (g)

m – quantity of fuel combusted (t)

EF – emission factor per quantity of fuel (g/t)

Derivated emission factors from [18] reference are listed in Table 2-35.

TABLE 2-36. 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

5.10.3. Source-specific planned improvements

Uncertainty analysis for the gas transport sector.

4. INDUSTRIAL PROCESSES AND PRODUCT USE

4.1. Source category description

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.

Dominating industry in Lithuania is manufacturing. Manufacturing constituted 87% of the total industrial production (except construction) in 2011. Four most important sectors within Manufacturing cumulatively produced 78% of production:

- Manufacture of refined petroleum products (~30%);
- Manufacture of food products and beverages (~20%);
- Manufacture of wood products and furniture (~10%);
- Manufacture of chemicals and chemical products (~10%).

4.2. Mineral products (2.A)

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.

4.3.1. Cement production (2.A.1)

4.3.1.1. Source category description

Cement is produced in a single company - AB Akmenės Cementas, which is situated in the North Western part of Lithuania. The factory was constructed in soviet times (1947-1974), cement produced in the factory was exported to other Republics of USSR, Hungary, Cuba and Yugoslavia. The total nominal capacity of the plant is about 5 million tonnes cement per year. The data on clinker production and composition were provided by the AB Akmenės Cementas. Activity data is collected on company level.

4.3.1.2. Methodology

The Tier 1 approach for process emissions from cement uses the general equation

$$E_{pollutant} = AR_{production} * EF_{pollutant}$$

where:

- *Epollutant* is the emission of a pollutant (kg)
- *ARproduction* is the annual production of cement (in Mg)
- *EFpollutant* is the emission factor of the relevant pollutant (in kg pollutant / Mg cement produced)

This equation is applied at the national level, using annual national total cement production data.

TABLE 4.2-1 EMISSION FACTORS

			95% confidencial level		
	EF		Lower	Upper	
TSP	260	g/Mg clinker	130	520	European Commission (2010)
PM10	234	g/Mg clinker	117	468	European Commission (2010)
PM2.5	130	g/Mg clinker	65	260	European Commission (2010)
BC	3	% of $PM_{2.5}$	1.5	6	US EPA (2011, file no.: 91127)

4.3.1.3. Uncertainty

Activity data uncertainty is assumed to be 2%. Data on clinker production provided by the single production company is considered reliable;

4.3.2. Lime production (2.A.2)

4.3.2.1. Source category description

Emissions from lime production, organic chemicals production and food and beverages production were estimated using emission factors proposed by EEA/EMEP Emission guidebook 2013.

TABLE 4.2-2 EF FROM INDUSTRIAL PROCESS

Pollutant	Value	Unit	95 % confidence interval		Reference
Lower			Upper		
TSP	9 000	g/Mg lime	3 000	22 000	European Commission (2001)
PM10	3 500	g/Mg lime	1 000	9 000	Visschedijk et. (2004) applied on TSP
PM2.5	700	g/Mg lime	300	2 000	Visschedijk et. (2004) applied on TSP
BC	0.46	% of $PM_{2.5}$	0.23	0.92	Chow et al. (2011)

4.3.2.2. Methodology

The Tier 1 approach for process emissions from cement uses the general equation

$$E_{pollutant} = AR_{production} * EF_{pollutant}$$

where:

- $E_{pollutant}$ is the emission of a pollutant (kg)
- $AR_{production}$ is the annual production of lime (in Mg)
- $EF_{pollutant}$ is the emission factor of the relevant pollutant (in kg pollutant / Mg lime produced)

This equation is applied at the national level, using annual national total cement production data.

4.3.2.2. Uncertainty

Activity data uncertainty is assumed to be 5%. Data on lime production provided by the single production company is considered reliable;

4.3.3. Glass production (2.A.3)

4.3.3.1. Source category description

There were three glass production plants in Lithuania: AB Ekranas producing cathode ray tubes, (got bankrupt in 2006), AB Guartis (the largest glass producer manufacturing both sheet glass and container glass) and UAB Kauno stiklas (the oldest glass production plant in Lithuania).

4.3.1.2. Methodology

The Tier 1 approach for process emissions from cement uses the general equation

$$E_{pollutant} = AR_{production} * EF_{pollutant}$$

where:

- $E_{pollutant}$ is the emission of a pollutant (kg)
- $AR_{production}$ is the annual production of glass (in Mg)

- $EF_{pollutant}$ is the emission factor of the relevant pollutant (in kg pollutant / Mg glass produced)

This equation is applied at the national level, using annual national total cement production data.

4.3.1.3. Uncertainty

Activity data uncertainty is assumed to be 7%. Data on lime production provided by the single production company is considered reliable;

4.3.4. Quarrying and mining of minerals other than coal (2.A.5.a)

No emissions were calculated.

4.3.5. Construction and demolition (2.A.5.b)

No emissions were calculated.

4.3.6. Storage, handling and transport of mineral products (2.A.5.c)

No emissions were calculated.

4.3.7. Other mineral products (2.A.6)

No emissions were calculated

4.3. Chemical Industry (2.B)

4.3.1. Ammonia production (2.B.1)

4.3.1.1. Source category description

AB Achema is a single ammonia production company in Lithuania. In the production plant ammonia is produced at 22,0-24,0 MPa pressure from hydrogen and nitrogen, which are generated at 800-1000 °C temperatures by conversion of natural gas. The converted gas is cleaned from impurities (CO, CO_2, H_2O vapour, etc.).

4.3.1.2. Methodology

The Tier 1 approach for process emissions from cement uses the general equation

$$E_{pollutant} = AR_{production} * EF_{pollutant}$$

where:

- $E_{pollutant}$ is the emission of a pollutant (kg)
- $AR_{production}$ is the annual production of ammonia (in Mg)
- $EF_{pollutant}$ is the emission factor of the relevant pollutant (in kg pollutant / Mg ammonia produced)

This equation is applied at the national level, using annual national total cement production data.

4.3.1.3. Uncertainty

Activity data uncertainty is assumed to be 5%. Data on ammonia production provided by the single production company is considered reliable;

4.3.2. Nitric acid production (2.B.2)

Nitric acid is produced by AB Achema which is the single nitric acid producer in Lithuania. According to information provided by AB Achema, the nitric acid is produced in UKL-7 units and GP unit by absorbing NO_2 with water. NO_2 is produced by air oxidation of NO with oxygen. Nitric oxide (NO) produced by air oxidation of ammonia with oxygen on Pt mesh catalyst. UKL-7 units are working by single pressure (high pressure) scheme. Gaseous emissions after absorption are cleaned from NOx in a reactor. Grande Paroisse (GP) unit uses a dual-pressure scheme (medium/high). Gaseous emissions from GP are cleaned from NOx in the reactor using a DeNOx technology.

4.3.1.2. Methodology

The Tier 1 approach for process emissions from cement uses the general equation

$$E_{pollutant} = AR_{production} * EF_{pollutant}$$

where:

- $E_{pollutant}$ is the emission of a pollutant (kg)
- $AR_{production}$ is the annual production of nitric acid (in Mg)
- $EF_{pollutant}$ is the emission factor of the relevant pollutant (in kg pollutant / Mg nitric acid produced)

This equation is applied at the national level, using annual national total cement production data.

4.3.2.3. Uncertainty

Activity data uncertainty is assumed to be 5%. Data on nitric acid production provided by the single production company is considered reliable;

4.4. Metal production (2.C)

There are two facilities producing cast iron in blast furnace in Lithuania. There were one facility using electric arc furnace for cast iron production, but it went bankrupt in 2010. Only scrap metal is used as raw material.

4.4.1. Metal production 2.C

4.4.1.1. Ferroalloys production (2.C.2)	Steel, sinter, coke, ferroalloys and aluminium are not produced in Lithuania.
4.4.1.2. Iron and steel production (2.C.1)	
4.4.1.3. Aluminium production (2.C.3)	
4.4.1.4. Magnesium production (2.C.4)	
4.4.1.5. Lead production (2.C.5)	
4.4.1.6. Zinc production (2.C.6)	
4.4.1.7. Copper production (2.C.7.a)	
4.4.1.8. Nickel production (2.C.7.b)	
4.4.1.9. Other metal production (2.C.7.c)	
4.4.1.10. Storage, handling and transport of metal products (2.C.7.d)	

4.5. Other solvent and product use

NMVOC emission from industrial and non-industrial paint application, metal degreasing, application of glues and adhesives, dry cleaning, use of domestic solvent were estimated (NFR sector 2).

4.5.1. Domestic solvent use including fungicides (2.D.3.a)

4.5.2. Road paving with asphalt (2.D.3.b)

4.5.3. Asphalt roofing (2.D.3.c)

4.5.4. Coating applications (2.D.3.d)

4.5.5. Degreasing (2.D.3.e)

4.5.6. Dry cleaning (2.D.3.f)

4.5.7. Chemical products (2.D.3.g)

4.5.8. Printing (2.D.3.h)

4.5.9. Other solvent and product use (2.D.3.i, 2.G)

4.5.1.1-9. Source category description

NMVOCs are used in a large number of products sold for use by the public. These can be divided into a number of categories:

Products for the maintenance or improvement of personal appearance, health or hygiene.

Cosmetics and toiletries	
Household products	Products used to maintain or improve the appearance of household durables.
Construction/DIY	Products used to improve the appearance or the structure of buildings such as adhesives and paint remover. This sector would also normally include coatings; however these fall outside the scope of this section (see B) and will be omitted.
Car care products	Products used for improving the appearance of vehicles to maintain vehicles or winter products such as antifreeze.

Domestic solvent use including fungicides and Other Product Use sector covered major Lithuania's NMVOC emissions in 2013. The largest share is for other product use – 52.9% (Figure 4-2). This subsector includes emissions from application of glues and adhesives, preservation of wood and other solvent use. The dominant emissions are from Coating aplications (51%), domestic solvent use 30%, degreasing (8%), chemical products (7%) and dry cleaning (4%).

4.5.1.1-9. Emission factor

NMVOC emissions were calculated according to EMEP/CORINAIR methodology simpler approach based on per capita data for several source categories. Default per capita emission factors proposed in EMEP/CORINAIR guidebook were used, multiplying them by the number of inhabitants.

Emissions were calculated using annual average population data provided by the Statistics Lithuania (Figure 4-3).

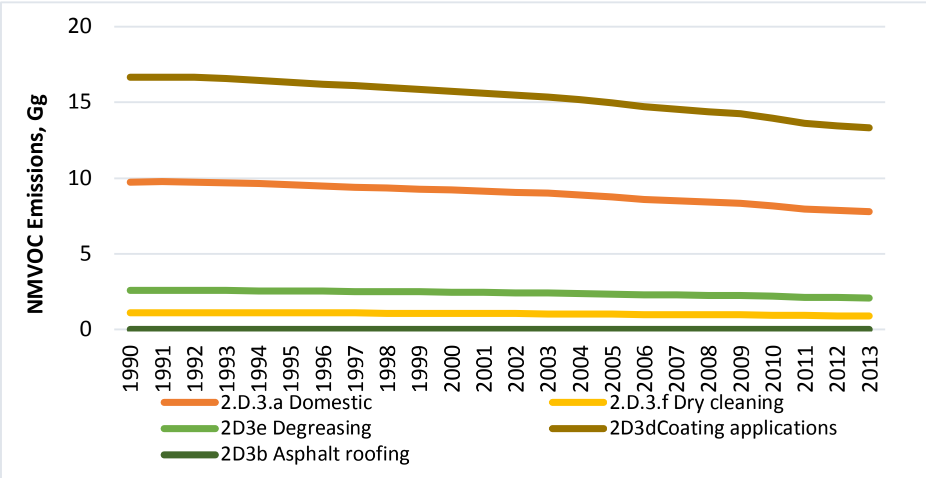

Figure 4.5-1 NMVOC emissions

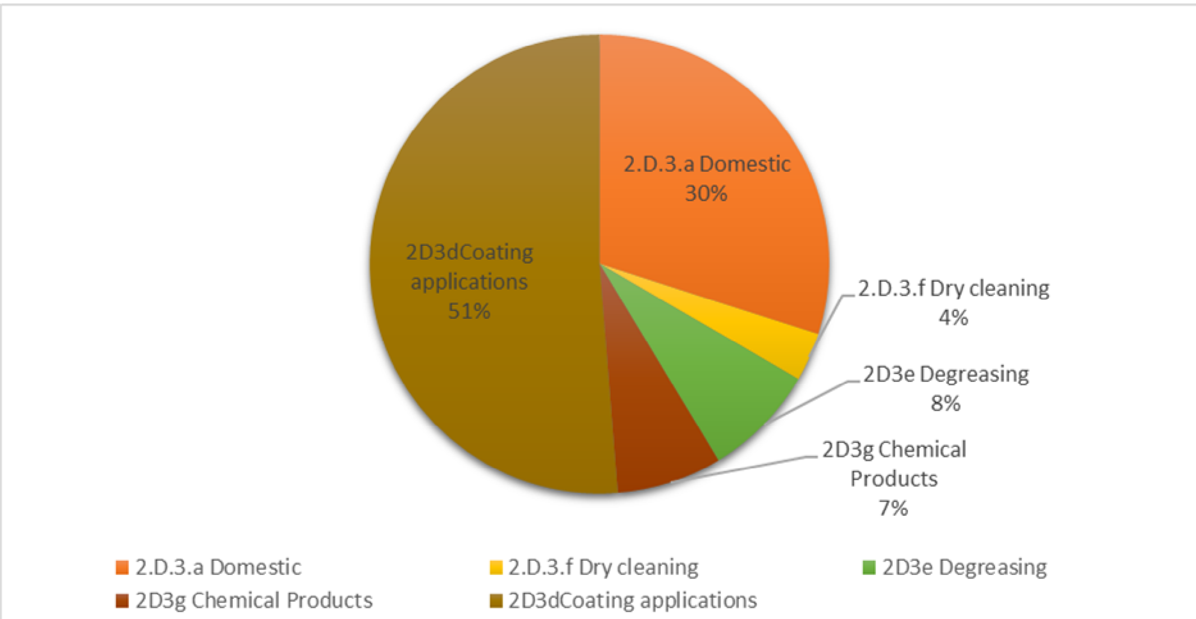

Figure 4.5-2 Distribution of NMVOC emissions in other solvent and product use sector for 2013 (Gg)

Emission from solvent and other product use were estimated according to number of population and NMVOC emission factor in [g/inhabitant] units given in. Derived and used in estimation NMVOC emission factors are listed in Tables 4-3 and 4-4.

TABLE 4.5-1 ADDITIONAL INFORMATIVE TIER 1 EMISSION FACTORS FOR SUBCATEGORIES IN SOURCE CATEGORY 2.D.3.A DOMESTIC SOLVENT USE INCLUDING FUNGICIDES ADDITIONAL INFORMATIVE TIER 1 EMISSION FACTORS

Pollutant	**Value**	**Unit**	**95% confidence intervala)**		**Reference**
Lower			**Upper**		
Household (cleaning) products					
NMVOC (all)	507	g/person	100	900	N=5 (Norwegian IIR, 2012; Swiss IIR, 2012; Italian IIR, 2012; Greece, 1996-2006; US EPA, 1996)
NMVOC (aerosol)	201	g/person	130	270	N=3 (UK IIR, 2012; UNECE (Canada), 1990; Italian IIR, 2012)
NMVOC (non-aerosol)	252	g/person	150	350	N=3 (UK IIR, 2012; UNECE (Canada), 1990; Italian IIR, 2012)
NMVOC (other)	54c)	g/person	30	80	Calculated difference
Car care products					
NMVOC (all)	464	g/person	20	900	N=4 (Norwegian IIR,

					2012; Italian IIR, 2012; Greece, 1996-2006; US EPA, 1996)
NMVOC (aerosol)	161b)	g/person	40	280	N=2 (UK IIR, 2012; UNECE (Canada), 1990)
NMVOC (non-aerosol)	303b)	g/person	150	450	N=2 (UK IIR, 2012; UNECE (Canada), 1990)
Cosmetics and toiletries					
NMVOC (all)	1 ,088	g/person	400	1 800	N=4 (Norwegian IIR, 2012; Italian IIR, 2012; Greece, 1996-2006; US EPA, 1996)
NMVOC (aerosol)	355	g/person	250	450	N=3 (UK IIR, 2012; Italian IIR, 2012; UNECE (Canada), 1990)
NMVOC (non-aerosol)	494	g/person	250	750	N=3 (UK IIR, 2012; Italian IIR, 2012; UNECE (Canada), 1990)
NMVOC (other)	239c)	g/person	40	440	Calculated difference
DIY/buildings					
NMVOC (all)	522	g/person	220	820	N=2 (Norwegian IIR, 2012; Greece, 1996-2006)

TABLE 4.5-2 SOLVENT AND OTHER PRODUCT USE NMLOJ EMISSION FACTORS, [G/INHABITANT].

Activity	NMVOC emission factor, kg/inhabitant/year
2.D.3.d Coating applications: paint application Industrial paint application	4.5
2.D.3.f Dry cleaning	0.3
2.D.3.e Metal degreasing	0.7
2.D.3.g **Chemical products**	0.65

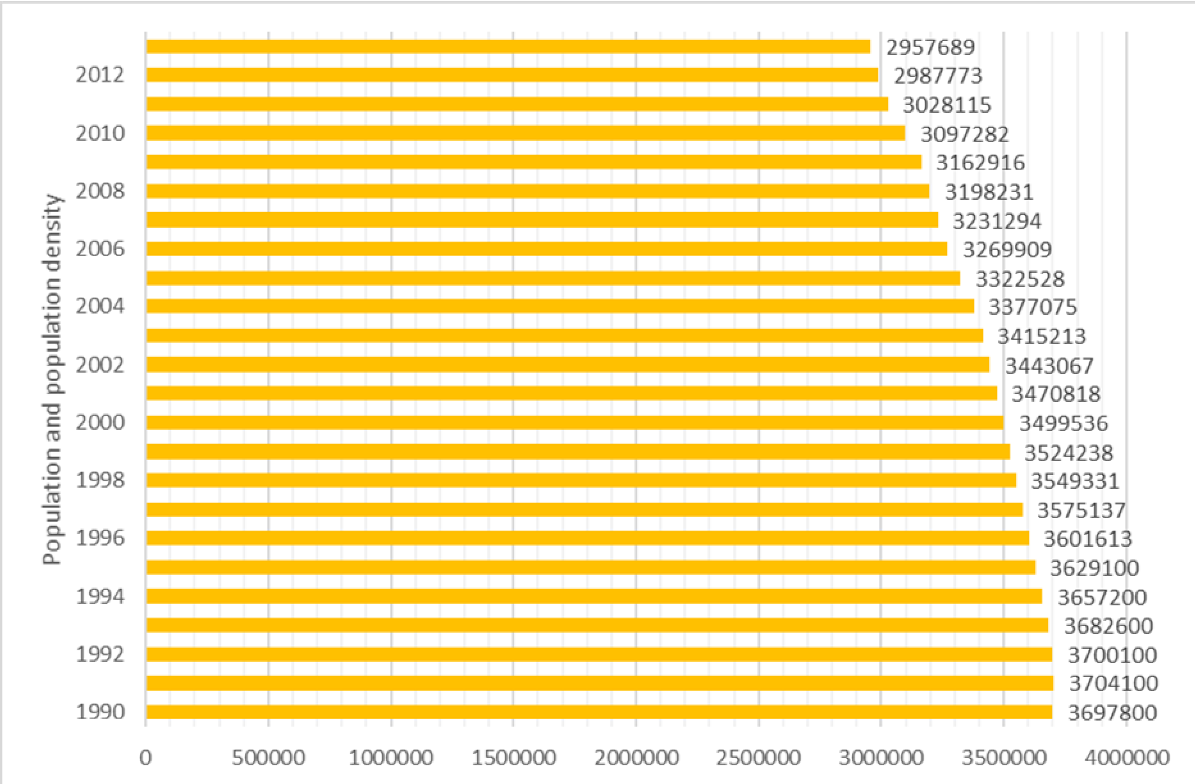

FIGURE 4.5-3POPULATION AND POPULATION DENSITY, [INHABITANT]

5. AGRICULTURE

5.1. Source category description

This chapter covers emissions from manure management, direct soil emissions and application of mineral fertilizer (NFR sectors 3B, 3Da1 and 3Da2b). 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. 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 (Fig. 5-1).

In Agriculture sector emissions from following subsectors are calculated:

- Manure management (NFR 3B), which includes cattle, sheep, goats, horses, swine and poultry;
- Agricultural Soils (NFR 3Da1), which includes Synthetic N-fertilizers;

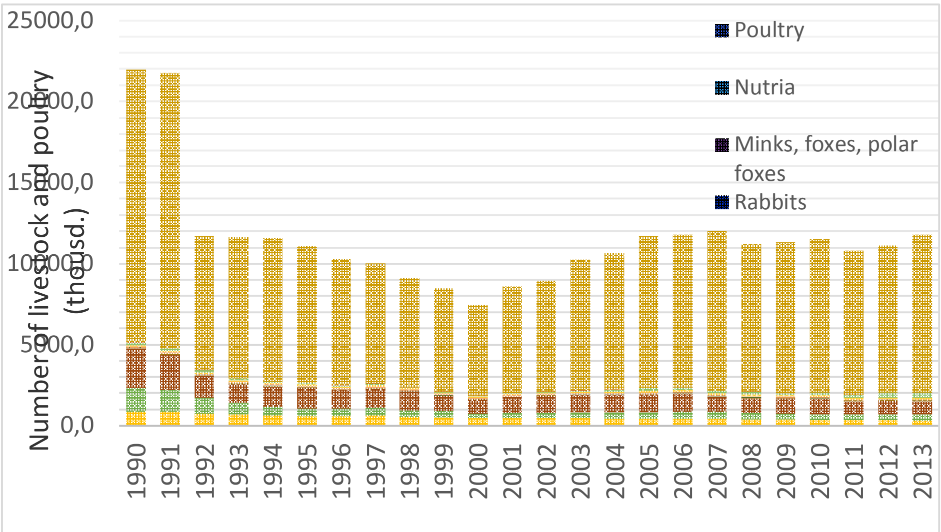

FIGURE 5.1-1. NUMBER OF LIVESTOCK AND POULTRY

5.2. Manure management (3B)

Number of livestock and poultry was taken from Department of Statistics and State enterprise Agricultural Information and Rural Business Centre are shown in Fig. 5-1.

State enterprise Agricultural Information and Rural Business Centre started its activities in 2002 to ensure effective operation of the agricultural information system components – registries and information systems and their databases at the Ministry of Agriculture and implement the administration system of the support to agriculture and rural development that meets the requirements of the European Union.

Currently, the Agricultural Information and Rural Business Centre focuses on the rational management and use of agricultural information resources in inter-institutional activities in the light of public administration requirements for e-government in developing a new generation of public services, based on information technology and telecommunications, for the creation of conditions for effective and competitive agricultural and rural businesses.

5.2.1. Emission factors

Emission factors for livestock and poultry manure management was taken from EMEP/EEA air pollutant emission inventory guidebook 2013.

TABLE 5.2-1 EMISSION FACTORS IN 3.B

EF	NMVOC, kg AAP^{-1} a^{-1}	TSP, kg AAP^{-1} a^{-1}	PM10, kg AAP^{-1} a^{-1}	PM2,5, kg AAP^{-1} a^{-1}
Dairy cattle	17,9	1,38	0,63	0,41
Non-dairy cattle	8,902	0,59	0,27	0,18
Swine	1,704	1,53	0,69	0,12
Sheep	0,279	0,139	0,0556	0,167
Goats	0,624	0,139	0,0556	0,167
Horses	7,781	0,48	0,22	0,14
Rabbits	0,059	0,018	0,0081	0,0042
Minks, foxes, polar foxes	1,941	0,018	0,0081	0,0042
Nutria	1,941	0,018	0,0081	0,0042

Poultry	0,489			

The calculation of the pollutant emissions, $E_{pollutant\_animal}$ for each livestock category, using the respective annual average population of each category, AAP_{animal} and the relevant EF $EF_{pollutant\_animal}$:

$$E_{pollutant\_animal}=AAP_{animal}\cdot EF_{pollutant\_animal}$$

Where AAPanimal=number of animals of a particular category that are present, on average, within the year. For a fuller explanation, see IPCC (2006).
The Tier1 method entails multiplying the average annual population (AAP) in each livestock class; by a single default EF, expressed as kg $AAP^{-1}a^{-1}$ NH3. This EF includes emissions during grazing for ruminant livestock and emissions following spreading of manures for all livestock categories. This means that when using the Tier 1 methodology for an animal category, emissions are reported under NFR 3.B.

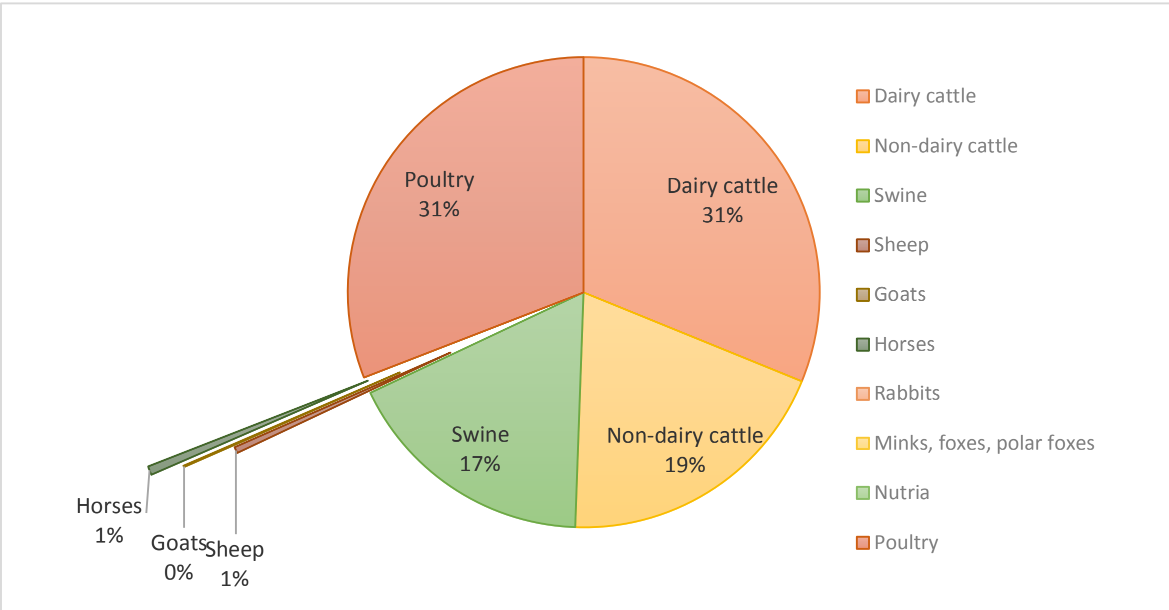

FIGURE 5.2-1 AMMONIA EMISSIONS FROM MANURE MANAGEMENT IN 2013

In Fig. 5-2 is shown emissions from Manure Management distributed on different livestock categories in 2013. It is seen that the majority of the emissions is related to the dairy cattle (31%), poultry (31 %), non-dairy cattle (19%) and swine (17%).

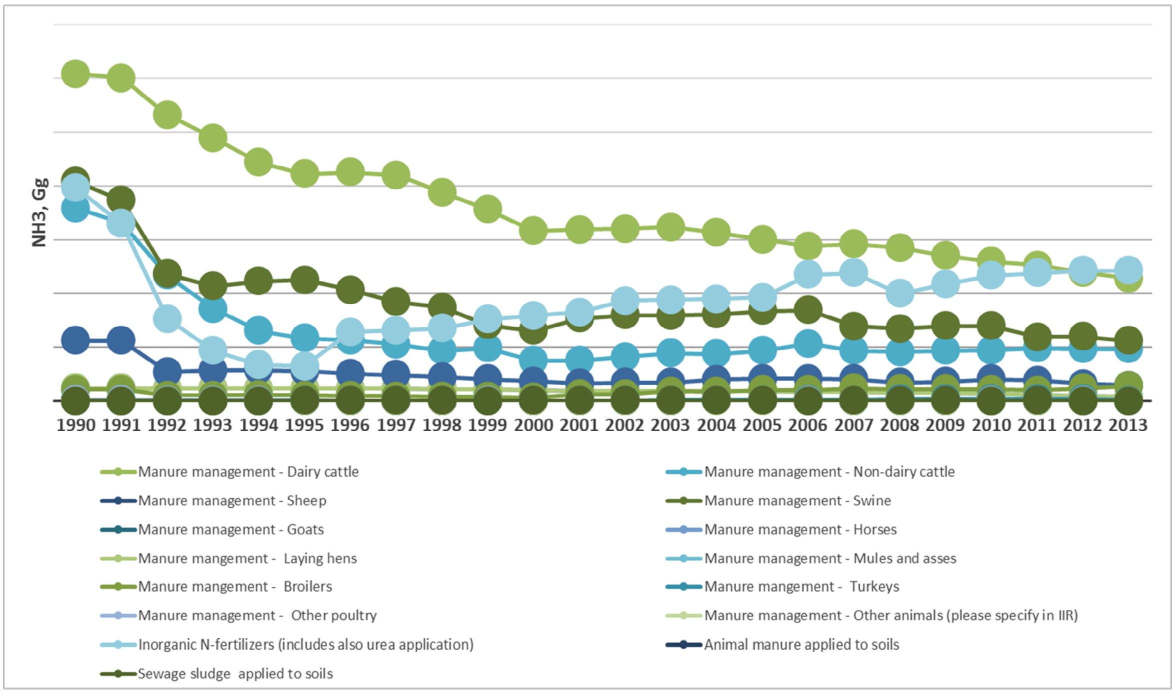

FIGURE 5.2-2 TREND OF NH3 EMISSIONS (NFR 3.B-L)

NH_3 emissions in Manure management decreased from 96,9 Gg in 1990 to 37,6 Gg in 2013.

5.2.2. Uncertainties

Activity data uncertainty is 2%. Emission factors may be uncertain to 50%.

5.3. Crop production and agricultural soils (3D)

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 EMEP/EEA Emission guidebook 2013.

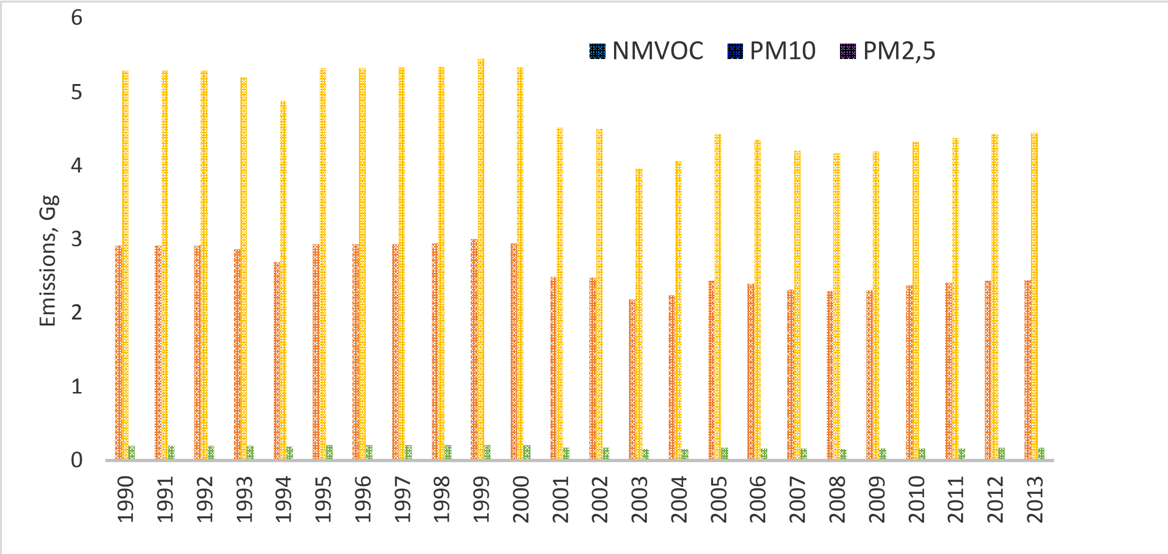

FIGURE 5.3-1 DIRECT SOILS EMISSIONS

5.3.1. Emission factors

The Tier 1 approach for NH3 emissions from soil uses the equation:

3.2 Tier 1 default approach

3.2.1 Algorithm

The Tier 1 approach for NH_3 and NO emissions from crop production and agricultural soils uses the general equation

$E_{pollutant} = AR_{fertiliser\_applied} \cdot EF_{pollutant}$ (1)

where:

$E_{pollutant}$ = amount of pollutant emitted (kg a^{-1}),

$AR_{fertiliser\_applied}$ = amount of N applied (kg a^{-1}),

$EF_{pollutant}$ = EF of pollutant (kg kg^{-1}).

TABLE 5.3-1 EMISSION FACTORS

	Emission factor, [kg ha^{-1}]
NMVOC	0.86
NH3 (kg kg^{-1} fertilazer-N applied)	0.081
PM10	1.56
PM2.5	0.06

For emission calculation the IPCC 1996 methodology was use NH3 emissions from fertilizers is depending on consumption and type of fertilizers, but such detailed information isn't available and it is decided to use IPCC default assumption that 10% of the mass of used fertilizers are NH_3 emissions.

The Tier 1 approach for PM and NMVOC emissions from crop production and agricultural soils uses the general equation:

$$E_{pollutant} = AR_{area} * EF_{pollutant}$$

where:

$E_{pollutant}$ = amount of pollutant emitted (kg a^{-1}),

AR_{area} = area covered by crop (ha),

$EF_{pollutant}$ = EF of pollutant (kg $ha^{-1}a^{-1}$).

5.3.2. Uncertainties

Activity data uncertainty is 2%. Emission factors may be uncertain to 150%.

5.3.3. Source-specific planned improvements

No source-specific improvements have been planned

6. WASTE

Data of waste generation and disposal are collected from 1991, earlier data on waste disposal are not available. Data from 2001 are available (Table 7-43) on the website of the Lithuanian Environmental Protection Agency (EPA)[2].

TABLE 5.3-1 AVERAGE COMPOSITION OF MSW IN LITHUANIA

Ingredient	Amount
Plastic	9%
Paper and cardboard	14%
Glass	9%

[2]EPA website: http://gamta.lt/

Metal	3%
Textile	4%
Biodegradable (kitchen) waste	42%
Composite packaging	2%
Construction and demolition waste	4%
Hazardous waste	2%
Leather, rubber	1%
Wood	2%
Sand, sweepings	4%
Other	4%

This chapter covers the NFR source category 5 Waste, including:

6.1. Solid waste disposal on land (5.A)

6.1.1. Source description

Municipal solid waste is the unwanted material collected from households and commercial organisations. It consists of a mix of combustible and non-combustible materials, such as paper, plastics, food waste, glass, defunct household appliances and other non-hazardous materials. The quantity produced per person varies with the effectiveness of the material recovery scheme in place and with the affluence of the neighbourhood from which it is collected.

TABLE 6.1-1

	NMVOC	TSP	PM10	PM2,5
1990	2,26	0,67	0,32	0,05
1991	2,27	0,67	0,32	0,05
1992	2,31	0,68	0,32	0,05
1993	2,06	0,61	0,29	0,04
1994	2,08	0,62	0,29	0,04
1995	2,27	0,67	0,32	0,05
1996	2,25	0,67	0,32	0,05
1997	2,25	0,67	0,32	0,05

1998		2,25	0,67	0,32	0,05
1999		2,27	0,68	0,32	0,05
2000		2,54	0,75	0,36	0,05
2001		2,25	0,67	0,32	0,05
2002		2,22	0,66	0,31	0,05
2003		1,79	0,53	0,25	0,04
2004		1,91	0,57	0,27	0,04
2005		1,90	0,56	0,27	0,04
2006		1,89	0,56	0,27	0,04
2007		1,99	0,59	0,28	0,04
2008		1,92	0,57	0,27	0,04
2009		1,75	0,52	0,25	0,04
2010		1,71	0,51	0,24	0,04
2011		1,62	0,48	0,23	0,03
2012		1,00	0,30	0,19	0,02

6.1.2. Methodological issues and emission factors

The simpler methodology relies on the use of a single emission factor for each pollutant species, combined with activity statistics. The equation can be written as:

$$E_{pollutant}=AR_{production}+EF_{pollutant}$$

This equation uses the cremation activity statistics and the Tier 1 emission factors, provided in the next section. The Tier 1 emission factors assume an averaged or typical technology and abatement implementation in the country. In cases where specific abatement options are to be taken in.

TABLE 6-6.1-2TABLE 0 1 TIER 1 EMISSION FACTORS FOR SOURCE CATEGORY 5.A BIOLOGICAL TREATMENT OF WASTE - SOLID WASTE DISPOSAL ON LAND

Tier 1 default emission factors					
Code			Name		
NFR Source Category		5.A		Biological treatment of waste - Solid waste disposal on land	
Fuel			NA		
Not applicable			NOx, SO2, Pb, Cd, As, Cr, Cu, Ni, Se, Zn, PCB, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB, BC, HCH		
Not estimated			NH3, Hg, CO		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NMVOC	1.56	kg/Mg	0.5	3.0	UK Inventory (2004)*

TSP	0 463	g/Mg	0.006	2.21	US EPA (2006)
PM10	0 219	g/Mg	0.003	1.05	US EPA (2006)
PM2.5	0 033	g/Mg	0.0004	0.16	US EPA (2006)
Notes: *UK Inventory (2004) refers to 5.65 g NMVOC per m3 landfill gas. According to US EPA (2006) chapter 2.4.4.1, the CH4 generation potential can vary from 6 to 270 m3 per Mg waste, the default emission factor has been calculated by using the default CH4 generation potential of 138 m3 per Mg waste and the default methane content of 50 % (IPCC, 2006, Vol. 5, Ch. 3.2.3).					

6.2. Municipal waste incineration (5.C.1.a)

6.2.1. Source description

Municipal solid waste is the unwanted material collected from households and commercial organisations. It consists of a mix of combustible and non-combustible materials, such as paper, plastics, food waste, glass, defunct household appliances and other non-hazardous materials. The quantity produced per person varies with the effectiveness of the material recovery scheme in place and with the affluence of the neighbourhood from which it is collected. Municipal waste can be incinerated to:

- reduce its volume;
- save landfill space and costs;
- recover energy from its combustion, either for district/process heating and/or for electricity generation.

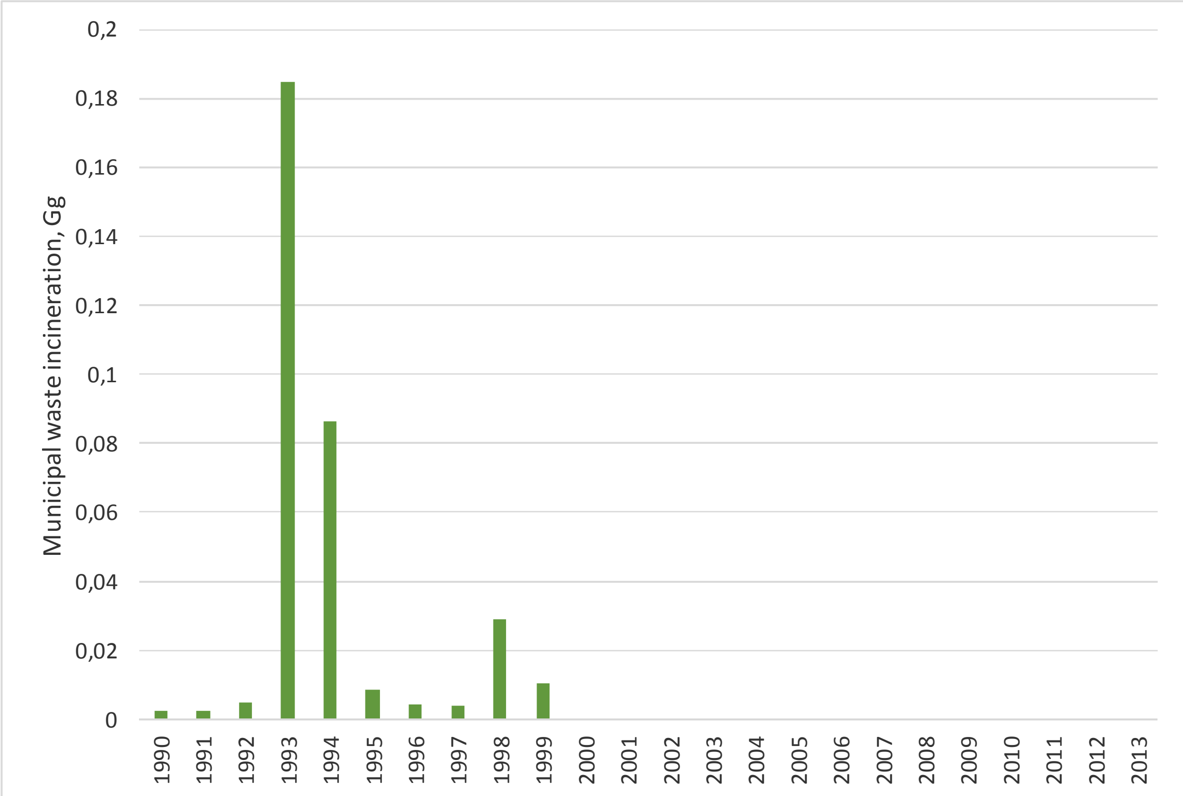

FIGURE 6.2-1MUNICIPAL WASTE INSCINIRATION IN 1990-2013

6.2.2. Methodological issues and emission factors

The simpler methodology relies on the use of a single emission factor for each pollutant species, combined with activity statistics. The equation can be written as:

$$E_{pollutant}=AR_{production}+EF_{pollutant}$$

This equation uses the cremation activity statistics and the Tier 1 emission factors, provided in the next section. The Tier 1 emission factors assume an averaged or typical technology and abatement implementation in the country. In cases where specific abatement options are to be taken in.

TABLE 6.2-1TIER 1 EMISSION FACTORS FOR SOURCE CATEGORY 5.C.1.A MUNICIPAL WASTE INCINERATION

Tier 1 default emission factors		
Code	Name	
NFR source category	5.C.1.a	Municipal waste incineration
Fuel	NA	
Not applicable	HCH	

Not estimated					
Pollutant	Value	Unit	95 % confidence interval		Reference
			Lower	Upper	
NOx	1071	g/Mg	749	1532	Nielsen et al. (2010)
CO	41	g/Mg	7	253	Nielsen et al. (2010)
NMVOC	5.9	g/Mg	2.7	12.9	Nielsen et al. (2010)
SO2	87	g/Mg	16	466	Nielsen et al. (2010)
NH3	3.0	g/Mg	0.5	18.3	Nielsen et al. (2010)
TSP	3.0	g/Mg	1.1	8.3	Nielsen et al. (2010)
PM10	3.0	g/Mg	1.1	8.3	CEPMEIP
PM2.5	3.0	g/Mg	1.1	8.3	CEPMEIP
BC	3.5	% of PM2.5	1.8	7	Olmez et al. (1988)
Pb	58.0	mg/Mg	12.0	280.3	Nielsen et al. (2010)
Cd	4.6	mg/Mg	1.1	19.3	Nielsen et al. (2010)
Hg	18.8	mg/Mg	7.3	48.3	Nielsen et al. (2010)
As	6.2	mg/Mg	1.3	29.6	Nielsen et al. (2010)
Cr	16.4	mg/Mg	3.0	88.7	Nielsen et al. (2010)
Cu	13.7	mg/Mg	3.9	47.3	Nielsen et al. (2010)
Ni	21.6	mg/Mg	4.2	111.6	Nielsen et al. (2010)
Se	11.7	mg/Mg	2.2	62.0	Nielsen et al. (2010)
Zn	24.5	mg/Mg	2.7	219.6	Nielsen et al. (2010)
PCBs	3.4	ng/Mg	1.2	9.2	Nielsen et al. (2010)
PCDD/F	52.5	ng/Mg	16.6	166.3	Nielsen et al. (2010)
Benzo(a)pyrene	8.4	µg/Mg	2.8	33.6	Nielsen et al. (2010)
Benzo(b)fluoranthene	17.9	µg/Mg	6.0	71.4	Nielsen et al. (2010)
Benzo(k)fluoranthene	9.5	µg/Mg	3.2	37.8	Nielsen et al. (2010)
Indeno(1,2,3-cd)pyrene	11.6	µg/Mg	3.9	46.2	Nielsen et al. (2010)
HCB	45.2	µg/Mg	8.0	254.1	Nielsen et al. (2010)

6.3. Industrial waste incineration including hazardous waste and sewage sludge (5.C.1.b)

6.3.1. Source description

The composition of industrial waste varies considerably. Industrial waste includes any unwanted hazardous/chemical waste such as acids and alkalis, halogenated and other potentially-toxic compounds, fuels, oils and greases, used filter materials, animal and food wastes. Industrial waste sources include chemical plant, refineries, light and heavy manufacturing, etc.

Industrial waste is incinerated to reduce its volume and to save landfill costs, and to prevent the release of chemical and toxic substances to the environment. In some cases energy is recovered from the waste combustion either for heating or electricity generation. In these cases it is good practice to report the emissions in the relevant combustion sector in the combustion section (1.A). If no energy recovery is applied, it is good practice to report the emissions in the waste incineration sector. Sewage sludge arises from two principal sources (HMIP, 1992):

- the removal of solids from raw sewage. This primary sludge has a solids content of about 5 % and consists of both organic and inorganic substances;
- the removal by settlement of solids produced during biological treatment processes, i.e. surplus activated sludge and human sludge. This is known as secondary sludge.

6.3.2. Methodological issues and emission factors

The simpler methodology relies on the use of a single emission factor for each pollutant species, combined with activity statistics. The equation can be written as:

$$E_{pollutant}=AR_{production}+EF_{pollutant}$$

This equation uses the cremation activity statistics and the Tier 1 emission factors, provided in the next section. The Tier 1 emission factors assume an averaged or typical technology and abatement implementation in the country. In cases where specific abatement options are to be taken in.

TABLE 6.3-1TIER 1 EMISSION FACTORS FOR SOURCE CATEGORY 5.C.1.B.I, 5.C.1.B.II, 5.C.1.B.IV INDUSTRIAL WASTE INCINERATION INCLUDING HAZARDOUS WASTE AND SEWAGE SLUDGE

Tier 1 emission factors					
Code			Name		
NFR Source Category	5.C.1.b.i, 5.C.1.b.ii, 5.C.1.b.iv		Industrial waste incineration including hazardous waste and sewage sludge		
Fuel			NA		
Not applicable			HCH		
Not estimated			NH3, Cr, Cu, Zn, Se, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	0.87	kg/Mg waste	0.087	8.7	European Commission (2006)
CO	0.07	kg/Mg waste	0.007	0.7	European Commission (2006)
NMVOC	7.4	kg/Mg waste	0.74	74	Passant (1993)
SO2	0.047	kg/Mg waste	0.0047	0.47	European Commission (2006)
TSP	0.01	kg/Mg waste	0.001	2.3	European Commission (2006)
PM10	0.007	kg/Mg waste	0.0007	0.15	US EPA (1996) applied on TSP
PM2.5	0.004	kg/Mg waste	0.0004	0.1	US EPA (1996) applied on TSP
BC	3.5	% of PM2.5	1.8	7	Olmez et al. (1988)
Pb	1.3	g/Mg waste	0.48	1.9	Theloke et al. (2008)
Cd	0.1	g/Mg waste	0.048	0.15	Theloke et al. (2008)
Hg	0.056	g/Mg waste	0.04	0.08	European Commission (2006)
As	0.016	g/Mg waste	0.01	0.019	Theloke et al. (2008)
Ni	0.14	g/Mg waste	0.048	0.19	Theloke et al. (2008)
PCDD/F	350	μg I-TEQ/Mg waste	0.5	35000	UNEP (2005)
Total 4 PAHs	0.02	g/Mg waste	0.007	0.06	Wild (1995)
HCB	0.002	g/Mg waste	0.0002	0.02	Berdowski et al. (1997

6.4. Clinical waste Incineration (5.C.1.b.iii)

6.4.1. Source description

Emissions from hazardous and clinical/hospital waste incineration without energy recovery are included in this category. Emissions from waste incineration fluctuate quite strongly. There were no dedicated waste incineration facility in Lithuania until 2006 and waste was incinerated on random basis in existing production facilities, which means that decisions on whether to incinerate or not was taken on ad hoc basis, therefore may fluctuate in quite wide range (it is worth noting that the total amount of incinerated waste is very small, even at its maximum).

New hazardous waste incineration facility (with nominal capacity 1000 kg per hour) with capacity 8000 tonnes waste per year was launched in 2010.

Hospital waste incineration facility with nominal capacity 200 kg per hour was put in operation in 2006 in Vilnius.

Hospital waste may be identified as 'specific hospital waste' and 'other hospital waste'. Specific hospital waste includes human anatomic remains and organ parts, waste contaminated with bacteria, viruses and fungi, and larger quantities of blood.

TABLE 6.4-1WASTE ACCOUNT, GG

Year	Hazardous	Clinical Health care	Total
1990	2.43	0.01	2.44
1991	2.63	0.01	2.64
1992	0.73	0.01	1.74
1993	2.12	0.00	2.12
1994	0.64	0.01	0.65
1995	2.48	0.01	2.49
1996	0.83	0.02	0.85
1997	0.81	0.04	0.85
1998	0.78	0.17	0.98
1999	0.34	0.07	0.42

2000	1.12	0.00	1.12
2001	1.43	0.11	1.54
2002	1.35	0.02	1.37
2003	3.66	0.00	3.67
2004	1.86	0.04	1.90
2005	3.33	0.26	3.59
2006	3.09	0.19	3.28
2007	0.18	0.52	0.70
2008	0.02	0.69	0.71
2009	0.01	0.74	0.76
2010	0.82	0.69	1.51
2011	0.98	0.75	1.73
2012	0.99	0.76	1.75
2013	0.98	0.75	1.74

6.4.2. Methodological issues and emission factors

The simpler methodology relies on the use of a single emission factor for each pollutant species, combined with activity statistics. The equation can be written as:

$$E_{pollutant}=AR_{production}+EF_{pollutant}$$

This equation uses the cremation activity statistics and the Tier 1 emission factors, provided in the next section. The Tier 1 emission factors assume an averaged or typical technology and abatement implementation in the country. In cases where specific abatement options are to be taken in.

TABLE 6.4-2 TIER 1 EMISSION FACTORS FOR SOURCE CATEGORY 5.C.1.B.III CLINICAL WASTE INCINERATION, UNCONTROLLED ROTARY KILN INCINERATOR

Tier 1 emission factors		
Code	Name	
NFR Source Category	5.C.1.b.iii	Clinical waste incineration (d)
Fuel	NA	
Not applicable	HCH	
Not estimated	NH3, PM10, PM2.5, Se, Zn, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene,	

			Indeno(1,2,3-cd)pyrene		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	2.3	kg/Mg waste	0.2	23	US EPA (1993)
CO	0.19	kg/Mg waste	0.002	2	US EPA (1993)
NMVOC	0.7	kg/Mg waste	0.3	1.4	Aasestad (2007)
SO2	0.54	kg/Mg waste	0.05	5	US EPA (1993)
TSP	17	kg/Mg waste	1.7	170	US EPA (1993)
BC	2.3	% of TSP*	1.8	2.8	Olmez et al. (1988)
Pb	62	g/Mg waste	6	600	US EPA (1993)
Cd	8	g/Mg waste	0.8	80	US EPA (1993)
Hg	43	g/Mg waste	4	400	US EPA (1993)
As	0.2	g/Mg waste	0.02	2	US EPA (1993)
Cr	2	g/Mg waste	0.2	20	US EPA (1993)
Cu	98	g/Mg waste	10	1000	US EPA (1993)
Ni	2	g/Mg waste	0.2	20	US EPA (1993)
PCB	0.02	g/Mg waste	0.002	0.2	US EPA (1993)
PCDD/F	40	mg I-TEQ/Mg waste	20	80	UNEP (2005)
Total 4 PAHs	0.04	mg/Mg waste	0.02	0.1	Aasestad (2007)
HCB	0.1	g/Mg waste	0.01	0.9	Guidebook (2006)
Note:* Olmez et al. (1988) provides the BC emission factor both as 3.5 % of PM2.5 and 2.3 % of TSP, the latter is chosen for this table since no emission factor for PM2.5 is available.					

6.5. Cremation (5.C.1.b.v)

6.5.1. Source description

This chapter covers the atmospheric emissions from the incineration of human bodies in a crematorium and animal carcass incineration.

6.5.2. Methodological issues and emission factors

The simpler methodology relies on the use of a single emission factor for each pollutant species, combined with activity statistics. The equation can be written as:

$$E_{pollutant}=AR_{production}+EF_{pollutant}$$

This equation uses the cremation activity statistics and the Tier 1 emission factors, provided in the next section. The Tier 1 emission factors assume an averaged or typical technology and abatement implementation in the country. In cases where specific abatement options are to be taken in.

6.5-1Tier 1 emission factors for source category 5.C.1.b.v Cremation, cremation of human bodies

Tier 1 default emission factors					
Code			Name		
NFR Source Category		5.C.1.b.v		Cremation	
Fuel			NA		
Not applicable			HCH, NH3		
Not estimated			BC		
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
Lower			**Upper**		
NOx	0.825	kg/body	0.0825	8.25	Santarsiero et al. (2005)
CO	0.140	kg/body	0.0140	1.40	Santarsiero et al. (2005)
NMVOC	0.013	kg/body	0.0013	0.13	CANA (1993)
SO2	0.113	kg/body	0.0113	1.13	Santarsiero et al. (2005)
TSP	38.56	g/body	3.856	385.6	WebFIRE, 1992
PM10	34.70	g/body	3.470	347.0	WebFIRE, 1992
PM2.5	34.70	g/body	3.470	347.0	WebFIRE, 1992
Pb	30.03	mg/body	3.003	300.3	WebFIRE, 1992
Cd	5.03	mg/body	0.503	50.3	WebFIRE, 1992
Hg	1.49	g/body	0.149	14.9	WebFIRE, 1992
As	13.61	mg/body	1.361	136.1	WebFIRE, 1992
Cr	13.56	mg/body	1.356	135.6	WebFIRE, 1992
Cu	12.43	mg/body	1.243	124.3	WebFIRE, 1992
Ni	17.33	mg/body	1.733	173.3	WebFIRE, 1992
Se	19.78	mg/body	1.978	197.8	WebFIRE, 1992
Zn	160.12	mg/body	16.012	1601.2	WebFIRE, 1992
PCBs	0.41	mg/body	0.041	4.1	Toda, 2006
PCDD/F	0.027	µg/body	0.0027	0.27	WebFIRE, 1992
Benzo(a)pyrene	13.20	µg/body	1.320	132.0	WebFIRE, 1992
Benzo(b)fluoranthene	7.21	µg/body	0.721	72.1	WebFIRE, 1992
Benzo(k)fluoranthene	6.44	µg/body	0.644	64.4	WebFIRE, 1992
Indeno(1,2,3-cd)pyrene	6.99	µg/body	0.699	69.9	WebFIRE, 1992
HCB	0.15	mg/body	0.015	1.5	Toda, 2006

6.6. Waste water handling (6.B)

6.6.1. Source category description

Data of wastewater composition and discharge are collected by the EPA from 1991. There are some very large fluctuations of data in the beginning of the monitoring period. This data was analyzed and some corrections were made.

6.6.2. Methodological issues

The Tier 1 approach for emissions from waste water handling uses the general equation:

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad (6.2.2)$$

This equation is applied at the national level. The Tier 1 emission factors assume an averaged or typical technology and abatement implementation in the country and integrate all different subprocesses in the handling of waste water.

6.6.3. Emission factors

A default emission factor for NMVOC emissions from waste water handling has been derived from a Turkish study (Atasoy et al., 2004). This emission factor should be handled with care, since it may not be applicable to all waste water treatment plants. Furthermore, the emission factors reported in literature show a high variation (Table 7-44).

TABLE 7-44. EF OF WASTE WATER

Emission	Activity data	EF value	Emission factor unit
NH_3	Population using latrines	1.6	kg/pers/year
NMVOC	Amount of waste water produced	15	mg/m^3 waste water

6.6.4. Source-specific planned improvements

No source-specific improvements have been planned.

Referencies

1. Department of Statistics (2012). Agriculture 2013. http://www.osp.stat.gov.lt/.
2. Department of Statistics (2012). Fuel and Energy Balance. 2013. http://www.osp.stat.gov.lt/.
3. Department of Statistics (2012). Industrial Processes 2013. http://www.osp.stat.gov.lt/.
4. Department of Statistics (2012). Transport and Communications 2013. ISSN 1648-0279.
5. European Environment Agency (2009)/EMEP/CORINAIR Emission Inventory Guidebook/EEA Emission inventory Guidebook 2013.
6. Institute of Environmental Protection (2004). Emission Inventory of SO2, NO2, NH3, CO, PM, NMVOC, HM's, and POP's in Poland in 2002.
7. International Institute for Applied Systems Analysis (2002). Modelling Particulate Emissions in Europe.
8. Jaskelevičius. B. (1997) Emision factors of organic fuel combustion products, Vilnius.
9. TNO (1995). TNO-Report TNO-MEP – 95/247: Technical Paper to the OSPARCOM-HELCOM-UNECE Emission Inventory of Heavy Metals and Persistent Organic Pollutants.
10. United States Environmental Protection Agency (1998). Locating and Estimating Air Emissions from Sources of Polycyclic Organic Matter.
11. United States Environmental Protection Agency (1998). Locating and Estimating Air Emissions from Sources of Polycyclic Organic Matter.
12. Asman, W.A.H., 1992. Ammonia emission in Europe: updated emission and emission variations. RIVM report 228471008. RIVM, Bilthoven, The Netherlands;
13. ECETOC, 1994. Ammonia emissions to air in western Europe. Technical Report 62. European Centre for Ecotoxicology and Toxicology of Chemicals, Brussels;
14. Sutton M.A., Place C.J., Eager M., Fowler D., Smith R.I. 1995b. Assessment of the magnitude of ammonia emissions in the United Kingdom. Atmospheric Environment 29, 1393- 1411

15. Seiler, W. and P. J. Crutzen, 1980. Estimates of gross and net fluxes of arbon between the biosphere and the atmosphere from biomass burning. Climatic Change 2, 207-247

16. Guenther A. B., P. R. Zimmerman, P. C. Harley, R. K. Monson and R. Fall, Isoprene and Monoterpene Emission Rate Variability – Model Evaluations and Sensitivity Analyses, J. Geophys.Res. Atmos. 98(D7), 12 609–12 617 (1993)

17. Guenther, A., J. Greenberg, D. Helmig, L. Klinger, L. Vierling, P. Zimmerman, and C. Geron (1996) Leaf, branch, stand and landscape scale measurements of volatile organic compound fluxes from U.S. woodlands. Tree Physiology, 16, 17-24.

18. ECOLAS, Devoldere, K., Van Hyfte, A., Callebaut, K. and Vermoote S. (2006). Proposed improvements for the system for emission control in Lithuania".

19. Vilniaus Universiteto Ekologijos institutas, LIETUVOS CORINE ŽEMĖS DANGA-2000, 2004.

20. Valstybinė miškotvarkos tarnyba, Lietuvos miškų ūkio statistika. 2012.